Involving radiographers in mammography image interpretation and reporting in symptomatic breast clinics: a realist evaluation.

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Abstract

Breast cancer is most often diagnosed using x-ray imaging (mammography). Images are traditionally interpreted and reported by medically qualified practitioners, ‘radiologists’; due to radiologist workforce shortages in recent years, the non-medical practitioners producing the images, radiographers, have become involved in their interpretation. This study used realist evaluation (RE) methodology and qualitative research methods to explore the change.

The aims of the study were to explain how and why mammography image interpretation and reporting (MIIR) could be transferred from radiologists to radiographers and identify what the consequences of this might be for patients, practitioners and service providers.

In Stage 1 of the study literature was reviewed to generate a series of ‘programme theories’ that hypothesised how responsibility for MIIR might be transferred from radiologists to radiographers, how radiographers could acquire the necessary knowledge and skills and how real-life situated factors might influence their practice.

Stage 2 of the study field-tested these theories and demonstrated that:

- involving radiographers in double reporting roles could improve diagnostic accuracy but required additional resource, did not always streamline the diagnostic journey and did not address local radiologist shortages;
- task substitution of trained and experienced radiographers could release radiologists for other duties in symptomatic clinics;
- role substitution of radiographers for radiologists might enable services to maintain and / or increase symptomatic service provision.

Stage 3 of the study re-tested and refined programme theories about ‘role substitution’. In addition to confirming that radiographers could achieve the expertise necessary to replace radiologists in diagnostic breast clinics, Stage 3 identified that:

- developing expertise required both the development of competence across a wide range of cases and the development of confident decision making;
- the multidisciplinary team operated as a ‘community of practice’ and provided radiographers with a social learning environment within which they improved their MIIR performance and gained acceptance as radiologist substitutes.

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AdvP	Advanced Practitioner
ARP	Assistant Radiographic Practitioner
BASO	British Association of Surgical Oncology
CC	Cranio-Caudal: routine mammography projection
CDR	Cancer Detection Rate
CLR	Clinical Lead Radiologist
CMO	Context, Mechanism, Outcome
CoP	Community of Practice
CP	Consultant Practitioner
CPD	Continuing Professional Development
CR	Consultant Radiographer
CRS	Cancer Reform Strategy
CT	Computed tomography
DCIS	Ductal Carcinoma In Situ
DGH	District General Hospital
DH	Department of Health
FNAC	Fine Needle Aspiration Cytology
GMC	General Medical Council
GP	General Practitioner
HSCIS	Health and Social Care Information Service
IPT	Initial Programme Theory
M1-M5	Mammographic scale of suspicion for cancer
MDT	Multidisciplinary Team
MIIR	Mammography Image Interpretation and Reporting
MLO	Medio-Lateral Oblique - routine mammography projection
MRI	Magnetic Resonance Imaging
NCB	Needle Core Biopsy
NCIN	National Cancer Information Centre
NHS	National Health Service
NHSBSP	NHS Breast Screening Programme
NHSCSP	NHS Cancer Screening Programmes
NICE	National Institute for Clinical Excellence
P1-P5	Clinical examination scale for suspicion for cancer
PCE	Preliminary Clinical Evaluation
PERFORMS	PERsonal perFORmance in Mammographic Screening
PET	Positron Emission Tomography
PgC	Postgraduate Certificate
PIS	Participant Information Sheet
QA	Quality Assurance
R1-R5	Overall radiology scale of suspicion for cancer
RCR	Royal College of Radiologists
RCRBG	Royal College of Radiologists Breast Group
RE	Realist Evaluation
RNI	Radionuclide Imaging
SCoR	Society and College of Radiographers
SoR	Society of Radiographers
VAB	Vacuum Assisted Biopsy

Chapter 1 Introduction

The research presented in this thesis explored the changing role of one professional group of non-medical healthcare practitioners, radiographers, in a specific area of practice – the interpretation and reporting of mammograms (breast radiographs) in National Health Service (NHS) breast clinics.

The study was triggered by anecdotal evidence that radiographers were extending their professional boundaries to encompass symptomatic mammography image interpretation and reporting (MIIR), work traditionally in the remit of the medically qualified radiologist, a desire to investigate how and why the roles and responsibilities of radiographers involved in symptomatic MIIR varied between organisations and between individual practitioners, and a curiosity to explore the impact of change and variation in practice for patients, practitioners and organisations.

The research was undertaken using the RE methodology first described by Pawson and Tilley (1997). Involving radiographers in symptomatic mammography image interpretation and reporting (MIIR) was conceptualised as a ‘complex intervention’, a ‘programme’ that brought about change in the inter-professional division of labour and working practices of radiographers and radiologists. RE philosophy conjectures that interventions only ‘work’ because people make them work - the aim of this study being to establish ‘what works, in what circumstances and for whom, to what effect?’

Chapter 2 of the thesis sets the scene for the investigation and critically evaluates the ‘big picture’ within which radiographers might engage in symptomatic MIIR. This chapter provides the reader with an understanding of breast cancer as a disease and outlines both its clinical and financial significance to the United Kingdom (UK) national health economy. The chapter charts the history of NHS breast cancer screening and diagnostic services in the UK critically reviewing the role of mammography in detection and diagnosis. The concepts of diagnostic test accuracy, the paired measures of sensitivity and specificity, are explained to the reader highlighting the cognitive complexity of diagnostic decision making and the situated nature of mammography as a component of ‘triple assessment’ - a combined clinical, imaging and pathology approach to diagnosis. It is in Chapter 2 that the evolution of the interdependent professions of radiology and radiography is charted and the reader guided through the arguments used by each profession to contest and negotiate legitimate ownership of image interpretation and reporting. This chapter apprises the reader of medical workforce capacity problems in breast imaging in the face of increasing demand for the service. The chapter concludes with the argument that the involvement of radiographers in MIIR in symptomatic breast services has emerged as a solution to these problems. It is argued that little is known about this area of professional practice - how and why this change in professional boundaries works in practice and what impact its has on services, professionals and patients. This chapter makes the case for an explorative evaluation.

The RE research methodology and study design employed are explained and justified in Chapter 3. The use of RE for this project was innovative and unique because it was used to evaluate how a 'programme of change' had evolved sporadically across a range of services, in this sense the evaluation was retrospective. More typically the method is used to evaluate a specific planned 'policy' level intervention which is designed and implemented prospectively. The reader is introduced to the theory driven nature of RE and its 'context, mechanism, outcome' (CMO) framework. This section of the thesis explains the complexity of the research problem, why RE is a suitable approach for capturing and making sense of this complexity. This chapter provides an overarching description of the three-stage research design used to build, test and refine 'programme' theories that explained how radiographers were involved in symptomatic MIIR in the real world and what the consequences of this were. Chapter 3 includes critical appraisal of the researcher's choice of qualitative data collection and analysis approaches to develop her own skill and understanding, and that of her professional discipline, whilst also addressing suitability for the exploratory remit of the study. Further operational detail about data collection and analysis is provided at the beginning of the subsequent 'results' chapters.

Stage 1 of the evaluation, articulation of the 'initial programme theory' (IPT), is presented in Chapter 4. The IPT was an attempt to identify how the programme of intervention 'might' work, identify the main influencing factor and express potential 'causal' relationships, study hypotheses, as 'context, mechanism, outcome' configurations. Chapter 4 incorporates the literature review of the thesis. In the study image interpretation and reporting was conceptualised as a decision making process which involved diagnostic reasoning, differential diagnosis and communication. It is in Chapter 4 that existing literature about radiographer involvement in mammography image interpretation was synthesised with the wider body of knowledge and substantive cognitive learning theory about image interpretation, diagnostic reasoning and clinical decision making. The subject-specific literature was biased by studies of radiographers 'reading' mammograms in population screening programmes, none of this involved radiographers making a differential diagnosis and writing an examination report - integral components of symptomatic MIIR. The IPT thus incorporated the professional conjecture of the researcher to hypothesise how findings from radiographer screen ‘reading’ studies might translate into the symptomatic clinical setting. Chapter 4 details critical arguments that underpin three families of programme theories - theories that explain how roles and responsibilities (professional boundaries) change, how knowledge and skill in symptomatic MIIR is acquired and how performing MIIR within a multidisciplinary care environment influences performance.

The first phase of empirical fieldwork undertaken in the study, testing the programme theories articulated in Stage 1, is presented in Chapter 5. The reader is first offered a detailed description and critique of data collection and analysis methods used. It was in Stage 2 of the study that programme stakeholders, radiographers and radiologists, described their real-life professional roles and working practices, the inter-professional working relationships which existed between the radiographers and radiologists and the way that the radiographers functioned within local multidisciplinary breast care teams. Chapter 5 critically examines the choice of eight NHS sites and the inclusion of total populations of radiographers involved in symptomatic MIIR and the single ‘lead’ radiologist at each site. The theoretical and practical use of an unstructured interview technique is justified and the approach to data analysis, comparing the real-life experiences of practitioners to the hypothesised programme theories, is critically reviewed. The Stage 2 results presented in Chapter 5 use a ‘case study’ approach. Initially the programme theories about radiographers sharing responsibility for symptomatic MIIR with radiologists in ‘double reporting’ roles were developed in a ‘commenting system’ case study and a ‘delayed second reading’ case study. Following this, composite case studies were used to develop the programme theories which explained the ‘influence of screen reading’ expertise and the evolution of a ‘new type of worker’. It was in the results section of Chapter 5 that new insights were identified. The concepts of professional specialisation in a clinical (breast) as opposed to a technical (imaging technique) domain and collaborative decision making with collective accountability emerged from the new empirical data. Chapter 5 concludes with a preliminary discussion of the interim findings of the project. In this section the IPT was revisited and programme theory revised. Evidence gaps about expertise, team working and role innovation were identified for further exploration.

The second phase of empirical fieldwork is presented in Chapter 6. A detailed description and critique of research methods used to test evolving programme theory explains how the real-life working practices of a theoretical sample of radiographers were observed as they interpreted and reported mammographic images in symptomatic clinics and participated in clinical case discussions at multidisciplinary team (MDT) meetings, in an attempt to explicate the nuances of theory in practice. Chapter 6 critically evaluates the ‘realist’ teacher-learner interview technique used to follow up the observations, explaining how these were used to check if radiographers agreed with the researcher’s ideas and explanations and build a mutual understanding of programme theory through researcher-participant dyad engagement in shared dialogue. Chapter 6 presents the results of Stage 3 in three sections which explored the development of expertise in symptomatic MIIR as both a cognitive and a social learning journey, the operation of the MDT as a ‘community of practice’ (CoP) within which radiographer competence and confidence improve, and the creation of a new innovative role that is ‘more than a radiographer, not quite a radiologist’.

Throughout the thesis the study findings are discussed as they are presented, the final chapter of the thesis summarising the main findings and tracking the iterative cycle of articulation, testing and revision of the programme theories to bring the analysis together thematically. It is in Chapter 7 that the final versions of the programme theories are presented demonstrating the pattern ‘regularities’ which explain the causal powers of formal cognitive learning, clinical specialisation and social interaction for successful involvement of radiographers in symptomatic MIIR. Comparison of sites operating under different conditions and with practitioners of different experience helped to identify the broad outcome footprint of the intervention - many of these aspects of programme theory remain untested, suggestions for how this project might be extended to evaluate these are outlined.

The thesis concludes by claiming that the findings address specific knowledge gaps about radiographer involvement in interpretation and reporting of symptomatic mammograms, radiographer decision making and radiographer involvement in multidisciplinary teams. It is claimed that the study also adds new dimensions to the existing bodies of knowledge about radiographer role extension, mammography image interpretation and realist evaluation. Recommendations for practice, policy and further research are suggested.

Chapter 2 Breast cancer and diagnosis

2.1 Introduction

The aim of this chapter is to ‘set the scene’ and familiarise the reader with the main issues and complexity of the evaluation. After first explaining the nature of breast cancer as a disease and its clinical and financial significance to the UK health economy, the chapter critically reviews the way in which people with breast cancer present to NHS screening and diagnostic services. To give the reader an understanding of the cognitive complexity of the image interpretation process the role of mammography and its situated nature within ‘triple assessment’ are explained and the concepts of diagnostic test accuracy, sensitivity and specificity are illustrated. The sociology of the interdependent professions of radiology and radiography is presented as a critical review of the historic arguments used to contest and negotiate legitimate ownership of the image interpretation task. The chapter includes critical appraisal of the nature of the radiology workforce shortage in the face of increasing demand for breast imaging services and makes the case for exploring how and why radiographer involvement in mammography image interpretation in symptomatic service might be a potential solution, and what the impact of this might be.

2.2 Breast cancer prevalence and cost

Breast cancer is a significant public health problem. Breast cancer is the most common type of cancer in the UK accounting for 15% of new cancer cases recorded in 2011, the last year for which statistics are publically available (Cancer Research UK, 2014). In 2011 in the UK there were 49,936 new cases of breast cancer in women and 349 cases in men with 11,643 female and 73 male deaths attributed to the disease in 2012 (Cancer Research UK, 2014). Over the last 30 years breast cancer incidence has been rising mainly due to the introduction of population screening programmes and use of hormone replacement therapy, (Cancer Research UK, 2014); incidence of around 57,000 new cases per annum by the year 2024 is predicted (Cancer Research UK, 2009). Breast cancer is of clinical concern because of its potentially lethal and life-shortening nature. Breast cancer is also of politico-economic concern because costs for diagnosis and treatment of cancer in the United Kingdom NHS are estimated to be in excess of £5.7 billion annually (NCIN, 2012).

2.3 Breast cancer aetiology and manifestation

Breast cancers occur when the structure and / or function of normal breast tissue is altered because of a disease process. Breast cancers occur as a result of hereditary mutations in genes, for example BRCA1, BRCA2, TP53, PTEN, that are responsible for deoxyribonucleic acid (DNA) repair which results in failure of damaged cells to be destroyed; they occur sporadically in the continuum of normal physiological growth and repair processes and they occur as a result of new '*de novo'* genetic abnormalities (Jeruss, 2006). With the exceptions of female gender and genetic mutation, the strongest risk factor for breast cancer is age, incidence rising sharply from the age of 40 years (Clough, 2007). Other established risk factors include reproductive history, for example age at menarche and menopause, number of pregnancies, duration of breast feeding, use of oral contraceptives and / or hormone replacement therapy, lifestyle choices such as diet, exercise, alcohol intake, and radiation exposure (Clough, 2007).

The term breast cancer encompasses a spectrum of pathological abnormality ranging from *in-situ* disease that is confined to the functional glandular tissue of the breast, *invasive* disease which has breached the glandular basement membrane to infiltrate adjacent connective stromal tissue and *metastatic* disease which has spread beyond the breast to sites elsewhere in the body, the most common sites for such 'secondary' disease being the axillary (armpit) lymph nodes, the lungs, bones and the liver (Porter et al., 2004).

Approximately 10% of breast cancers are *in situ* (Cancer Research UK, 2014) being further divided into ductal, lobular or intracystic papillary types depending on the type of cells affected (Dixon, 2007). By definition these tumours are localised and lacking in ability to invade surrounding tissue or spread beyond the breast (Tot et al., 2002; Dawson, 1996). Although not in themselves lethal they are considered nevertheless to be clinically important and are treated aggressively when discovered because of their potential to progress to invasive and metastatic life-limiting disease (Heywang-Kobrunner et al., 2001). Somewhat paradoxically however, increased detection of *in situ* disease in recent years has been a cause for concern with claims of over-diagnosis and over-treatment based on the observation that most *in situ* cancers do not develop into lethal disease if left untreated (Gotzsche, 2012).

The majority of breast cancers are invasive at detection. Invasive breast cancer is classified according to its cytological features and its architectural growth pattern (Dixon, 2007). The majority of invasive cancers are 'ductal' with lobular, tubular, mucinous, medullary and ‘other’ types accounting for less than 20% of breast cancers overall (Tot et al., 2002).

Pathological change in the breast does not always result in a malignant (cancerous) tumour however. Benign breast disease is very common and is considered by some to be at the opposite end of a spectrum of proliferative (growth) change to malignancy (Enion and Dixon, 2007). Benign breast disease, although sometimes painful and the cause of local physical deformity, is not a lethal condition and is usually treated by simply reassuring affected individuals (MacMillan, 2006).

All pathological processes in the breast cause enlargement of the functional (glandular) components - the terminal duct lobular units (TDLU) - and eventually produce discrete mass lesions (Tot et al., 2002). It is this property of breast disease which underlies current approaches to detecting breast cancer. Timely detection of breast cancer, that is when it is relatively small in size, of low histological grade (a measure of the degree of abnormality of cell structure) and before it has spread beyond the breast, offers the best chance of survival (American Cancer Society, 2013). A 35% reduction in breast cancer mortality in England and Wales between 1989 and 2006 has been attributed to the combined impact of more effective treatments and better organised health services (Autier et al., 2010).

2.4 Breast cancer detection and diagnosis

2.4.1 Mammography

The most significant advance in breast cancer care in the last 50 years is the development of breast x-ray (radiographic) imaging, or mammography (Kopans, 2006). Radiographic images are generated by directing a relatively uniform beam of x-ray radiation at the body and capturing the radiation that passes through the body (Allisy-Roberts and Williams, 2008). The x-ray beam emerging from the body carries a ‘pattern’ of different radiation intensities which is dependent on the thickness and physical composition of the body structures it has passed through (Allisy-Roberts and Williams, 2008). The invisible emerging x-ray beam is captured and converted into a visible image for display either on photographic film or digital monitor (Allisy-Roberts and Williams, 2008). The different emerging radiation intensities are represented as different density (grey-scale) values in the visual image.

Breast cancer may be detected on mammograms by comparing images of the left and right breasts, comparing current images with any previously obtained (priors) and by systematically examining the images for areas of asymmetric density, areas of new density, new or enlarging masses (localised dense areas), areas of architectural (anatomical structure pattern) distortion or the presence of punctate (tiny spot) densities - microcalcification (Kopans, 2006).

Breast cancer may be detected in the asymptomatic ‘well woman’ with no abnormal clinical signs or symptoms that she has disease attending a population screening programme and in ‘symptomatic’ men and women who present via their General Practitioner (GP) to hospital out-patient services with clinical signs and symptoms of disease (MacMillan, 2006).

2.4.2 Mammography in breast cancer screening

In the United Kingdom a mammography based population screening programme, the National Health Service breast screening programme (NHSBSP), was implemented in 1988 following the recommendations of the Forrest Report (Forrest, 1986). At inception the NHSBSP invited women between the ages of 50 – 64 years to attend for single view mammography, a medio-lateral oblique (MLO) radiographic image of each breast, every three years. In an attempt to increase NHSBSP cancer detection the NHS Cancer Plan (DH, 2000b) pledged to include two views of each breast, MLO and cranio-caudal (CC) views at all prevalent (first) and interval (subsequent) attendances by 2003 and to increase the upper age limit for invitations to 70 years by 2004. Most recently the NHSBSP initiated a randomised controlled trial to screen women from 47 years or up to 73 years (Patnick, 2013). Screened women are able to continue to ‘self-refer’ to the NHSBSP once they exceed the upper age limit(s).

In a screening programme mammograms are considered either normal (negative) if they demonstrate no or unequivocally benign disease, or abnormal (positive), if they demonstrate an abnormality that might represent breast cancer. In a screening service a woman will be returned to routine interval screening recall if her mammogram is negative; a woman attending a screening programme will be recalled for further tests to obtain more information that will help to confirm or exclude cancer, when the mammogram is positive.

Women recalled with an abnormal screening mammogram attend an ‘assessment clinic’ where additional tests are performed to elucidate the nature of the abnormality using a nationally agreed protocol known as ‘triple assessment’ (RCR, 2003; Briggs et al., 2002). Depending on the nature of the abnormality further information is collected using additional imaging (additional mammographic views and / or ultrasound), visual inspection and physical palpation (clinical examination), and cell (fine needle aspiration cytology, FNAC) or tissue (histology - needle core biopsy, NCB) sampling.

To support the introduction of triple assessment the NHSBSP claimed it yielded an accurate diagnosis of cancer without resorting to surgery in up to 99% cases (Ellis et al., 2001). This claim was corroborated in the literature review of Irwig et al. (2002) and remains valid today (Wai et al., 2013). The value of considering information from different tests in isolation or in combination when making a diagnosis is illustrated by comparing their sensitivities, that is their ability to detect cancer when cancer is truly present (Table 2.1).

Table 2.1 Triple assessment sensitivity - asymptomatic screening population

	Clinical evaluation	**Imaging**	**Tissue sampling**	**Triple assessment combined**
		Mammography	FNAC	
Irwig et al. (2002) mean range	 85% 51-90%	 90% 79 – 98%	 91% 87-95%	 99.6% 98-100%
		Mammography +/- ultrasound	FNAC / NCB	
Wai et al. (2013)	92%	88%	95%	99%

In addition to increasing the accuracy of breast cancer diagnosis routine use of triple assessment was considered to be associated with speedier diagnosis, lower cost of diagnosis, reduction in unnecessary surgery and reduced patient anxiety (NICE, 2002).

In the year April 2013 – March 2014 just under 2.1 million women were screened through the NHSBSP and approximately 18,000 cancers were detected (HSCIC, 2015). Approximately 20% of cases were *in situ* disease and almost 40% of cases were classified as ‘small’ (less than 15 mm diameter) tumours – characteristics associated with a ‘good prognosis’. With the exception of unsuspected cases diagnosed post mortem, all other cases of breast cancer are detected when people with signs and symptoms that might represent underlying cancer are referred to hospital by their GP - the ’symptomatic’ route.

2.4.3 Symptomatic breast cancer clinics

The symptomatic referral route captures cancers in men, in women outside the screening programme age range, in women who fail or choose not to attend for screening, in men and women at increased genetic risk (family history screening) and in women whose cancers present between successive screening attendances (interval cancers). Although the statistical counting periods of the NHSBSP and the Office for National Statistics do not align precisely, approximately 67% of breast cancer cases i.e. approximately 34,000 cases annually, present via the GP referral route (HSCIC, 2015; Cancer Research UK, 2014).

Dedicated symptomatic breast clinics evolved following publication of the Chief Medical Officers' for England and Wales 'Calman-Hine' report 'A policy framework for commissioning cancer services' in 1995 (Expert Advisory Group on Cancer to the Chief Medical Officers of England and Wales, 1995). In an attempt to reduce national variation in the management of patients with breast cancer the most influential recommendations in this report were to establish specialist breast cancer units at District General (local) hospital level and the formation of dedicated multidisciplinary teams (MDTs) of specialists to deliver cancer care (NICE, 2002). The Department of Health (DH) responded to the recommendations of the Calman-Hine report by publishing 'Improving Outcomes' guidance (DH, 1996). This highlighted a rising number of new referrals, the need to respond to demand within tight time-scales (waiting time targets) and advances in diagnosis and treatment that would require MDTs to be well organised and well supported (NICE, 2002). The 2000 NHS Cancer Plan (DH, 2000b) contained recommendations that further improved access and waiting times for people diagnosed with / thought to have cancer (maximum urgent GP referral to specialist consultation, 2 weeks; urgent GP referral to treatment, 2 months; diagnosis to treatment, 1 month).

Updated national guidance on cancer services 'Improving Outcomes in Breast Cancer Manual Update' was published by the National Institute for Clinical Excellence in 2002 (NICE, 2002). This report recommended better alignment of screening and symptomatic breast services and provided further guidance about which patients ought to be referred urgently (within 2 weeks) and those that could be referred routinely. NICE recommended that all people suspected to have breast cancer, whether identified through screening or symptomatic referral, should receive the same standard of care and that 'triple assessment' should be available in both services at a single visit (NICE, 2002). The recommendations suggested that the staff carrying out the tests should all be in close proximity and that rapid and accurate information on diagnostic test results must be provided (NICE, 2002).

Evidence of the potential advantages of 'one-stop' (rapid-access or fast-track) symptomatic breast clinics had been first reported in the mid-1990s. A prospective audit of four one-stop clinic sessions run weekly at St Bartholomew's Hospital (London, UK) demonstrated that 48/50 (96%) patients (including four with cancer) had definitive management decisions made at a single visit (Gui et al., 1995). The mean waiting (arrival to consultation) time for patients in these clinics was 38 minutes and the mean time from diagnostic investigation to results review was 57 minutes, with the clinic transit time (attendance duration) of 72% (36) patients less than two hours.

The NICE recommendations also drew on evidence from a published audit of patient satisfaction (Berry et al., 1998) and three prospective quantitative studies of patient anxiety (Poole et al., 1999; Harcourt et al., 1998; Ubhi et al., 1996). These studies demonstrated that attending a breast clinic was distressing for patients irrespective of their final (benign / malignant) diagnosis but that the availability of an immediate result was particularly reassuring and effective at reducing anxiety for the largest group of women attending the clinics – those who have no or benign disease (NICE, 2002).

2.4.4 Mammography and triple assessment

In the symptomatic service approximately 94% of the breast cancers detected are invasive with only 6% of GP referral cases being *in situ* disease (HSCIC, 2015; Cancer Research UK, 2014). Most of the patients referred through the symptomatic route that are eventually diagnosed with breast cancer present with a breast lump however breast lumps are a common clinical problem and have a variety of underlying causes (McCowan et al., 2011; Patel et al., 2000). Patients with breast cancer also present with changes in the nipple (discharge or rash), axillary (armpit lymph node) lumps or breast ‘thickening’ (McCowan et al., 2011). Breast cancer prevalence in symptomatic populations is around 8-10% (Britton et al., 2012; Britton et al., 2009; Patel et al., 2000) and these patients have to be identified and differentiated from ‘non-cancer’ patients who present with similar symptoms, anxiety or other miscellaneous clinical complaint (Patel et al., 2000).

On arrival at a ‘symptomatic’ clinic triple assessment is initiated with a physical clinical examination performed by a surgeon or clinical nurse specialist. Following this patients are referred for imaging, mammography and/ or ultrasound scanning, using protocols based on patient age and clinical symptoms (Willett et al., 2010). Cell (FNAC) and / or histology (NCB) sampling is performed when clinical and / or imaging examinations confirm the presence of an abnormality.

In the symptomatic setting, the mammogram is not simply considered negative or positive (for malignancy) but is given a more precise estimate of the likelihood that an abnormal appearance represents cancer. In contrast to making a binary decision about a screening mammogram, individuals interpreting symptomatic mammograms are expected of assign a ‘level of suspicion’ for cancer using a 5-point categorical scale (M1-normal, M2-benign, M3-probably benign, M4-suspicious for cancer, M5-highly suspicious for cancer), (Willett et al., 2010) and make recommendations for any additional tests needed to clarify or confirm this. The value of considering information from different tests, in isolation (Table 2.2) and in combination (Table 2.3), when making a diagnosis in a symptomatic patient was illustrated by Berg et al. (2004).

Table 2.2 Isolated test sensitivity - symptomatic population (Berg et al., 2004)

	Clinical evaluation	Mammography	Ultrasound
Symptomatic population	50.3%	67.8%	83%

Table 2.3 Combined test sensitivity - clinical population (Berg et al., 2004)

	Clinical evaluation and Mammography	Mammography and Ultrasound	Clinical evaluation Mammography and Ultrasound
Symptomatic population	137/177 (77.4%)	162/177 (91.5%)	165/177 (93.2%)

The triple assessment sensitivity data illustrate that diagnostic tests are not definitive, alone or even in combination, and when used to investigate breast disease will not unequivocally determine the presence or absence of cancer.

Diagnosis of disease using radiographic imaging tests relies on both the technical properties of the imaging system – how human anatomy and pathology is represented in the radiographic image and also, arguably more importantly, on the visual and decision making processes of a human observer who must identify and recognise an abnormal appearance in the image and evaluate its clinical significance (Manning, 2010). Radiographic images are thus not ‘self-explanatory’ but meaningless greyscale patterns until viewed and analysed by an intelligent observer (Kundel and Nodine, 2010). The observer must see, recognise and interpret the information represented in the image and use it to inform decisions about patient care and treatment (Krupinski, 2010).

2.5 Radiographic image acquisition and interpretation

2.5.1 Radiographers and radiologists

In the early years following the discovery of x-rays in 1895 images used for medical diagnosis were produced and interpreted by ‘radiographers’ from a variety of occupational groups including doctors, photographers, chemists, electrical engineers and physicists (Thomas, 2005; Price, 2001). The radiographer’s role encompassed receiving requests for examinations, producing images (positioning subjects and operating x-ray machines), interpreting the findings and conveying a report to the requesting medical practitioner (Price, 2005). At the outset there was no distinct occupational boundary between the practice of medically qualified and non-medical radiographers. This changed when doctors began to establish consultant ‘radiologist’ posts specifically in the discipline and in doing so excluded non-medical radiographers from practising independently (Thomas, 2005). When doctors founded the Faculty of Radiologists (now the Royal College of Radiologists, RCR) they exerted their professional jurisdiction over their non-medically qualified ‘assistants’ by suggesting they would ‘organise and educate’ these ‘lay helpers’ and educate the public as to why such people were ‘extraordinarily dangerous’ as independent practitioners (Thomas, 2005). In 1924 the sub-ordinate fate of non-medically qualified radiographers was sealed when the Council of the newly formed Society of Radiographers (SoR) agreed that its members would not accept referrals for imaging except under the direction and supervision of qualified medical practitioners (Thomas, 2005). In addition the SoR explicitly stated that it was ‘unfitting’ conduct for their members to issue a report or make a diagnosis, although they did retain the concession that in ‘special circumstances’ in the absence of a radiologist it might be appropriate for a radiographer to describe image appearances to a referring clinician if this assisted in making a diagnosis (Thomas, 2005).

For many decades the occupational boundary between radiographers and radiologists was thus defined and remained unchallenged. In 1960 the Professions Supplementary to Medicine Act conferred independent professional status on radiographers but despite an explicit statement that ‘supplementary does not mean subordinate’ (Moodie, 1970, cited by Nixon, 2001) the ‘master-servant’ relationship did not begin to change until the early 1970s.

2.5.2 Radiographer involvement in image interpretation

As the discipline of medical imaging evolved throughout the 20th century service workloads, that is demand for and range of imaging examinations, increased faster than the clinical capacity of radiologists did (Swinburne, 1971). In addition to an increasing number of requests for x-ray imaging, technological developments such as computed tomography (CT) introduced examinations of greater complexity and that were more time consuming to interpret; the discipline also expanded to encompass diagnostic imaging techniques which used ultrasound, radioisotope (radionuclide imaging, RNI) and magnetic resonance (magnetic resonance imaging , MRI) technology (RCRBG, 2010; Swinburne, 1971). The feasibility of transferring (some) image interpretation responsibility back to radiographers was raised.

In 1971 a key protagonist for renegotiating the medical / non-medical professional boundary, Leeds radiologist Swinburne, suggested that radiographers were 'functioning below their potential', were unofficially contributing to image interpretation all over the world, and that it was time this was officially recognised (Swinburne, 1971). Swinburne pointed out how other 'technical' healthcare workers, such as those employed in cytology, haematology and cardiology laboratories were not restricted to 'knob-twiddling and button pushing' but were engaged in 'reading' test results (Swinburne, 1971). Swinburne highlighted the 'interdependency' of radiography and radiology and suggested that if 'ancient prejudices' were swept away and radiographers were 'free to use their intelligence and experience' both parties would benefit. Although not universally supported, this was a turning point for radiologists conceding some of their core work and over the next 30 years professional jurisdiction over image interpretation was renegotiated by the two professions.

In the early 1990s Saxton (1992) suggested that radiographers could be trained to interpret and report examinations such as screening mammography and fracture radiography and co-ordinated attempts were initiated to put pilot schemes into place. The pioneering work of an inter-professional group in Leeds demonstrated that training was key if radiographers were to provide a useful examination report which was indistinguishable from that of a radiologist (Culpan, 2006). Radiographer image interpretation had to be accurate and their reports had to be coherent if they were to assist clinicians and surgeons to manage patients effectively (Culpan, 2006)

Although professional boundary changes can occur by mutual agreement, where one profession actively discards or surrenders a role and it is taken up by members of another professional group, they also occur by usurpation when the change is contested or disputed (Nancarrow and Borthwick, 2005). Martin et al. (2009) note how dominant professions concede core work reluctantly and this was evident in radiologists' continued rhetorical strategies to defend their 'medical' jurisdiction. Some radiographers had local support to undertake image interpretation and reporting but dissident radiologists continued to undermine radiographers' claims to legitimacy by reinforcing the specialist nature of radiologist expertise (Martin et al., 2009). The radiologists' professional body, the RCR tried to diminish the status of a radiographer's interpretation of an image by suggesting that they were making 'clinical observations' and producing a 'descriptive' report, in contrast to performing a 'medical interpretation' and generating a 'medical' report – which they claimed could only be produced by a doctor (RCR, 1995, cited by Price, 2001). They also refuted the jurisdiction of radiographers in this area of practice by claiming radiologists retained responsibility for image interpretation and reporting because radiographers were operating in a 'delegate' capacity (RCR, 1999 cited by Culpan, 2006). Culpan (2006) suggested somewhat diplomatically that radiographers could produce a 'definitive' report – the legal record of the imaging examination, if they were able to recognise and describe 'all injuries and significant pathologies and make a judgement as to what was clinically significant'.

Capacity and demand pressures on the medical imaging workforce have continued to rise into the 21st century. Increased use of imaging investigations for diagnosis and expanded use of image-guided non / minimally invasive procedures for diagnosis and therapy (interventional radiology) have been compounded by political pressure to reduce / remove waiting lists, offer seven-day 24 hour services and realise cost-efficiencies through recruitment restrictions (RCR, 2012). In 2007 Price and Le Masurier (2007) demonstrated that radiographers were becoming involved in image interpretation and reporting across a widening range of examinations and in an increasing number of NHS Trusts.

Despite the adoption of image interpretation and reporting into the radiographer's scope of practice at operational level in 2010 the respective professional bodies were still disputing its legitimacy. In guidance to its Fellows, the RCR asserted that radiographic training did not equip radiographers with the 'knowledge and skills to offer a differential diagnosis' and that successful completion of an image reporting course was not an 'accredited medical qualification that enabled (radiographers) to interpret medical images independently' (RCR, 2010). In response the SoR issued its own 'definitive' guidance counterclaiming that 'medical image interpretation was legally and legitimately within the regulated practice of radiographers'; they cited published studies which demonstrated radiographer and radiologist reporting concordance (SoR, 2010).

The SoR reiterated the status of radiography as an independent profession and refuted the role of the RCR in determining what was or was not appropriate practice for radiographers.

In 2012, the RCR acknowledged that approximately 84% of imaging services were failing to meet image interpretation demand with their quota of radiologists and that by this time over 60% of services were addressing this by involving radiographers (RCR, 2012). The Centre for Workforce Intelligence, in an independent review of radiologist training requirements commissioned by the DH, considered that boundaries and overlaps between the medical and non-medical imaging professions needed continual review and suggested that radiographers should continue to take on more responsibility for interpreting and reporting routine imaging examinations so that radiologists could concentrate on reporting the more complex investigations (Centre for Workforce Intelligence, 2012).

2.5.3 Capacity and demand for breast imaging

The inability of the radiology profession to keep pace with increasing demand for mammography image interpretation was recognised over 40 years ago (Dowdy et al., 1970). Since this time the problem has been exacerbated by factors including development and introduction of improved and increasingly complex technology (Moran and Warren-Forward, 2011; Moran and Warren-Forward, 2010), population demographics (Moran and Warren-Forward, 2011; Wivell et al., 2003), increased compliance with screening (Sumkin et al., 2003), screening programme expansion (Wivell et al., 2003; Mucci et al., 1997; Pauli et al., 1996a) and introduction of ‘double reading’ of screening cases (Tanaka et al., 2014).

Increase in demand for breast imaging in the UK is predicted to continue for the foreseeable future (RCRBG, 2010). Particular challenges include:

- the 1960’s ‘baby boom’ generation entering NHSBSP eligibility and NHSBSP age expansion (47 – 73 years) which are expected to generate an approximate increase in workload of 40%;
- technical advances, such as tomosynthesis which increases the number of images and time required for interpretation, and contrast enhanced digital subtraction which increases examination time and requires administration of intravenous pharmaceuticals;
- expanding scope of breast radiology practice to include percutaneous excision of benign lesions (vacuum assisted biopsy - VAB);
- incorporation of family history screening (MRI examinations) into the NHSBSP.

Additional pressures to increase capacity / productivity in symptomatic services were introduced by the 2007 Cancer Reform Strategy (DH, 2007). The Cancer Reform Strategy (CRS) included all GP referral patients with breast symptoms, i.e. even those in whom cancer was not initially suspected, in the ‘two week wait’ (referral to clinic appointment) target (DH, 2007). This was in response to significant numbers (approximately one-third) of breast cancer cases presenting in the ‘non-urgent’ GP referral stream (Sauven, 2001).

The first report of performance against the CRS standards published in 2009 demonstrated 94.5% compliance with the target that all (urgent) GP referrals with suspected cancer (all types) be seen by a specialist at an out-patient appointment within 2 weeks (Richards, 2009). Richards suggested that the data demonstrated that the NHS was moving in the right direction because more patients were benefiting from timely and high quality cancer care and treatment but he acknowledged that more had to be done to ensure that delivery was sustainable (Richards, 2009). The most recent NHS performance data for England (Table 2.4) demonstrates falling target compliance (DH, 2014; DH, 2013; DH, 2012).

Table 2.4 NHS cancer waiting target compliance

Waiting time target	2012-13	2013-14	2014-15
all cancer 2-week wait (urgent GP referral)	95.4%	95.2%	93.6%
non-urgent breast referrals	95.7%	94.5%	93.5%

The annual DH reports on cancer outcomes identified two further influences on breast screening and diagnosis both of which are likely to increase future demand on breast imaging, particularly symptomatic services. Firstly, an independent review of the benefits and harms of breast screening (Marmot et al., 2013) highlighted the risk of ‘over diagnosis’ and the need for improved publicity materials so that women could make an ‘informed choice’ about attending (DH, 2012). In 2014, arguably as a result of improved informed choice publicity materials and the controversy which prompted the review (Gotzsche, 2012), the DH reported a reduction in NHSBSP coverage (attendance / invitation) rates for the last three years (DH, 2014). A potential consequence of reduced NHSBSP attendance is presentation of more cancers through symptomatic services.

The second factor that increased demand for cancer screening and diagnosis in recent years was a ‘Be Clear On Cancer’ campaign which highlighted symptoms and raised awareness of breast cancer in women over the age 70 years (DH, 2013). Local and regional pilot studies of the campaign had shown increased referral rates of 8% for urgent and 4% for non-urgent symptomatic patients (DH, 2013). Roll out of the national campaign however resulted in much larger increases - 64% for urgent and 75% for non-urgent referrals, and also increased self-referrals to the NHSBSP by a factor of 2.33, that is by over 12,000 extra attendances (DH, 2014). As intended however, the campaign increased the cancer detection rate, by 25%, in this population sub-group of women (DH, 2014). These effects are likely to persist given the UK demographic trend for growth of the over-65 age group.

A survey conducted by the RCR Breast Group in 2009/10 suggested a breast radiologist vacancy rate of approximately 15% in combined screening and symptomatic units and slightly higher (19%) in units that only provided a symptomatic service (Britton, 2011). The latest radiology workforce census figures demonstrated that ‘breast’ was one of the top three radiology specialties experiencing recruitment difficulties with 57% of posts advertised in this speciality failing to attract a candidate suitable for appointment (RCR, 2012). The RCR census data suggested that 23% of the breast radiology workforce was expected to retire within the next 5 years (RCR, 2012), the RCRBG survey estimating that this would likely increase vacancies to 22% in combined services and have a greater impact, raising vacancies to almost 30% in units providing only a symptomatic service (Britton, 2011).

On publishing its latest census figures, the RCR offered no explanation as to why ‘breast’ radiology might be a difficult speciality to recruit to, nor did they offer any ideas about how they might address their recruitment problem (RCR, 2012). The Breast Group survey conducted in 2009/10 had identified that ‘breast’ was eighth out of the 10 most popular radiology specialisms for radiology trainees, respondents suggesting that trainees considered breast radiologists to lack status and their work to be high volume, lacking in variety and at high risk of litigation (Britton, 2011). Britton (2011) suggested more interest might be generated in trainees by raising the profile of breast radiology, reducing misconceptions about the nature of the role and promoting its centrality to MDT decision making and its interventional and patient interactive nature.

2.5.3.1 Radiographer involvement in breast image interpretation

Radiographers in the UK have been involved in mammography image interpretation for over 20 years. By 1995, radiographers had a formal role in this aspect of the service in 6% (6/103) NHSBSP screening units (Wells and Cooke, 1996). A 2008 NHSBSP workforce report did not provide comparative data at ‘unit’ level but demonstrated that 205 (69.7%) of the 10 consultant and 284 (260 qualified and 24 trainee) advanced radiography practitioners working in the service were involved in image interpretation by this time (Nickerson and Sellars, 2008).

Price and Le Masurier's most recent (2004) NHS survey of longitudinal change in radiographer roles in the NHS revealed that 38/177 (22%) of their responding Trusts were involving radiographers in MIIR and in 14 (37%) of these radiographers practiced autonomously as independent practitioners (Price and Le Masurier, 2007). A postal survey of UK consultant breast radiographers published in 2014 (Rees, 2014) demonstrated that all 22 respondents (response rate 22/24; 91%) were involved in the provision of symptomatic services however no further information about the exact nature of their involvement or their mammography image interpretation and reporting practices was ascertained.

2.5.4 Multidisciplinary team working

In their guidance on improving outcomes in breast cancer NICE suggested that expert care should be available locally for all patients but recognised that how this was achieved could vary from place to place (NICE, 2002). In order that sufficient expertise was available at all times, NICE recommended that there were at least two specialists, individuals who have specialist qualifications and experience with breast cancer patients, for each role in the core breast care team and that each of these individuals should have a substantial fixed time commitment, at, least 50% of their time to breast care (NICE, 2002). At the time the radiologist was identified as a core member of the breast MDT, but radiographers were only identified as having a supporting role to 'carry out the decisions' of the core team (NICE, 2002).

Shortly after the NICE publication the RCR updated their previously published Guidance on Screening and Symptomatic Breast Imaging (RCR, 2003). Their revised guidelines concurred that symptomatic patients should be seen in multidisciplinary breast clinics where triple assessment (clinical assessment, imaging and needle cytology / histology) was available. The RCR further recommended that imaging should no longer be performed in isolation using a direct GP access route (RCR, 2003).

The most comprehensive and influential guidance on organisation of symptomatic services was published by the Association of Breast Surgery, a division of the British Association of Surgical Oncology (BASO) itself part of the Royal College of Surgeons of England, in 2005 (BASO, 2005). The BASO guidance provided a template for the reorganisation of symptomatic services in the UK. The guidelines advised that in addition to being seen within 2 weeks of receipt of an 'urgent' GP referral (rapid-access, fast-track) diagnostic processes should be organised so that patients with benign disease had all the required tests and got their results at a single clinic visit (one-stop). The BASO guidelines included a useful range of quality objectives and outcome measures against which service performance might be measured; standards relevant to mammography image interpretation are summarised in Table 2.5.

Both NICE (2002) and BASO (2005) advised that breast specialists from a range of healthcare professions should work together in ‘multidisciplinary’ teams and that clinical decision making should be democratic. The NHS Cancer Plan had outlined the introduction of a four-tier (assistant, practitioner, advanced, consultant) skills mix model to make better use of the skills of existing non-medical staff by expanding their traditional roles and placing emphasis on competency, i.e. appropriate skills and experience, rather than specific (medical / non-medical) professional background (DH, 2000b).

Although back in 2002 NICE did not identify radiographers as members of the MDT, BASO specifically identified both the specialist radiologist and radiographer as ‘diagnostic team’ members (BASO, 2005). The current Breast Cancer Service Specification (NCIN, 2012) reflects the changing landscape of professional practice in the imaging service and specifies that membership of the core MDT breast team includes two imaging specialists without referring to any specific professional group.

Table 2.5 Symptomatic imaging service standards (BASO, 2005)

	Service standard
Patient journey	• Imaging and tissue sampling performed at initial visit • <10% new patients attend more than twice for diagnostic purposes
Staff	• Appropriate initial training • Continuing competence o At least 500 cases annually o At least 2-3 sessions per week o NHSBSP experience desirable o 10 hours external study time annually o Personal & MDT audit of performance
Radiologist	• Involved in decisions about most appropriate imaging investigations
Imaging reports	• a description of the abnormality • a characterisation of the level of suspicion of cancer (R1-5) • recommendations for any further imaging or biopsy
MDT	• held weekly • record of attendance • consider clinical, radiological & pathological results of new patients

Little is currently known about the practices of radiographers involved in MIIR in symptomatic breast services. This study addresses that knowledge gap by exploring the different ways in which radiographers and radiologists share and / or transfer the mammography image interpretation and reporting workload between the professions to maintain breast diagnosis service provision in the face of increasing clinical demand and medical workforce shortages. The study also examined the evolving role of the radiographers who undertake mammography image interpretation and reporting in the breast care multidisciplinary team.

2.6 Chapter 2 summary

This chapter has set the scene for the reader by identifying and explaining the main contextual factors that might trigger the involvement of radiographers in symptomatic MIIR. In order to understand the complex nature of the mammography image interpretation task the chapter explained the nature of breast cancer and its detection. The chapter critically reviewed the historic discourse of professional boundary conflict between the radiography and radiology professions. Finally the chapter argued that despite the existence of national drivers for change in working practices, little is currently known about the implementation of change at local level. The next chapter explains the methods used in this study to try to address this gap.

Chapter 3 Research methodology

3.1 Introduction

The choices underpinning the overall design and conduct of this study are presented in this chapter. The chapter begins with a critical review of the complexity of the research problem and justification of RE methodology as a suitable approach to capture this complexity. The specific research aims and objectives of this study are identified and the overall research design is explained.

The theory-driven philosophy of the method is used to justify a three-stage design which incorporated theory articulation (Stage 1), theory testing (Stage 2) and theory refinement (Stage 3) phases. Detailed descriptions and critical arguments for choice of sampling, data collection and data analysis methods for each of the three stages are presented in the subsequent chapters alongside the respective results.

This chapter explains the ethical conduct of the study, critically reviewing the measures taken to access NHS premises, recruit practitioners and protect patients, participants, researcher and sponsoring institutions from harm.

3.2 Research problem complexity

This thesis explored the involvement of non-medical allied health professionals, radiographers in MIIR in symptomatic NHS breast clinics, a responsibility traditionally within the professional domain of medically qualified specialists, radiologists.

Involving radiographers in symptomatic MIIR was conceptualised as a programme of organisational ‘intervention’ the purpose of which was to change the working practices, that is the roles and responsibilities, of radiographers and radiologists in a specific area of NHS service provision. The project was unusual in that it evaluated actual shifts in the professional boundaries of real-life practitioners in relation to a specific challenge to their inter-professional division of labour rather than the potential for hypothetical professional boundary shifts between the two professions isolated from any particular clinical application (Martin et al, 2009).

The research problem was broad and complex and it encompassed concepts at macro (organisational / strategic), meso (day to day / clinic / team) and micro (individual) levels. The study sought to explore and explain what factors affected how services were organised so that radiographers could undertake some or all of the symptomatic

MIIR work of their radiology colleagues, what factors affected the participation and practices of radiographers in such roles, what the consequences of this were and what conditions were critical for this intervention to be successful.

The previous chapter, outlining the background to the study, illustrated some of the complexity of the thesis. For example, programmes of professional task and role shift involve multiple individual and groups of stakeholders and each has different ambitions about what such programmes are intended to achieve; individual organisations have their own professional cultures and a local history of how the division of labour has evolved, through co-operation and / or conflict over the years. At the outset it was thus envisaged that the ideas driving (and constraining) radiographer involvement interventions would be multitudinous, that the intervention would trigger change in myriad ways and that there was infinite variation in landscapes within which the intervention could be implemented (Pawson, 2013). The VICTORE checklist offered by Pawson (2013) was a useful starting point for mapping out *a priori* factors that contributed to the complexity of the programme of interventions under evaluation – see Table 3.1.

Table 3.1 Mapping programme complexity

Complex feature VICTORE	**Definition**	**Examples of complexity in programme under evaluation**
Volitions of programme subjects	Choice architecture – what choices do subjects have to make to achieve the programme's ambitions? How are enthusiasts accommodated / harnessed? How are detractors persuaded to reconsider?	Variation in response of individuals - service managers, radiologists, radiographers, surgeons, for example Different personal circumstances / motivation Organisational and professional power hierarchies
Implementation chain	Process of change is implemented over time – months, years; inconsistencies are introduced	Fluctuations in (radiologist) capacity and (service) demand over time - radiologist availability / vacancies; clinic workloads & waiting lists Variation introduced in response to incoming / leaving personnel (radiographers / radiologists) and new places (expansion / merging of clinics / sites)
Contexts	Prevailing circumstances – multi-layered (onion skin) Individuals' characteristics and capabilities Interpersonal relationships that carry the programme Institutional rules, norms and customs Infrastructure – wider social, economic and cultural setting	Variations in radiographer & radiologist skill, competence, training & experience (MIIR expertise) Radiographer / radiologist (inter-professional) working relationships – collaboration or competition; support / opposition Management / organisational support; team culture within multidisciplinary breast care service Government / DH / NHS policy; legal & statutory (professional body) regulation; professional guidelines, evidence base

Contd.

Table 3.1 contd.

Complex feature VICTORE	**Definition**	**Examples of complexity in programme under evaluation**
Time	Where the intervention is in its history of implementation - previous efforts, experiences; Showcasing effect Disillusion	Are the practitioners pioneers or involved in established precedents; is the programme new or an existing model Are subjects enthusiastic volunteers for a new pilot / opportunity? Are subjects cynical and reluctant to repeat failed prior attempts?
Outcomes	Different viewpoints / priorities about monitoring systems and measuring effectiveness	Different ways of defining 'success', for example: diagnostic accuracy (cancer detection; benign disease differentiation); interpretation and reporting speed (patient waiting / transit times through clinic); appropriate use of additional tests (specialist mammograms, ultrasound examinations, tissue sampling), service capacity (access to one-stop clinic / waiting lists); patient satisfaction; service cost.
Rivalry	Pre-existing policy landscape Contiguous policies / programmes with shared / opposing ambitions	How national NHS / SoR / RCR strategies support / constrain the programme, for example: NHS cost efficiencies; NHS 24 hour 7 day working; DH cancer waiting time targets; RCR lobbying DH for more breast radiologists; SoR career development policy for radiographers.
Emergence	Emergent effects – long term adaptations, societal changes, unintended consequences Consequences of spreading / duplicating - is there a 'natural' limit? Balance of recruitment / retention / attrition	Ways in which the programme has changed to accommodate different practitioners (radiographers and radiologists) coming into or leaving departments; Ways in which incumbents have modified the programme to adapt to changes / effects that were not anticipated at the outset.

3.3 Realist evaluation

This study was undertaken using RE methodology because the diverse nature of the research problem required a methodology capable of dealing with complexity. The explanatory nature of the research also required a methodology that would provide an understanding of how involving radiographers in symptomatic MIIR was supposed to work, what factors might contribute to or might hinder its success and what the intended and unintended consequences might be.

RE was originally conceived for evaluating social interventions, programmes of change for social betterment that involve righting wrongs, correcting deficient behaviours or alleviating inequality (Pawson and Tilley, 2009).

In this study involving radiographers in symptomatic MIIR was conceptualised as a family of ‘interventions’, a programme of change, aimed at healthcare betterment. It was hypothesised it had the potential to solve clinical and logistic problems by meeting increasing demand for accurate and timely breast cancer diagnosis in the face of medical workforce shortages, correct potential deficiencies in radiographer decision making to ensure that their diagnostic reasoning was similar to that of radiologists, and alleviate patient inequality by providing timely and cost-effective access to breast diagnosis.

RE provides a theory driven deductive approach for understanding the mechanisms by which, and the contexts in which a programme works or does not work (Cheyne et al., 2013). Although programmes introduce ideas and opportunities for change, the social context within which a programme is implemented shapes the way individuals interpret and act on these ideas and opportunities such that programmes do not work in exactly the same way in different settings (Cheyne et al. 2013). In this study RE was used to explore and explain the ways in which radiographers were involved in symptomatic MIIR in different ways in different NHS Trusts, and how some but not all practitioners were involved, as individuals and as groups, within and across Trusts.

In contrast to many previous RE studies, the programme evaluated in this study was not a planned and co-ordinated intervention. There was no specific national policy, or otherwise co-ordinated programme for involving radiographers in symptomatic MIIR. The interventions evaluated in this study had been implemented sporadically and unilaterally by individual NHS Trusts in response to local service and workforce pressures. The initial stimulus for the evaluation was to understand and explain why patients encountered different services in different NHS hospitals and what effect this might have on their care.

3.4 Research design

The epistemological basis for RE is critical realism. The critical realist approach holds that it is only possible to understand events and discourses by identifying the structures that work to generate them, rather than observing and measuring relationships between variables (Pawson, 2013). In contrast to existing positivist quantitative research which considered isolated measurements of radiographer involvement outcomes, such as diagnostic accuracy and decision speed for example, and compared them to those of radiologists, RE offered the opportunity to ask multi-faceted research questions to clarify why and how radiographers might make accurate and timely decisions, what factors influenced their ability to do this to a similar standard as radiologists, and what effect their performance had on service provision.

Realism is differentiated from pure interpretivist epistemology which places emphasis on understanding human behaviour as it is 'lived and experienced' without concern for influencing external forces (Bryman, 2008; Cresswell, 1998). This study recognised that in the real world, radiographers (and radiologists) do not interpret and report mammograms in isolation, but are influenced by multiple extraneous factors. These factors cannot be considered in a contrived closed experimental system neutralised of external forces. As a general evaluation strategy RE adopts the experimental model of 'partial closure' where real life practice is observed to help identify and explain what is happening, rather than measure a hypothesised relationship between variables.

This study had three phases. In the first phase (Stage 1) potential 'uniformities', hypothetical causal relationships, were suggested and articulated as 'initial programme theories' (Pawson, 2013). In the second phase (Stage 2) 'partial and imperfect' regularities, that is real-life manifestations of relationships between variables, were observed in the field (Pawson, 2013). In a final phase (Stage 3) programme theories were re-explained and subject to further observational scrutiny in an iterative cycle of additional data collection (Pawson, 2013). Interpretation of the findings at each stage was underpinned by the evolving programme theory (Rossi et al., 2004).

Research disciplines encompass traditions of data collection and analysis (Silverman, 2013; Cresswell, 1998). Pawson (1996) argued that the complex research questions addressed in RE require a synthesis of quantitative and qualitative data collection and analysis strategies. For the purposes of researcher development, this study focussed on qualitative data collection and analysis methods.

Qualitative data collection and analysis are traditional in social enquiry (Holloway and Wheeler, 2002) and use visual and verbal methods (Long and Godfrey, 2004) to examine and explore behaviour (actions) and cognitive (thinking) processes (Aitken et al., 2009) or uncover new insight to help understand and explain behaviour (Skjørshammer, 2002). In this study a qualitative approach was adopted to explore organisational, cognitive and social aspects of the diagnostic reasoning and decision making behaviours and practices of radiographers involved in symptomatic MIIR. Although the methods were carefully planned, expressed and approved in a formal protocol, the design was flexible enough to allow response to the research context as the study progressed to ensure it remained relevant and productive (Maxwell, 2012).

Quantitative methods would have been appropriate where the phenomenon of interest were numerically measureable, for example if the study had been a specific evaluation of programme outcomes such as service cost, radiographer accuracy, patient waiting times or cancer mortality.

Stage 1, initial programme theory elicitation and articulation, incorporated review of the literature to identify possible causal relationships between variables. In RE programme theories are expressed in terms of context (C), mechanism (M) and outcome (O) configurations: programmes work (outcomes) because of the action of underlying mechanisms, resources which affect human reasoning, and which only come into operation in particular contexts, individual or environmental circumstances or conditions.

In Stage 2 evidence about how the programme theories manifested in the ‘real world’ was collected using interviews with a range of different programme stakeholders - radiologists and radiographers in NHS Trusts across England.

In Stage 3 emerging theory was validated and further refined with participants using non-participant observation and post-observation interviews to collect additional data about real-life events where radiographers were substituting for radiologists

This thesis exhibits the three characteristic features of realist evaluation:

- it has an explanatory focus – a theory driven approach was adopted to find and refine explanations of programme effectiveness;

- it used multiple data media – literature review, unstructured interview data, non-participant observation and semi structured ‘teacher-learner’ interview data;
- it investigated contexts, mechanisms and outcomes in configurations adhering throughout to the concept of causal and conditional relationships; the thesis suggested, developed, refined and tested hypotheses that consequences of involving radiographers in symptomatic MIIR (outcomes) occurred because of the action of some underlying resource which affected radiographer reasoning and decision making (mechanism) which came into operation in a particular circumstance or condition (context).

RE was an original and appropriate choice for this study because of its explanatory nature and its broad perspective (Pawson and Tilley, 1997).

Identification of generative mechanisms of ‘what works, for whom and in what circumstances’ (Pawson and Tilley, 2009) offered the potential for manipulation of radiographer involvement in symptomatic MIIR to maximise potential benefits and limit undesirable consequences at micro (individual), meso (service) and macro (national policy) levels.

3.5 Research aim and objectives

The overall aim of this research project was to explore and explain variation in how radiographers involved in symptomatic mammography image interpretation contributed to clinical decision making in UK diagnostic breast services.

The subsidiary aims of this project were to:

- articulate a programme theory which described potential causal relationships that would explain how different local circumstances and practitioner characteristics give rise to different decision making practices and how these give rise to different service, practitioner and patient outcomes;
- develop the programme theory in consultation with a sample of stakeholder radiologist and radiographer practitioners;
- test specific candidate programme theories empirically;
- refine the programme theory and make recommendations for service provision and / or further research, as appropriate.

The objectives of this research were to:

- identify potential (realist evaluation) context, mechanism, outcome (CMO) configurations underpinned by existing knowledge of decision making theory and radiographer mammography image interpretation literature and express these as an initial programme theory (Stage 1);.
- develop the programme theory by collecting and analysing new original data from medical and non-medical practitioners at a cross-section of sites where radiographers are involved in symptomatic MIIR in different ways (Stage 2);
- test a selection of specific programme theories arising from Stage 2 by collecting and analysing original primary data using observation of practice and post observation interviews with radiographers undertaking symptomatic MIIR at one or two case study sites (Stage 3);.
- refine the programme theory and disseminate findings through presentation and publication to a variety of stakeholder (organisational, professional, public) audiences.

3.6 Ethical considerations

Research studies are regulated to safeguard individuals who participate, researchers who conduct them and the institutions sponsoring and funding them (Hope et al., 2008).

Access to healthcare professionals on NHS premises and observation of their practice in the naturalistic setting of real-life NHS clinics posed multiple ethical difficulties (Cresswell, 1998). The presence of the researcher in the clinical environment required careful planning to avoid intrusion (Coombs and Ersser, 2004), uphold the ethical rights of patients (Aitken et al., 2009) and avoid obstructing normal clinical practice (Aitken et al., 2009).

The study was conducted in accordance with University of Leeds research ethics and safeguarding data policies; the main ethical considerations are explained below.

3.6.1 Ethical and R&D approval

The Health Research Authority confirmed that University ethical approval was appropriate for this study because participants were NHS staff and any patients who might be present during practitioner observations were not themselves study participants (personal communication, 21.7.14). Ethical approval was granted by the University of Leeds School of Healthcare Research Ethics Committee (SHREC) on 10th

October 2013 (Stage 2, reference: SHREC/RP/350) and 1st September 2014 (Stage 3, reference: SHREC/RP/453).

Research and Development permission to approach NHS staff and collect data on NHS premises was obtained at each NHS Trust site from which participants were recruited. R&D approvals and letters of access were obtained through the Integrated Research Application System (references R137544 & R161814) using the ‘research passport’ system and the Clinical Research Network portfolio register (references 15552 & 17702).

3.6.2 Informed consent

The autonomy of individuals to participate or decline to participate in research is respected in the principle of informed consent. A potential participant must be fully informed, competent and not coerced for consent to be valid (Hope et al., 2008). All radiographer and radiologist participants were volunteers who gave informed written consent.

After first contacting the researcher, potential participants had two to four weeks to decide if they wanted to participate in the study. In accordance with ethical approval they were only contacted on one further occasion to confirm whether they wished to participate or not. To avoid wasted resource, consent was obtained prior to arranging site visits such that site visits were not arranged until at least one consent form had been returned to the researcher. Consent was re-affirmed just prior to each interview and observation. Participants were able to withdraw from the study at any time before the interviews / observations, during the interviews / observations and were able to withdraw their data up to two weeks after their last interview / observation had taken place. The Participant Information Sheet explained that after this concurrent / iterative data analysis would have commenced making it impossible to identify and exclude individual participant contributions.

In accordance with guidance received from the Health Research Authority (email 21.7.14) patients were not required to give informed written consent to observation of the staff providing their healthcare. To avoid violating the patients’ privacy (Bryman, 2008) participating radiographers verbally informed patients of the researcher’s presence and purpose and gave the patient the opportunity to exclude the researcher from their examination without having to give a reason. Written notices to this effect were also displayed in the imaging department reception and / or clinic waiting areas.

MDT meeting participants were not required to consent to the researcher’s presence to observe radiographer participation but again as a courtesy, the researcher was introduced and her presence and purpose explained at the start of each MDT meeting attended.

3.6.3 Anonymity

Anonymity protects the identity of research participants and safeguards against personal and sensitive information coming into the public domain (Bryman, 2008). To protect the identity of radiographer and radiologist participants they were allocated an anonymous study specific identification number & code corresponding to their site / profession. This allowed participant identities to be concealed in observation field-notes, interview transcripts and research dissemination.

It was difficult to maintain participant anonymity in the research report because potentially identifiable information about participant characteristics (grade and or training status) was needed to make sense of their contributions. Participants were forewarned that low participant numbers made it difficult to guarantee that individual participants / participating sites would not be inadvertently identifiable in research reports and dissemination to others that had taken part.

It was acknowledged in the Stage 3 ethical approval application that the researcher would need to record general observations about patients and other members of staff in respect of observed participant radiographers' decision making behaviour but this was restricted to information that would not identify individual patients or members of staff who were not study participants. Participants were asked not to make reference to identifiable staff or patient details in their interviews; inadvertent disclosures were redacted from transcripts.

3.6.4 Confidentiality and data protection

Research in a medical environment exposes the researcher to personal information which is held under the Data Protection Act, 1998 and should not be disclosed to unauthorised persons (Hope et al., 2008).

Whilst observing the practice of radiographers in the clinic and during MDT clinical meetings the researcher had direct and indirect contact with other members of staff, with patients and with confidential and patient identifiable information (hospital records). No staff or patient identifiable data was recorded in field-notes and the researcher at all times observed staff and patient confidentiality.

In accordance with the University of Leeds safeguarding data policy all identifiable participant information and electronic data (interview transcripts) were stored electronically on secure (University of Leeds password protected) servers (student M drive); original paper consent forms were shredded. Digital audio recordings of interviews were transferred daily to an encrypted laptop and uploaded to the secure University server at the end of each site visit. Paper documents (e.g. anonymised observation field-notes) were stored securely in locked filing cabinets on University premises and at the researcher's home. All data was scheduled to be deleted from the researcher's University 'M' drive 3 years after PhD thesis submission and from back up servers within 18 months of this date.

3.6.5 Disclosure

Breaches of confidentiality represent research misconduct as information contributed by participants should not normally be passed to third parties (Hope et al., 2008). During the course of research however, information sometimes comes to light which places people (participants or others) at risk and researchers may have a legal or professional duty to disclose this to someone else (Webster et al., 2014).

The risk of disclosure in this study was considered low. Practice observations and interviews covered the professional practices of existing NHS employee radiographers and were unlikely to involve personally sensitive / distressing material. In the unlikely event that potential professional misconduct / bad practice / criminal behaviour was observed or described, provision had been made to discuss this with research supervisors to consider if information should be passed on to the participant's employer or professional registration body. Participants were to be notified of any action taken. No disclosures occurred during the study.

The researcher shadowed the radiographer participants at all times and was never left alone with the patient precluding any direct patient disclosure.

3.6.6 Risk of harm

Despite the potential value of any research, one of the guiding principles of ethical research conduct is to minimise the risk of harm to participants (Hope et al., 2008). University research sponsors also have an obligation to ensure the safety of their researcher employees.

No significant harm arising from conducting or participating in the research was foreseen for participants, other NHS staff, patients or researcher. The researcher undertook Good Clinical Practice training and obtained Disclosure and Barring Service clearance prior to commencement of field work. Data collection events were arranged to avoid adverse impact on patient care.

Researcher risks during offsite field work were also low because observation and interview data collection took place on NHS premises during normal working hours (8am – 6pm). Researcher risk was managed within the University's 'low risk' fieldwork assessment process with daily contact (email) with supervisors and / or family members whilst off-site.

3.7 Study quality and rigour

Rigour in qualitative research is underpinned by credibility, transferability, dependability and confirmability (Bryman, 2008) and by trustworthiness and authenticity (Maxwell, 2012). This section of the thesis explains the way in which each of these criteria was addressed in this study highlighting the subtle nuances of the realist perspective for qualitative methods.

Credibility, also sometimes referred to as plausibility or validity, is a measure of the extent to which the phenomena under study have been accurately reflected, as perceived by the study population (Lewis et al., 2014). First order credibility and confirmability, what Maxwell (2012) calls descriptive validity in the realist paradigm, were reinforced in this thesis by illustrating study findings with representative quotations from participant interviews and direct examples from field-note observations. The RE methodology builds in 'second order' credibility and confirmability, what Maxwell (2012) calls interpretive validity, because evaluation findings are continuously re-presented to participants (Skjørshammer, 2001) in an iterative cycle of recursive theory testing - this was most explicit in the 'teacher-learner' interview approach adopted in Stage 3 of this study.

Throughout the study credibility was enhanced further by transparent and critical examination of the empirical findings against established substantive theories and existing and further potential evidence to identify plausible alternative explanations (Platt, 1964 cited by Maxwell, 2012). Evidence for and against the arguments claimed, the causal relationships expressed as programme theories, were interwoven throughout the presentation and discussion of study findings. Fair representation of different realities, making comparisons and contrasts between different sites and different practitioners, enhances the authenticity of the study (Lincoln and Guba, 1985).

Trustworthiness can be underpinned by prolonged engagement in the setting. In this study engagement in the field was maximised by using multiple sites (Stage 2) and maximum populations of participants (Stages 2 and 3). The period of engagement was shorter in Stage 3 but justified on the basis that the study was in-depth and cross-sectional rather than a longitudinal evaluation of ‘change’ over time. Trustworthiness was enhanced also by subjecting the study findings to researcher peer review. Regular verbal discussion and critical feedback on written drafts of the thesis were used to enrich the description and analysis of the study data. A clear audit trail is evident in the study report with annotations tracing cited raw data to original transcripts and field-note entries, and signposting study themes across successive chapters.

Dependability is a similar concept to reliability and replicability (Lewis et al., 2014): would another study undertaken using the same methods generate the same results? The influence of the researcher on the data collected and how it is analysed is a recognised threat to both credibility (validity) and dependability in qualitative methods (Holloway and Wheeler, 2002).

At the outset the researcher had limited experience of qualitative data collection and analysis. This was addressed using a combination of formal external training courses, interview simulation and feedback, and discussion and revision of transcript coding and data analysis with supervisors. Collaboration between multiple researchers during qualitative data analysis in this way helps to improve the trustworthiness of the study.

Reactance, the influence of observation processes on observed practice was a threat to credibility (internal validity), (Wallace, 2005) but ‘observer effects’ were also a valuable source of data that triggered discussion (Monahan and Fisher, 2010). Although some of the participants were known to the researcher, independence from the study sites helped to maintain rigour. ‘Hawthorne’ effects, that is alteration of natural behaviour due to being studied (Bowling, 2002), were observed during Stage 3 data collection at Site 3. Whilst observing one participant preparing for the MDT meeting, another was observed to undertake MIIR in a different location to that she had used when she was being observed; another explained she would ‘normally’ wear headphones and listen to music to help her concentrate, but was not doing that today because she was being observed for the study. Post-observation interviews allowed these observations and other discrepancies in observed and recounted behaviour to be challenged and explored.

In realist evaluation, understanding starts with the researcher’s own fallible constructions as opposed to any ‘objective’ perception or interpretation of actual phenomena (Maxwell, 2012). Researcher preconceptions and provisional knowledge were integral to the programme theories developed and explored in this study.

The study has interpretive validity (Maxwell, 2012) because there was a conscious effort to capture and represent participant meaning and understanding (emic perspective) and transform the researcher’s (etic) understanding. Empowering participants and helping them to develop ‘more sophisticated’ understandings of the concepts being explored enhances the authenticity of the study (Lincoln and Guba, 1985).

Theoretical validity is the extent to which they study findings have explanatory power as a theory (Maxwell, 2012). Theoretical validity concerns both constructs, the validity of concepts and categories, and causation, the validity of the CMO relationships. The study has theoretical validity because the findings represent the consensus understanding of the community involved in the study – this thesis presents a combined evaluation generated by study participants, the researcher and the research supervisors.

Transferability – or empirical generalisation, is the concept that study findings might be applied to populations or settings beyond the sample studied (Lewis et al., 2014). The theories developed within this study explained how the same processes, in different situations, lead to different results (Pawson & Tilley, 1997). As such the findings might reasonably be applied to the wider ‘parent’ population of symptomatic breast imaging sites and practitioners from which the sample was drawn where local service and practitioner characteristics are similar to those described in the programme theories. It is also plausible that the study findings might have more universal application – theoretical generalisation because the theory building nature of the study established concepts and constructs which might be more generally predictive (Lewis et al., 2014). For example the programme theories about inter-professional (medical / non-medical) skills mix might apply also to ‘non-breast’ imaging settings and the programme theories about social learning and team working might apply to non-imaging practitioners re-negotiating professional boundaries in other multidisciplinary settings.

Articulating and clarifying the study’s features and methods as above helps the reader to assess the quality of the study quality, although adhering to procedural criteria alone does not necessarily yield sound data or ‘true’ conclusions (Philips, 1987 cited by Maxwell, 2012). In conclusion it is argued that the quality of this study is underpinned by using the RE method in a suitable context for an appropriate purpose (Maxwell, 2012).

3.8 Chapter 3 summary

This chapter has justified RE as an appropriate methodology given the complexity of the research problem and has explained the study design adopted. The study aims and objectives have been defined and the ways in which rigour and ethical conduct have been maintained were critically reviewed. The following three chapters present the three successive stages of the study. Chapter 4 presents the first of stage of the study in which the initial programme theory was articulated using the ‘context, mechanism, outcome’ framework described above. Chapters 5 and 6 present the second and third stages of the study and include further critical analysis of the qualitative data collection and analysis approaches used and theoretical justification of the study site and participant sampling strategy.

Chapter 4 Articulation of Initial Programme Theory

4.1 Introduction

This chapter presents Stage 1 of the study which involved articulating a number of ‘initial programme theories’ which could explain how a programme of intervention to involve radiographers in symptomatic MIIR might work.

The chapter incorporates critical review of a broad range of topic-specific literature and the professionally informed conjecture of the researcher, herself a clinical subject specialist, to build a series of hypotheses suitable for testing in the subsequent empirical stages of the project.

The chapter starts by describing how relevant professional literature and substantive underlying theory were identified. This is followed by a critical and detailed explication of programme theories which identify potential causal relationships between local and individual circumstances and conditions that might support, or obstruct the successful involvement of radiographers in symptomatic MIIR and the potential consequences for organisations, practitioners and patients.

Throughout the chapter, the initial programme theories are summarised in the form of CMO configurations in line with the project’s underlying RE methodology.

4.2 Evidence identification

4.2.1 Method

The evidence used to build the initial programme theories was wide ranging, drawn from a broad spectrum of disciplines and was identified using an iterative on-going search strategy (Wong et al., 2013). A pre-study search for peer-reviewed publications which had investigated the ability of radiographers to interpret mammograms had been performed in conjunction with an experienced information technologist using systematic review methodology (Glasziou et al., 2001) and a generic ‘breast neoplasm’ search strategy (Cochrane Breast Cancer Group, 2011) with additional ‘health professional’ and ‘performance / quality’ search terms added to reflect the particular focus of this project. Search hits were screened and filtered by the researcher, with independent corroboration of 10% cases, to identify sources which had reported primary studies where radiographers had interpreted authentic clinical mammography images.

No attempt was made to extract quantitative ‘results’ data to perform a formal meta-analysis which might generate an overall estimate of how accurately radiographers could interpret mammograms. Of more interest was an exploration of research methods - participant and case heterogeneity, study design and methodological quality for example, to try to identify and explain how study variables had the potential to influence radiographer performance and generate different performance outcomes - sensitivity, specificity, decision speed for example, within and across the studies.

The introduction and discussion sections of the publications were interrogated to identify if, and where investigators made reference to substantive theory which might explain how and why radiographers made interpretive judgements and reached diagnostic decisions.

Holloway and Wheeler (2002) suggest that clinical practitioners are often '*less concerned with philosophical and theoretical issues'* , as such it was anticipated that theoretical explanations would rarely be offered by investigators or where present might be speculative and unsubstantiated by formal theory. In order to supplement and strengthen the programme theories in this academic thesis reference was therefore made to a wide body of additional literature from the disciplines of cognitive and behavioural psychology, diagnostic reasoning, clinical decision making and sociology. After being directed to several keynote introductory texts (Samei and Krupinski, 2010; Schwartz and Bergus, 2008; Koehler and Harvey, 2004; Gigerenzer, 2002; Wenger, 1998; Hutchins, 1995) a 'funnel' approach was used to purposively search for additional literature that might help underpin an explanation of how radiographers might undertake mammographic image interpretation and reporting successfully within the multidisciplinary team environment of the symptomatic service.

Articulation of the initial programme theories drew on the researcher's own professional conjecture (Blamey and Mackenzie, 2007) to help apply the existing evidence to the specific parameters of this study. This stage of the study also drew on the findings of a small pilot survey conducted as a pre-study scoping exercise (Dixon et al., 2013b).

4.2.2 Existing studies of radiographer MIIR

From an initial sample of over 8000 potentially relevant sources 15 topic-specific primary peer-reviewed studies were identified –Table 4.1. Across the studies the performance of 126 radiographers was evaluated over 164,658 mammography cases. Only image interpretation studies which used actual patient outcome as the diagnostic reference standard (absolute accuracy) were included. None of the studies evaluated the ability of radiographers to compile a mammography examination report.

Table 4.1 Summary of radiographer accuracy studies

	Location	Date	radiographer sample	training status	case sample	mammogram series type	cancer prevalence	test conditions
UK screening								
Haiart & Henderson 1991	UK	1991	1	trained	3362	consecutive	1.6%	laboratory
Mucci et al. 1997	UK	1997	8	none	3142	consecutive	0.7%	clinical
Pauli et al. 1996a	UK	1996	7	trained	17202	consecutive	20.0%	clinical
Wivell et al. 2003	UK	2003	3	trained	100/54000	test / consecutive	14.9% 0.7%	laboratory & clinical
non-UK screening								
Bassett et al. 1995	USA	1995	8	pre/post	1238	test set	6.9%	laboratory
deBono et al. 2014	Australia	2014	10	none	500	test set	10.0%	laboratory
Moran & Warren Forward 2010	Australia	2010	11	none	50	test set	44.0%	laboratory
Moran & Warren Forward 2011	Australia	2011	7	none	250	test set	22.0%	laboratory
Tanaka et al. 2014	Japan	2014	6	trained	75	test set	33.0%	laboratory
Dowdy et al. 1970	USA	1970	1	trained	337	consecutive	2.0%	laboratory
Duijm et al. 2008	NL	2008	21	none	78325	consecutive	0.4%	clinical
Sumkin et al. 2003	USA	2003	33	none	2985	consecutive	0.2%	laboratory
non-screening								
Holt 2006	Canada	2006	5	none	50	test set	14.0%	laboratory
van den Biggelaar et al. 2010a	NL	2010	3	trained	1048	consecutive	4.7%	laboratory
van den Biggelaar et al. 2010b	NL	2010	2	trained	1994	consecutive	4.8%	laboratory
Total			**126**		**164,658**			

Most (12/15) of the studies identified investigated the performance of radiographers using mammograms obtained in population ‘screening’ programmes, most (11/15) originated outside the UK and most (12/15) were conducted under manipulated experimental ‘laboratory’ conditions. This limited the generalisability of the existing evidence to explain how UK radiographers might perform in a real-life symptomatic setting.

Three studies evaluated radiographer performance using a sample of mammograms that included some non-screening (diagnostic / symptomatic) cases. However, again none of these involved UK radiographers. All three of these studies were again performed under manipulated ‘experimental’ conditions where radiographer decisions did not influence actual patient management. This evidence also had limited ability to predict how UK radiographers might perform in a real-life one-stop clinic setting with a purely symptomatic case load.

The literature review highlighted the fact that there was no existing published evidence about the characteristics and practices of radiographers involved in interpreting and reporting symptomatic mammograms in the UK.

Articulation of some prospective initial programme theories required considerable theoretical conjecture and creative insight. The literature triggered hypotheses about how and why:

- responsibility for interpreting mammograms in the symptomatic service might be transferred, or shared, between radiologists and radiographers in new roles;
- confidence and anxiety might affect the performance of radiographers in shared (double reading) and autonomous (single reading) roles;
- screen reading experience might not prepare radiographers adequately for interpreting and reporting symptomatic cases;
- dedicated training, feedback and repetition could increase radiographer performance levels to similar standards as those of radiologists;
- radiographers and radiologists might adopt different approaches to decision making;
- the real-life ‘one-stop’ clinical practice environment would generate different performance characteristics to those observed under manipulated and controlled experimental conditions.

In the next sections of this chapter the initial programme theories are presented as explicit descriptions of the conceptions, assumptions and expectations required for successful involvement of radiographers in symptomatic MIIR, along with identification of potential unintended consequences (Rossi et al., 2004). The programme theories are grouped into three 'families':

- theories about the MIIR roles and responsibilities radiographers might undertake;
- theories about how radiographers develop the necessary attributes to undertake these roles and responsibilities;
- theories about how radiographers undertake these roles and responsibilities within a multidisciplinary breast care team.

4.3 Theories about the MIIR roles and responsibilities

4.3.1 Professional boundary change

Professional boundaries define the scope of practice of an occupational group (Sibbald et al., 2004). The traditional scope of practice of mammography radiographers is image acquisition. Symptomatic mammography image interpretation and reporting (MIIR) is a new role for these radiographers because they are not trained to do it initially and it is a role which is usually undertaken by another profession, medically trained radiologists. In terms of realist evaluation, professional boundary shift might be considered a 'mechanism' (resource) which enables mammography radiographers to become involved in symptomatic MIIR.

Sibbald et al. (2004) and Nancarrow and Borthwick (2005) devised taxonomies which were used in this thesis to describe how the professional boundaries of radiographers might change when they become involved in symptomatic MIIR. The definitions provided in the taxonomies were used to describe how performance of the MIIR 'task' and responsibility for the clinical consequences of this might be shared and / or transferred between radiologists and radiographers.

4.3.1.1 Role enhancement

Role enhancement involves extending, adding to or increasing the depth of a practitioner's existing role (Sibbald et al., 2004). This term was used to explain how the professional boundary of a radiographer who acquired mammographic images (their own job) changed if they were involved in annotating the images they considered to show an abnormality (abnormality signalling). The literature suggested that the scope of practice of radiographers involved in abnormality signalling might range from merely providing a simple visual 'flag' to indicate they considered an abnormality to be present to providing a verbal or written opinion and / or description about the images to indicate the nature and clinical significance of the abnormality (preliminary clinical evaluation / commenting).

4.3.1.1.1 Abnormality signalling - a ‘red dot’ system

In the survey of NHSBSP units conducted by Wells and Cooke (1996) only 2% (2/101) units used radiographers to identify ‘obviously abnormal’ mammograms after checking their technical quality. In Dixon et al.’s (2013b) more recent survey of radiographers working in both screening and symptomatic units, 7/38 (18%) responding radiographers who worked in symptomatic services said they were involved in annotating images they considered to be abnormal.

Abnormality signalling systems were first introduced in the UK in the 1980s in trauma radiography services (Berman et al., 1985). Initially the role involved sticking a red paper dot onto hard copy photographic film images but with the advent of digital imaging ‘red dotting’ now often involves overlaying the words ‘red dot’, or another locally agreed text character(s) onto the electronic image file as a visual ‘flag’ to signal abnormality. In the context of this thesis, it was hypothesised that in addition to assessing the technical quality of the images the radiographer acquiring the mammography image might ‘red dot’ images they suspected might demonstrate cancer.

The original purpose of red dot systems was to provide a timely and informed opinion about diagnostic images in the absence of a radiologist (Culpan, 2006). Out of routine working hours an ‘expert imaging professional’ opinion from a radiographer could assist non-imaging specialists, such as accident & emergency physicians, to make a correct diagnosis and instigate appropriate management (Culpan, 2006). In this study a similar argument might be made for radiographers assisting a breast surgeon to appropriately manage patients in a ‘one-stop’ symptomatic clinic if a radiologist is not available.

The potential to involve UK mammography radiographers in a red dot system was investigated in a formal study conducted in 1993 by the Cumbria Breast Screening Service (Mucci et al., 1997). For a trial three month period (3142 cases) eight ‘senior radiographers’ were asked to flag up cases they considered to have abnormal mammograms and thus were in need of further assessment by annotating patient case-notes with a ‘red dot’ sticker. As in the original trauma radiography red dot schemes the screening mammograms were subsequently read by radiologists who gave the definitive diagnostic opinion and this occurred later at a time / date once the patient had left the department.

In the screening situation, where mammograms are interpreted ‘cold’ once the patient has left the department, radiographer involvement in ‘red dotting’ confers no immediate patient management advantage. In contrast, in a symptomatic service where the patient is present, it was hypothesised in this thesis that radiographer red dotting might have the potential to expedite patient management in the absence of a radiologist in the one-stop clinic.

Unintended consequences

Red dot systems are however, compromised by lack of precision – the presence of a red dot might alert an uninformed viewer, such as a surgeon or breast care nurse to a potential abnormality but would not indicate its nature or location, or indeed if there was more than one abnormality. The system relies either on the recipient of the image (second viewer) having some ‘task’ knowledge to interpret the image definitively (radiologist) or a scheme of work where patients are managed conservatively (by the surgeon / nurse) until a definitive interpretation is obtained.

There is also a risk that a red dot will prompt second guessing, protracted deliberation or the need to seek out the radiographer for discussion, if an abnormality in a ‘red dot’ image is not readily apparent to the second viewer or the abnormality does not correlate with the clinical findings. This can introduce error and mismanagement into the diagnostic process or might offset any time saved by offering an ‘interim’ opinion.

Further problems occur because participation in red dot systems can be optional (Snaith and Hardy, 2008). If some radiographers choose to participate whilst others refrain, an image with no red dot is ambiguous (Dimond, 2002). It either represents ‘no abnormality detected’ or that the radiographer is not participating in the scheme. If the second viewing surgeon, nurse or radiologist does not know if the image has come from a non-participating radiographer they may erroneously assume that an image without a red dot is considered to show no abnormality. Again, this could be a source of potential diagnostic error and mismanagement and might lead to false (interim) reassurance of patients.

A voluntary service also introduces inequity for patients – where the radiographer participates in the red dot system the patient is afforded two diagnostic opinions. The (informed) second reader, the radiologist is in a position to overrule the radiographer’s judgement, accept and incorporate their opinion into the final image interpretation and report, or challenge and consult the radiographer to reach a collective decision about the mammogram. Double reading has the potential to improve diagnostic accuracy – see section 4.3.2.1 below). If the image acquisition radiographer does not participate in the red dot scheme, patients only get a single (radiologist) opinion, and their examination might arguably be considered less accurate.

4.3.1.1.2 Abnormality signalling - a commenting system

‘Commenting’ takes the red dot system a step further by requiring a radiographer to give a verbal or written diagnostic opinion – a ‘free text’ description incorporating a more precise indication of any abnormality identified (Hardy and Culpan, 2007). Assessment of imaging appearances, making clinical judgements and decisions about them and communicating these in written format is known as ‘preliminary clinical evaluation’ (SoR, 2013). Producing a descriptive interpretation for all images is an improvement on the red dot system because it clarifies the ‘normal / no significant abnormality’ status of a ‘negative’ (no red dot) image.

Commenting systems seem to be more prevalent than red dot schemes in mammography. In the NHSBSP, radiographers who acquired mammographic images were encouraged to ‘look at’ them and give an opinion that was subsequently ‘available to the radiologist’ interpreting them, in fourteen out of 101 (14%) units responding to the 1995 national survey (Wells and Cooke, 1996). In Dixon et al.’s (2013b) survey 34% (n = 13) respondents working in symptomatic services indicated that they participated in verbal commenting and 29% (n = 11) in written commenting schemes.

<u>Consequences</u>

In addition to offering an informed opinion about images to clinicians and / or nurses in a one-stop clinic in the absence of a radiologist, involving all mammography image acquisition radiographers in preliminary clinical evaluation would afford all cases a ‘double read’. It was hypothesised in this thesis that incorporating commenting into the existing image acquisition role of a radiographer might be a ‘cost-neutral’ way of improving diagnostic accuracy in a symptomatic service (see section 4.3.2.1 below). Any additional time incurred, for diagnostic deliberation and report writing, represents a ‘hidden’ cost.

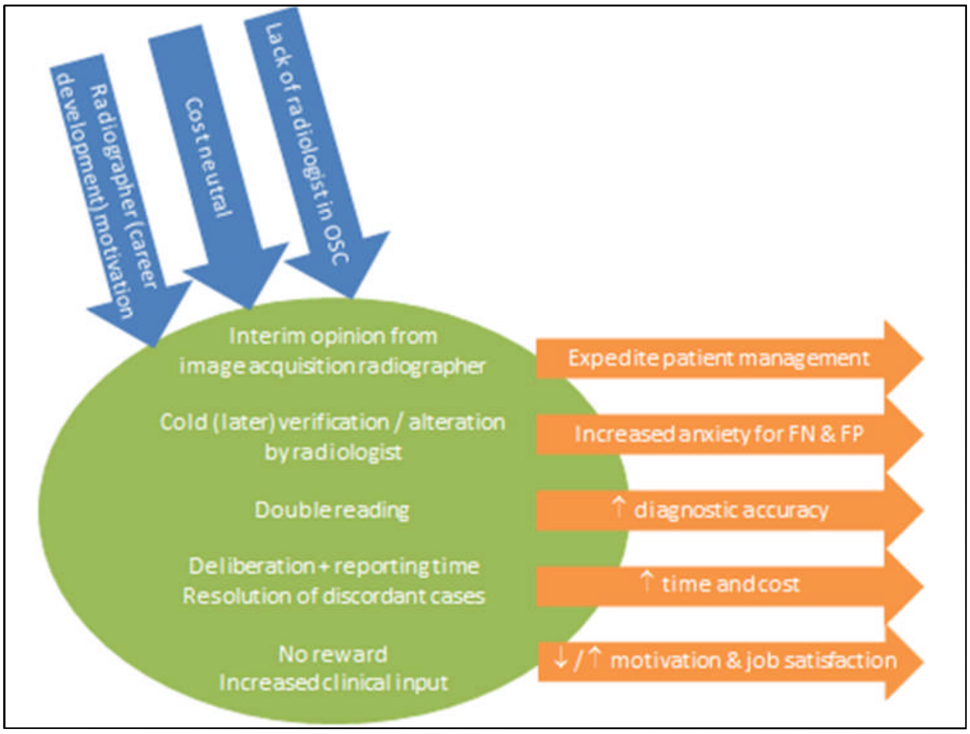
4.3.1.1.3 Reward and recognition

The inclusion of additional tasks into a basic or junior role in the demanding working environment of a busy out-patient clinic of anxious patients, with no official recognition or reward (pay increase / re-grading) might reduce radiographer motivation (Larrick, 2004) and job satisfaction (Culpan, 2006). It was hypothesised that radiographers might feel taken advantage of - that their employer was ‘getting something for nothing’ – and that this could lower individual or team morale and could potentially adversely affect retention and recruitment of the mammography workforce. Conversely however, it was considered that increased involvement in clinical decision making might generate more interest and greater job satisfaction for radiographers. Role enhancement opportunities might identify radiographers who were motivated to progress and might help organisations identify, select and recruit candidates for career advancement / promotion opportunities and assist in workforce planning.

4.3.1.1.4 CMO configuration

In keeping with RE methodology the above programme theory is summarised in the form of a CMO configuration in Figure 4.1. The blue arrows indicate circumstances and characteristics (contexts) which might trigger abnormality signalling, the green oval contains the resources and reasoning processes (mechanisms) that occur and the orange arrows indicate the potential consequences (outcomes).

Figure 4.1 CMO configuration - role enhancement



4.3.1.2 Role diversification

Nancarrow and Borthwick (2005) used the term ‘diversification’ to describe ‘a novel approach to practice not previously ‘owned’ by a professional group’. Given the SoR’s insistence that image interpretation is legitimately within a radiographer’s scope of professional practice (SoR, 2013), this term might also have encompassed the role ‘enhancement’ described above. Using this definition image acquisition radiographers would extend their role ‘within their own discipline, an intra-disciplinary change’ to encompass interpretation of the images they produced.

In this thesis however, role 'diversification' was used to explain how radiographers who already undertook mammography image interpretation in the screening service (NHSBSP screen reading) might extend their scope of practice to include interpretation and reporting of symptomatic cases.

Whilst back in 1995 only six (out of 101) NHSBSP units formally involved radiographers in screen reading (Wells and Cooke, 1996) their 2008 workforce report (Nickerson and Sellars, 2008) indicated that a large proportion of radiographers, 205 (69.7%) of the 10 consultant and 284 (260 qualified and 24 trainee) advanced practitioners were at that time involved. In accordance with the suggestion of Hatala et al. (2003), in this thesis it was hypothesised that it might be feasible to diversify the scope of practice of this pool of radiographers who are trained & experienced in screen reading into a non-screening setting rather than train completely new practitioners. This idea was supported by the current national guidelines which suggest it is advantageous for practitioners working in symptomatic services to also have NHSBSP experience (BASO, 2005).

4.3.1.2.1 Pre-screening

It was hypothesised that a potential role for radiographers who are trained and experienced in reading screening mammograms would be 'pre-screening' or 'filtering'. This involves a radiographer who may but need not have produced the images, making a judgement about image appearances and making a decision about the need for a radiologist (medical) interpretation and report.

This system had been explored in the early 1990s by Haiart and Henderson (1991) who investigated the potential for radiographers to help reduce the screening mammography workload of radiologists in the Lothian's Mobile Mammography Project (Edinburgh, UK). In a simulation experiment using historical archive images from closed patient episodes they assessed the feasibility of using radiographers to 'pre-screen' cases with the hypothesis that not all cases needed to be read by radiologists. A single radiographer was asked to review mammography images and prospectively sort cases into 'normal/benign', 'not diagnostic' or 'abnormal' categories, stating which 'abnormal-potential cancer' cases they would refer to a radiologist if acting in a 'pre-screening' capacity.

In a similar, more recent study which used a mixed sample of screening and diagnostic (symptomatic) cases (van den Biggelaar et al., 2010b), three radiographers were asked to imagine they were operating in a 'pre- screening' capacity to filter out 'uncomplicated' cases and make hypothetical decisions about whether they would refer images to a radiologist. With only mammograms assigned to 'abnormal' categories referred to a radiologist for detailed interpretation and a medical opinion about further management, definitive interpretation and reporting of cases that were normal or demonstrated ‘uncomplicated’ benign pathology was ‘delegated’ to the radiographer – see section 4.3.1.3 below.

In this thesis it was suggested that experienced NHSBSP screen reading radiographers operating in a pre-screening / filtering role might sort symptomatic mammography images into two groups - normal / common uncomplicated benign abnormalities and unusual, complicated / possibly malignant abnormalities, in a similar way to how they sort screening cases into ‘routine recall’ and ‘recall to assessment’ groups. In this role the radiographer might be responsible for issuing a simple standardised report for cases in the first group. This would reduce the MIIR workload of radiologists because the number of cases sent for a medical interpretation (radiologist read) and a bespoke report would be restricted to those demonstrating more unusual, complicated and potentially malignant abnormalities.

In Dixon et al.’s (2013b) survey 27 (71%) radiographers working in symptomatic services said they were involved in making dichotomous (normal/abnormal) judgements about images but only 6 (16%) said they pre-screened or filtered images for the practitioner officially interpreting the images. In the ‘free text’ responses one survey respondent explained that her unit did not offer a ‘one-stop’ symptomatic clinic but stratified patients to re-attend for mammograms which were either interpreted and reported ‘cold’ (delayed) once the patient had left the department or ‘hot’ (immediate) reporting whilst the patient was still present, on the basis of the results of the P1-5 assessment made by the surgeon who performed a physical breast examination at an initial clinic visit.

In this thesis it was hypothesised that a similar scheme of work in a one-stop clinic might involve a radiographer (delegate) interpreting and reporting a subset of cases at low clinical risk of having a mammographic abnormality – those in which the examining surgeon considered the patient’s breasts to feel and look ‘normal’ (P1) or to have uncomplicated ‘unequivocally benign’ (P2) pathology. In this role the radiographer would forward any ‘unexpected’ abnormal mammograms to the radiologist for medical interpretation and reporting. Radiologists would also interpret and report all cases considered to be ‘indeterminate’, ‘suspicious’ or overtly ‘malignant’ (P3, P4 and P5 respectively) by the surgeon performing the physical examination.

Filtering schemes of work have been used in UK trauma (accident and emergency) imaging settings as radiographer-led discharge schemes. These schemes involved radiographers in interpreting images and managing normal / uncomplicated cases according to a pre-defined ‘discharge plan’ provided by the referring (trauma) clinician (Henderson et al., 2012; Snaith, 2007). The main driver for such schemes was to reduce patient waiting times without compromising quality of care, again in the absence of an immediate radiologist opinion. Their success depended on the provision of clear and explicit discharge and onward referral plans (Snaith, 2007). In the context of this thesis clinicians, radiographers and radiologists would need to be aware of the consequences of their physical examination categorisation, this would determine who initially interpreted the images, and there would need to be clear guidelines and protocols for onward (radiologist) referral and management of P1 / P2 radiographer-read cases which had unexpected potentially malignant mammographic abnormalities.

The ability to limit (reduce) the MIIR workload of radiologists to mammograms which demonstrate an abnormality has the potential to expedite transit of patients through symptomatic clinics by releasing the radiologist to undertake other task such as performing and interpreting ultrasound examinations and undertaking tissue sampling procedures. Streamlining service provision by reducing patient transit / waiting time bottlenecks and sharing the MIIR workload between radiographers and radiologists also have potential to enhance practitioner working conditions and job satisfaction.

The engagement of an additional person to filter cases in the diagnostic chain, and the requirement for them to have had some (screening) MIIR training is associated with increased service cost. van den Biggelaar et al. (2010b) suggested this could be offset against reduced radiologist cost if radiographers could filter out enough cases. If the radiographer does not reduce the radiologist’s workload significantly, for example if their specificity is poor and they refer too many normal cases to the radiologist, or their confidence is low and they take a long time to make decisions, Haiart & Henderson (1991) demonstrated that a radiographer / radiologist pre-screening (filtering) scheme can be more expensive than allowing a radiologist to read all the images themselves. In their study using screening cases filtering offered no economic advantage because the cost of radiographer / radiologist pre-screening was estimated at £84.97 per 1000 cases, compared to the cost of having the radiologist read all the cases (£79.10).

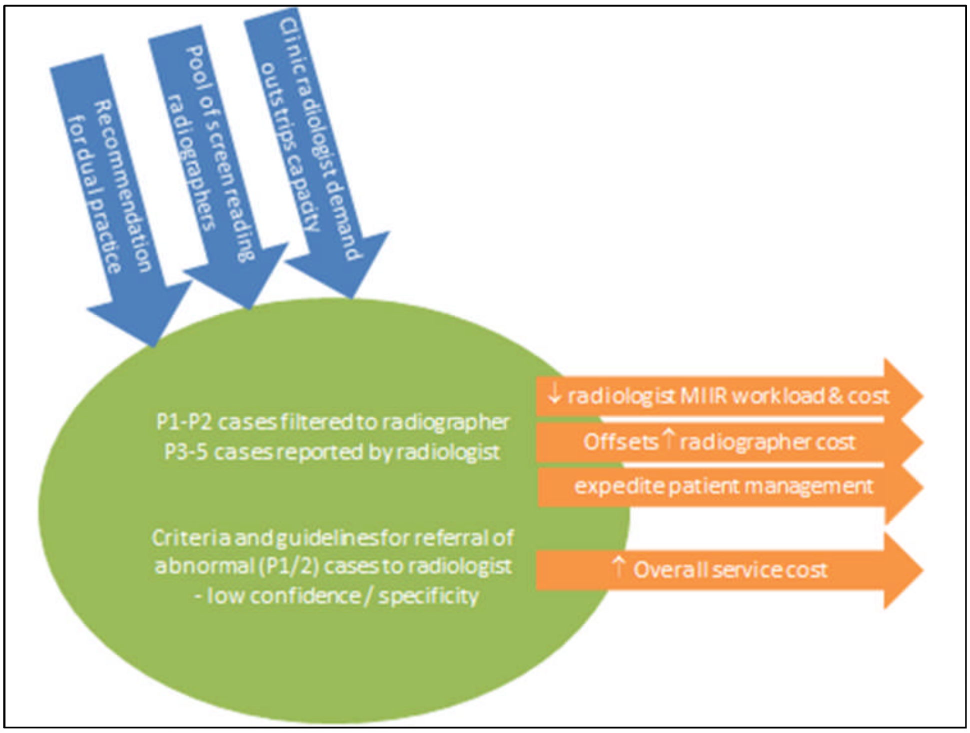
Using a mixed caseload that included a range of screening and non-screening cases, van den Biggelaar et al. (2009) modelled a potential reduction in radiologist workload of 73% assuming that the radiographers filtered out all the 1019 ‘normal’ cases from the 1389 cases they reviewed. These investigators calculated a potential mean cost saving of 17.2%. They modelled a variety of (single / double reading, normal / abnormal threshold) radiographer / radiologist pre-reading scenarios that could reduce diagnostic costs to €122,494 - €139,781 against the cost where a radiologist read all cases (€150,602).

In a purely symptomatic setting the number of 'normal' (M1) and uncomplicated benign (M2) cases might be expected to be lower than in both these above screening and 'mixed' case mix studies. In Toomey et al.'s (2006) study of 1429 cases referred to a newly established rapid access breast clinic in Dublin, Ireland, 32% (442) patients referred for mammography were categorised by radiologists as M3, M4 or M5; this still however leaves 68% cases showing no or generalised benign disease that might potentially be filtered out by a radiographer in a pre-screening role.

4.3.1.2.2 CMO configuration

As before, the above programme theory is summarised in the form of a RE CMO configuration (Figure 4.2) with blue arrows indicating triggering circumstances and characteristics (contexts), the green oval illustrating resources and reasoning processes (mechanisms) and orange arrows indicating potential consequences (outcomes).

Figure 4.2 CMO configuration – role diversification - filtering



4.3.1.3 Role delegation

Transfer of (some or all of) the MIIR role from a radiologist to a radiographer involves either inter-professional delegation or professional substitution.

Delegation typically involves a junior practitioner undertaking some or all of the duties of a more senior practitioner who need not be from the same profession. Inter-professional delegation moves the performance of, but not necessarily the responsibility for, a role between practitioners of different professions (Sibbald et al., 2004). Substitution occurs where a previously defined role, in this thesis MIIR, and its associated clinical responsibility, is transferred to a lesser or more narrowly trained, usually non-medical, in this thesis a radiographer, healthcare professional (Hoskins, 2012).

The professional regulatory body for doctors, the General Medical Council (GMC) defines delegation as 'asking a colleague (who need not be another doctor) to provide care or treatment on your behalf' and stipulates that doctors who delegate retain clinical responsibility for patients (GMC, 2013). The difference between role delegation and role substitution is thus medico-legal. In this thesis the difference hinges on how the MIIR task is conceptualised – if defined as a task in the professional domain of radiologists transfer to a radiographer involves delegation – the radiographer performs it on behalf of the radiologist; if MIIR is a task within the professional domain of a radiographer transfer involves substitution because they perform it in their own right instead of a radiologist.

<u>Delegation</u>

The GMC (2013) requires that a delegate has the knowledge, skills and experience to carry out the required task(s). It was hypothesised in this thesis that this would require the radiographer to be able to recognise mammographic abnormalities, categorise their appearances on a 5-point diagnostic scale (normal, benign, indeterminate/probably benign, suspicious or malignant) and compose a free-text definitive report for the surgeon. The GMC (2013) also requires that delegates are adequately supervised, in this thesis that would require a radiologist to still be immediately available.

It was anticipated that organisations would need formal documentation that defined the radiographer's role and status and clearly established whether they were undertaking the MIIR task in a delegation or substitution capacity (RCR and SoR, 2012). In delegation MIIR could only be performed in the presence (however remote) of a supervising medical practitioner (radiologist) but if MIIR was performed in substitution it could be occur independently in the absence of a radiologist.

Delegation is an appropriate description for the situation where some or all of the image interpretation is undertaken by a radiographer (delegate) but a radiologist (delegator) retains clinical responsibility for this aspect of the service.

In the above filtering example, radiographers identifying and issuing a simple descriptive and standardised report for a subset of low risk ‘normal’ mammograms and those showing uncomplicated benign pathology, would be acting as delegates; they would pass cases demonstrating potentially malignant or other complicated pathology which were outside their knowledge, skill and experience to their supervising radiologist to issue a more complex explanatory and bespoke report informed by their ‘medical’ interpretation.

It was hypothesised that delegation might also occur where radiographers interpreted and reported all cases but still had access to a supervising radiologist who retained overall organisational responsibility for the clinical consequences of the image interpretation service. It was envisaged this might occur for example when radiographers were novice MIIR practitioners or where screen reading radiographers were new to symptomatic cases; in such situations supervision might be a means of providing on-going training and / or preceptorship (see sections 4.4.3.3 and 4.4.3.5).

A trained and experienced radiographer might undertake MIIR for all cases in the one-stop symptomatic clinic and only occasionally need to seek advice / a second opinion about unusual or complicated cases. Although the radiologist must provide adequate supervision (GMC, 2013) the intended consequence of delegation would be that the radiographer makes autonomous judgements and decisions (single reading) about the majority of cases. In this situation it was hypothesised that a supervising radiologist could be located remotely, on the hospital site but not in the breast clinic, because they had access to digital mammography images and communication with the radiographer via a networked Picture and Archiving Communication System (PACS).

It was anticipated that delegation could reduce radiologist MIIR workload but give rise to benefits that were site specific. At a site where radiologist availability was not a limitation, as in filtering they could be released to undertake other duties in the breast clinic which would potentially reduce patient clinic transit time and streamline workflow. Working in parallel, a radiographer (interpreting and reporting mammograms) and a radiologist (performing and reporting ultrasound and tissue sampling examination) should be able to get through more cases in a given clinic than a radiologist could by working alone. This would have the potential to increase clinic capacity and improve compliance with external referral to diagnosis targets.

It was hypothesised that replacing a radiologist in the breast clinic with a professional who had lower training and employment costs would generate financial efficiencies, and these might be used to offset task (MIIR) specific radiographer training and career progression costs. Displacing the radiologist out of the breast clinic might also improve patient access to other ‘bottleneck’ areas in the wider imaging service.

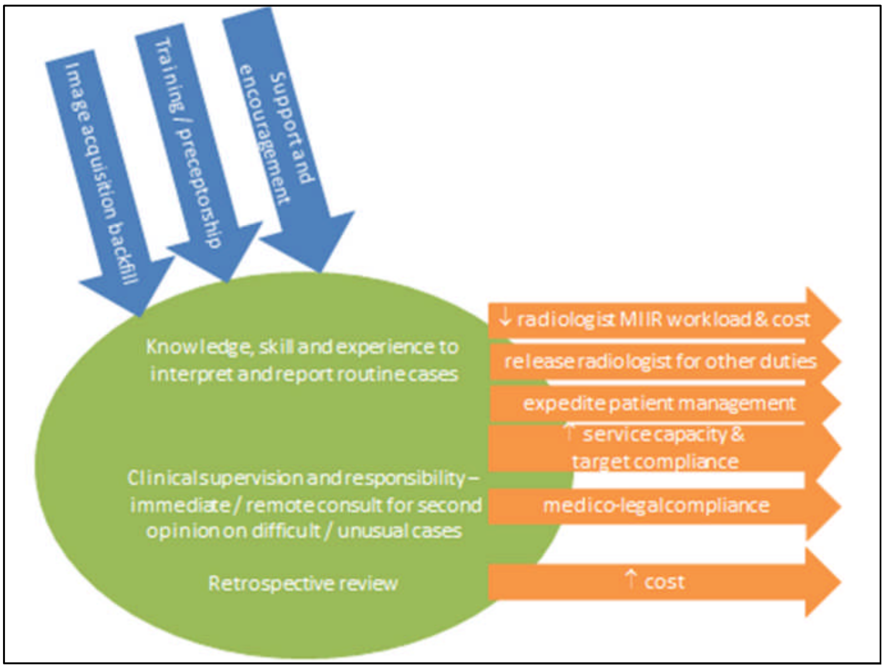
With remote / indirect supervision the radiologist can still monitor and review radiographer performance through formal (personal or team) peer review (audit) and would also have access to their decisions at MDT meetings. Cost and logistic efficiencies would be compromised if the radiologist engaged in formal retrospective verification of all radiographer decisions and reports as described by one of the participants in Dixon et al.’s (2013) survey:

> *‘I run fast track clinics with no radiologist. My report goes straight back to the surgeon and the patient is given the results. Reports (with my name on them) are verified by radiologist at a later date.’ [ID 4090]*

It was anticipated that successful involvement of radiographers in a delegate role would be contingent on the attitudes of local radiologists, their support and encouragement for both training and practice. Johansen and Brodersen (2011) suggested that a local culture of inter-professional conflict and / or resistance to professional boundary change (turf battles) might occur where medical colleagues had concerns about radiographer knowledge, maintenance of training and continuing competence opportunities for radiologists and backfill of the image acquisition role of radiographers.

The above programme theory is summarised in the form of a RE CMO configuration in Figure 4.3; blue arrows indicate triggering circumstances and characteristics (contexts), the green oval illustrates resources and reasoning processes (mechanisms) and the orange arrows indicate potential consequences (outcomes).

Figure 4.3 CMO configuration - delegation



4.3.1.4 Substitution

Substitution differs from delegation because it involves the transfer of duties and their associated responsibility from a practitioner of one profession to a practitioner from another profession (Sibbald et al., 2004). Vertical substitution, also known as ‘encroachment’ describes the adoption of tasks across disciplinary boundaries where levels of training and expertise are not equal (Nancarrow and Borthwick, 2005). This describes more precisely what would happen if symptomatic MIIR was transferred from medically trained radiologists to non-medically trained radiographers. In contrast, horizontal substitution describes the transfer of duties between professionals of similar levels of expertise and training (Nancarrow and Borthwick, 2005).

It was hypothesised in this thesis that substitution would occur where a radiographer performed MIIR instead of a radiologist, was individually accountable and was responsible for the consequences of this in an independent capacity. It was hypothesised that in this situation a radiologist need not be present in the clinic, or on hospital premises, if for example ultrasound and tissue sampling were also performed by a radiographer in a substitution role.

In this thesis it was envisaged that substitution might occur at two levels - ‘task’ substitution where the radiographer performed MIIR in the one-stop clinic instead of a radiologist and ‘role’ substitution where the radiographer replaced a radiologist in the entire symptomatic service.

4.3.1.4.1 Task substitution

Task substitution would be similar to the delegation role described above but the radiographer would interpret and report mammography examinations without the need for supervision by a medical practitioner. The radiographer would interpret and report mammograms independently instead of a radiologist – the radiographer ‘single read’ replacing the opinion of a radiologist in the same scheme of work. This duty would be included in the radiographer’s job description and they would be allocated their own specific clinic sessions (caseload) on the workload rota.

It was hypothesised that radiographers and radiologists could work as an inter-professional team. MIIR task substitution would enable radiologists to perform other triple assessment imaging examinations in the clinic and still retain responsibility for giving a final and decisive image-based opinion at multidisciplinary clinical decision meetings. Task substitution would augment the radiologist workforce because it allowed organisations to provide a single (radiographer OR radiologist) interpretation and report on symptomatic mammography images.

4.3.1.4.2 Role substitution

It was hypothesised that a radiographer might also substitute in the 'role' of a radiologist. In this situation they would not only interpret and report mammograms autonomously but replace the radiologist in the other imaging aspects of triple assessment (ultrasound and tissue sampling). In this scenario, it was envisaged that radiographers might be recognised as independent members of multidisciplinary breast care teams in their own right.

4.3.1.4.3 Unintended consequences

One of the consequences of replacing radiologists with radiographers is de-skilling of the medical workforce. It was hypothesised that this would be a risk where radiographers substituted into MIIR roles and displaced existing radiologists to other duties. Conversely however, it was hypothesised that this would not be a concern where radiographers substituted into the role of an 'additional' radiologist, that is where they worked alongside existing radiologists to meet increased demand or they substituted into unfilled radiologist vacancies.

In independent practice the radiographer would be individually accountable for their MIIR practice and professionally liable for any mistakes, missed cancers for example. Bennett et al. (2012) had reported that radiographers have difficulty handling the additional responsibility of making clinical decisions without the involvement of radiologists. It was hypothesised that the performance of radiographers who undertake MIIR, and any other triple assessment investigations, in an autonomous capacity might be influenced by regret bias if they were fearful, for example of the professional and financial repercussions of error (Worrall et al., 2009). If fear of withdrawal of registration and / or litigation for negligence triggered defensive practice it was envisaged that this could incur additional (human and financial) cost because radiographers might be biased to recommend that an excessive number of patients have additional diagnostic tests and investigations just reassure themselves that they have not missed a cancer.

4.3.1.4.4 Reward and recognition

It was hypothesised that radiographers taking on tasks and roles traditionally in the professional domain of medical practitioners would expect recognition and reward for their increased involvement in clinical decision making. This might take the form of higher organisational status (promotion to advanced or consultant practitioner grades) and a financial increment (pay rise). Larrick (2004) suggested that financial incentives can increase willingness to participate in role substitution because practitioners appreciate investment in their lifelong learning and development, and that motivation has the potential to improve effort and performance.

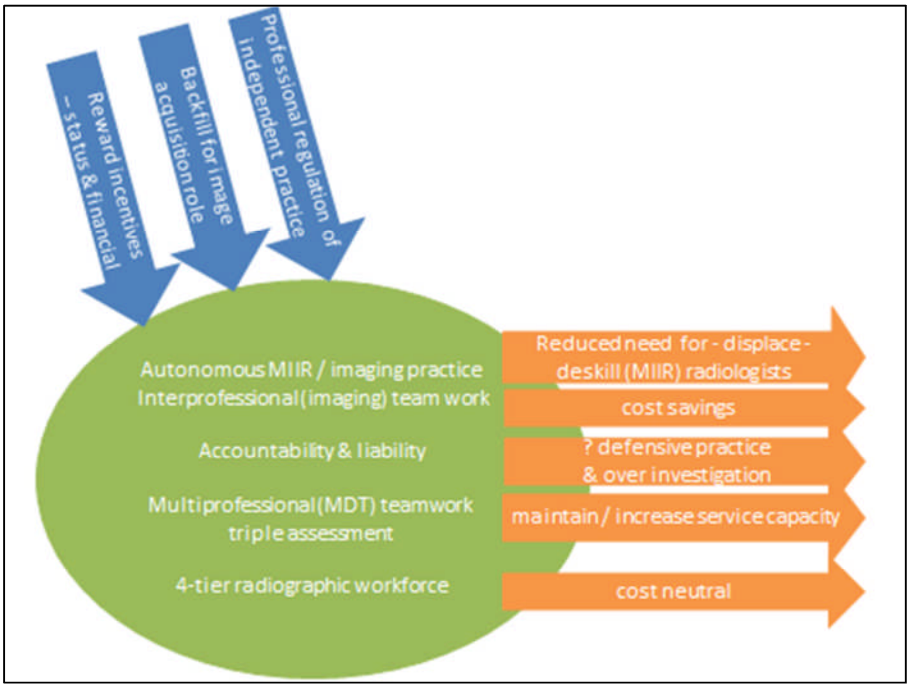
It was anticipated that ‘like for like’ training and employment costs of radiographers involved in MIIR would be less than those of the radiologist they substitute for; it was thus envisaged that additional training and employment costs for substitute radiographers could be offset against radiologist cost savings. It was also considered that the radiographer’s image acquisition role (practitioner) might be backfilled at a lower (assistant) grade worker and thus reconfiguration of the workforce to upgrade a practitioner into an advanced practitioner would be cost-neutral.

Recruitment and retention of the specialist radiographer workforce is fostered where departments have proactive and strategic workforce plans and all four tiers (assistant, practitioner, advanced, consultant) of the radiographic skills mix model are implemented (Williams, 2003; DH, 2000b). It was hypothesised that in departments where organisational support to backfill the radiographer’s image acquisition role was lacking and / or where there was reluctance to reward ‘advanced practice’ skill, radiographers would lack motivation and conscience for their increased responsibility. Low morale and lack of job satisfaction would be potential counter-incentives that might prompt ‘undervalued’ trained and skilled radiographers to seek employment elsewhere.

4.3.1.4.5 CMO configuration

The RE CMO configuration for the ‘substitution’ programme theories is summarised in Figure 4.4. Blue arrows indicate triggering circumstances and characteristics (contexts), the green oval illustrates resources and reasoning processes (mechanisms) and the orange arrows indicate the potential consequences (outcomes).

Figure 4.4 CMO configuration - substitution



4.3.1.5 Specialisation and role innovation

4.3.1.5.1 Specialisation

In this thesis the principle of 'specialisation' was used to describe how the professional boundaries of a radiographer might change because they limit their practice to a single clinical area (Nancarrow and Borthwick, 2005). It was hypothesised that radiographers who worked full-time in the breast imaging service would have time and be encouraged to expand their scope of practice beyond the 'technical' tasks such as image acquisition which lay within their traditional regulatory professional boundary. It was envisaged that 'specialisation' might enable radiographers to become multiskilled across the full spectrum of technical and clinical roles in the diagnostic breast service – undertaking MIIR, ultrasound, tissue sampling and pre-operative lesion localisation (traditionally the remit of medical radiologists) and also undertake clinical examination, giving patients results and acting as patient advocates (traditionally the remit of surgical and nursing professionals).

This programme theory aligned with Kelly et al.'s (2008a) description of the appointment of a 'consultant' breast radiographer at a small integrated (screening and symptomatic) breast unit in the north west of England in 2005. The appointment described by Kelly et al. (2008a) was driven by the need to cover radiologist leave, increased workload resulting from NHSBSP programme (age range) expansion and inability to recruit an additional radiologist. Their descriptive and reflective account explained how the consultant breast radiographer increased service capacity and reduced waiting lists because she could deliver additional ‘fast track’ symptomatic clinics.

At present just over half (52/102, 51%) of the UK SoR Consultant Radiographer Group members work in breast imaging (SCoR, 2015); it was hypothesised that these practitioners would work exclusively in this domain and would function across the whole diagnostic service as multiskilled specialists.

4.3.1.5.2 Role innovation

Role innovation, a form of role advancement, describes a radical new approach to skills and competence and the creation of a new role, the introduction of a new type of work or a new type of worker (Sibbald et al., 2004). New roles arise through maturation and evolution of role substitution to the extent that practitioners are no longer considered to be undertaking tasks or roles that ‘belong’ to another profession (Hoskins, 2012). Role innovation was used in this thesis to describe a new ‘hybrid’ or ‘fusion’ imaging professional, a practitioner who would be ‘more than a radiographer but not quite a radiologist’. In their new role it was hypothesised that radiographers would be fully legally accountable for a spectrum of diagnostic tasks and responsibilities which bridged the traditional professional boundaries between medical (radiologist/surgeon) and non-medical (radiographer/nurse) practice.

It was hypothesised that a new role might emerge for three reasons. Firstly because practitioners who specialised and undertook more of the complex and clinically orientated tasks and responsibilities traditionally in the domain of the radiologist, might start to give up some of their traditional tasks that defined them as ‘radiographers’ – in giving up routine tasks of a more technical nature, they might for example no longer position patients to acquire mammographic images.

Secondly, it was hypothesised that there might be limitations which prevented radiographers appropriating all the tasks and responsibilities within the traditional remit of radiologists. For example a specialist practitioner with expertise limited to the ‘breast’ would not be able to undertake, interpret and report on the whole body MRI and / or CT and / or RNI examinations performed to stage metastatic or detect co-morbid disease.

This programme theory is illustrated in the following two figures where colour coding represents the professional boundaries of radiographers and radiologists. Figure 4.5 shows the traditional scopes of practice of radiographers (purple) and radiologists (blue) in the breast imaging service.

Figure 4.5 Traditional professional boundaries

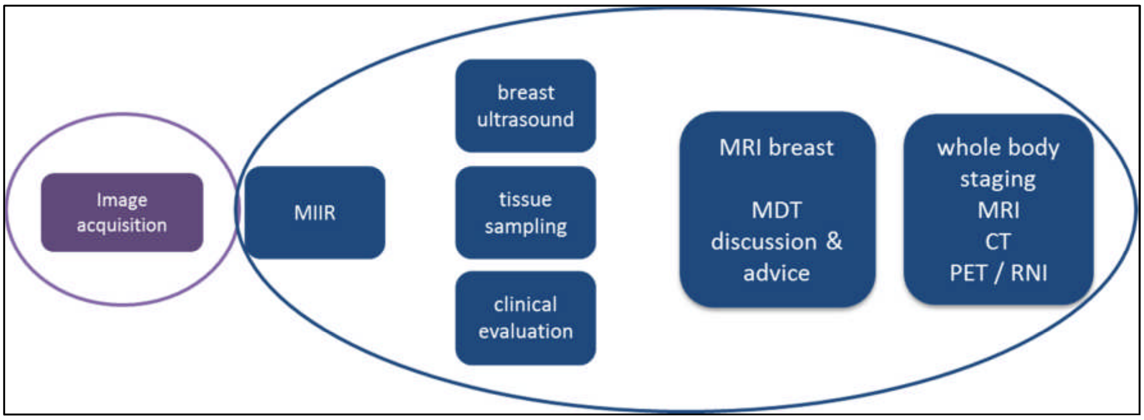
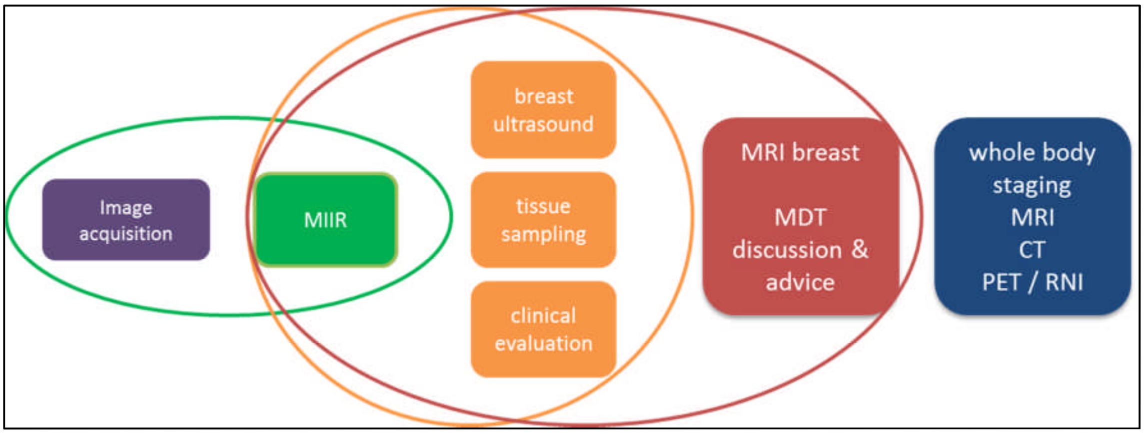


Figure 4.6 illustrates the hypothetical changes in the professional boundaries of the radiographer proposed, as follows:

- green – radiographer extends traditional image acquisition duties to encompass MIIR;
- orange – multiskilled specialist radiographer undertakes all routine diagnostic breast imaging duties traditionally performed by radiologist but no longer performs image acquisition;
- red – innovative hybrid practitioner undertakes all traditional duties of radiologist but is limited to 'breast' clinical domain.

Figure 4.6 Reconfigured professional boundaries

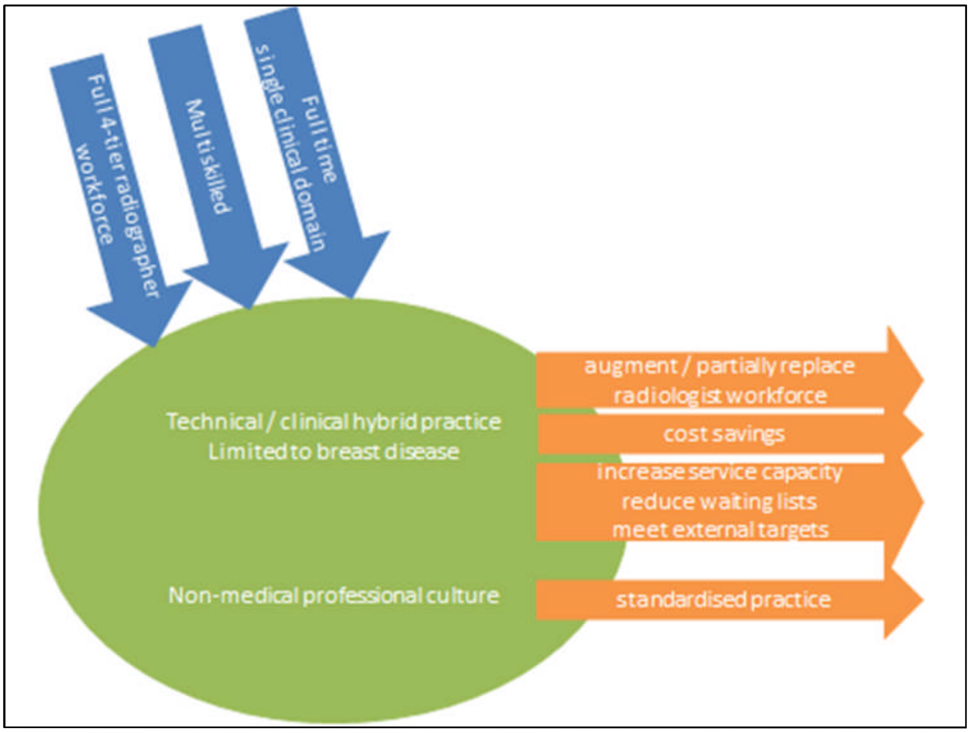


The third reason it was hypothesised that a 'new type of imaging worker' might emerge was due to differences in the professional backgrounds and professional cultures of radiographers and radiologists that might predispose them to functioning in different ways. For example Dixon and Dearnley (2008) had suggested that the practice of radiographers in advanced and consultant practice roles was more standardised than that of radiologists. One explanation for this might be that 'medical' radiologists are more likely to exhibit overconfidence (Berner and Graber, 2008) with radiographers having a professional culture of following protocols and agreed schemes of work.

4.3.1.5.3 CMO configuration

The RE CMO configuration for the programme theories about ‘specialisation and role innovation’ is illustrated in Figure 4.7. Blue arrows indicate triggering circumstances and characteristics (contexts), the green oval illustrates resources and reasoning processes (mechanisms) and the orange arrows indicate the potential consequences (outcomes).

Figure 4.7 CMO configuration - role innovation



4.3.1.6 Summary

Section 4.3.1 of this thesis presented the programmes theories which explained how change in professional boundaries could enable radiographers to become involved in symptomatic MIIR. In particular the theories presented in this section explained how performance of the MIIR ‘task’ might be shared and / or transferred between radiologists and radiographers. The next section of the thesis extends these theories to explain how responsibility for the clinical consequences of MIIR might be shared and / or transferred across professional boundaries.

4.3.2 Re-distribution of professional responsibility

Following on from the above programme theories about how the task and role of MIIR might be distributed between radiographers and radiologists, this next section of the thesis considers how and why clinical responsibility for MIIR might be shared and / or transferred between radiologists and radiographers and what the consequences of this might be. It was hypothesised that responsibility might be:

- shared where radiographers and radiologists ‘double read’ all cases;
- shared where radiographers and radiologists ‘single read’ different types of case;
- transferred where radiographers ‘single read’ all cases.

4.3.2.1 Double reading

Double reading involves sharing the diagnostic decision making process with another practitioner. Clinical practitioners invariably have access to a colleague for a second opinion but the formal use of ‘double’ decision making (double / second reading) in mammographic image interpretation is a recognised strategy for improving diagnostic accuracy.

<u>Evidence</u>

In the early 1990’s evidence began to emerge from screening programmes that cancer could be improved if all cases were interpreted by two (radiologist) readers (Anderson et al., 1994; Thurfjell et al., 1994; Anttinen et al., 1993). Historically UK NHSBSP units that operated a single (radiologist) reading regime had the lowest cancer detection rates (CDR) with double (radiologist) reading improving the detection particularly of small (less than 15 mm) cancers by 32% for similar recall rates (Blanks et al., 1998). Arbitration of discordant double radiologist read decisions in the local NHSBSP unit increased the overall number of cancers detected annually by 8% (range 3.6-11.4) over a 7 year period (Liston and Dall, 2003).

Haiart and Henderson (1991) demonstrated that radiographer / radiologist double reading had the potential to improve overall screening service accuracy because their radiographer identified two ‘interval’ cancer cases as ‘abnormal’ that the radiologist had overlooked. Interval cancers being those not detected at screening but presenting clinically before the next scheduled attendance (Heywang-Kobrunner et al., 2014). Pauli et al. (1996a) also demonstrated that double reading by radiologist / radiographer dyads increased the overall number of screen detected cancers by 6.4% in comparison to what the radiologists would have detected alone.

<u>Substantive theory</u>

Double reading offers the opportunity for individual practitioners to identify cancers that single readers miss (Wivell et al., 2003; Pauli et al., 1996a) due to inter-observer (reader) variability (Hillis, 2010).

Inter-operator variability in image interpretation is a recognised occurrence with human observers making different judgements and decisions when viewing and analysing the same (objective) image (Hillis, 2010; Moran and Warren-Forward, 2010). Inter-observer variability occurs because diagnostic reasoning is subjective and value laden (Norman et al., 2007). Different cognitive behaviours arise because no two people have identical knowledge, experience or prior exposure to cases and differences in perception occur due to natural biological variation in human brain anatomy and physiology (Krupinski, 2010). Differences in personality and personal attitudes and different responses to extrinsic (socio-environmental) factors such as inter-professional hierarchical relationships and evolved culture are also acknowledged sources of variability in affective behaviour but are less well understood.

Variation in the perceptive judgements (ability to detect lesions) of experienced radiologists interpreting mammograms has been reported at 16%, and variation in diagnostic decisions (differential diagnosis) at 6% (Pitman et al., 2011). Variation in the performance measures of radiographers in the six reviewed studies which reported individual radiographer, rather than pooled (mean), performance data is summarised in Table 4.2.

Table 4.2 Variation in radiographer performance

	Number of participants	Number of cases	Sensitivity (%) range	Specificity (%) range
Untrained				
Bassett et al. 1995	8	1238	31.3 (62.5 - 93.8)	70.2 (21.9 – 92.1)
deBono et al. 2014	10	500	16 (76.0 – 92.0)	21.4 (74.8 – 96.2)
Moran & Warren Forward, 2011	7	250	40 (57.0 – 97.0)	17 (63.0 – 80.0)
Trained				
Bassett et al. 1995	8	1238	26.2 (71.4 – 97.6)	29.9 (53.1 – 83.0)
Tanaka et al. 2014	6	75	40 (24.0 – 64.0)	51 (44.5 – 95.5)
van den Biggelaar et al. 2010a	3	1048	1.7 (88.5 – 90.2)	7.3 (76.9 – 84.2)
van den Biggelaar et al. 2010b	2	1994	2.2 (89.0 – 91.2)	0.6 (81.8 – 82.4)

Methodological and participant heterogeneity might explain some of the inter-study variation in sensitivity and specificity. For example the relatively poor performance of trained radiographers in Tanaka et al.'s (2014) study might be attributed to testing them on inherently difficult cases; the relatively good performance of deBono et al.'s (2014) radiographers might be attributed to their extensive (median 13 years) mammography image acquisition experience despite having no formal MIIR training.

With the exception of van den Biggelaar et al.'s (2010a; 2010b) two studies which measured the performance of a low number of participants over a large number of cases, it was not possible to otherwise explain why radiographer sensitivity varied by 16% - 40% and specificity by 17% - 70% within or across the studies. Specific theories about the development of diagnostic accuracy are presented later in Section 4.4.

Programme theory

There is no national recommendation for formal double reading in symptomatic services although a hypothetical argument to afford symptomatic patients a similar standard of service as in the NHSBSP might be proffered. In the face of an existing radiologist workforce shortage, it was hypothesised that involving radiographers in double reading in the symptomatic service would have to be justified by a clinically significant improvement in diagnostic accuracy.

Double reading inherently increases the time taken to reach a definitive decision about image appearances and increases service cost. Discordant interpretations in double reading increase overall diagnostic decision time further because they may require discussion to reach consensus or they prompt arbitration by a third party, the latter adds to service cost as it requires additional human resource.

It was hypothesised that double reading in the symptomatic service might be difficult to justify because it involved a trade-off between clinical impact, that is effect on cancer detection and more crucially patient prognosis (morbidity and / or mortality) against increased cost (resource use) and increased decision time (diagnostic delay).

This hypothesis was based on an initial conjecture that the advantages of double reading in the NHSBSP, increased diagnosis of small or subtle early stage and pre-invasive (*in situ*) cancers, were not readily transferable to the symptomatic setting because in this setting cancers would more likely be large and at a more advanced stage, and thus less likely to be missed by a single practitioner.

A UK study reported overall accuracy for triple assessment, incorporating single radiologist read mammography, in their symptomatic service of 99.6% (Britton et al., 2009). In this service 29 patients were discharged with a non-malignant diagnosis and presented with cancer during a subsequent 3 year period. In less than a third of these (n=9) a cancer was considered to have been definitely ‘missed’ (apparent but not recognised) at the time of initial patient presentation. The interval cancer rate in this ‘high risk’ cohort of symptomatic patients was 1.7 per 1000, lower than that in the NHSBSP low-risk asymptomatic population (2.1 – 3.43 per 1000) for the comparable period (NHSCSP, 2012). This team subsequently claimed that given the low number of cancers missed in a symptomatic service by single reading radiologists double reading of all cases would produce very little gain for a large increase in workload (Britton et al., 2012).

However, in an investigation of double reading for symptomatic cases in a decentralised healthcare service in northern Germany (Waldmann et al., 2012) further investigation rates rose from 3% to 5.7% (by 90%) for an increase in CDR from 14.6/1000 to 16.4/1000 (52 extra cases, 12.3%) when arbitration (third party casting vote) was used to resolve discordant cases. Just under a third of the additional cancers (32%) were pre-invasive *in situ* disease.

Although, as in the NHSBSP there is an over-diagnosis argument against the detection of (potentially non-life limiting) atypia / pre-invasive (DCIS) disease (Gotzsche, 2012) this can be refuted in the symptomatic setting by arguing that the detection of incidental small subtle multifocal / multicentric / bilateral malignant disease has the potential to alter surgical management which might reduce the risk of recurrent disease and thus improve long term patient health outcome.

It was hypothesised that double reading would increase patient clinic ‘transit time’ and that this might reduce patient ‘satisfaction’. In the absence of additional resource it was anticipated that double reading had the potential to reduce service (meso level) capacity, adversely increase waiting lists and reduce compliance with external performance targets. Although some individual (micro level) patients might benefit from increased diagnostic accuracy, diagnostic delay might adversely affect population (macro level) breast cancer survival rates (Rajkomar and Dhaliwal, 2011).

Despite the above arguments being equivocal about the feasibility and utility of double reading in the symptomatic service, 50% of the radiographers responding to Dixon et al.’s (2013b) survey stated that they were indeed involved in ‘double opinion interpretation and reporting images in combination with doctors, doctors and radiographers or other radiographers’ in UK symptomatic services. One respondent specifically stated that:

> *'Second reading of symptomatic patients is done at the time, if someone is available but cold (later in the week) if not.' (ID 8272)*

As a consequence, the following mechanisms for sharing MIIR responsibility between radiographers and radiologists were included in the initial programme theory for exploration in Stage 2 of the study.

4.3.2.1.1 Hierarchical double reading

It was hypothesised that arbitration or consensus could be eliminated to a large extent by ordinal hierarchical double reading.

In a large prospective trial conducted in three NHS breast screening centres in South West Thames (London, UK) the opinion of the radiologist was supplemented with that of a radiographer in a radiographer / radiologist double reading scheme of work (Pauli et al., 1996a). Although the images were interpreted independently by the two professional groups, radiologists re-reviewed any cases considered abnormal by radiographers and always made final decisions about whether these cases were recalled. In this way the double reading was both ordinal - the radiographer did the 'first' read and the radiologist did the 'second read', and was hierarchical because the radiologist could overrule radiographer decisions.

The 'red dot' and 'commenting' systems described earlier (see section 4.3.1.1) were ordinal because the radiographer was designated first reader and the radiologist designated second reader. It was hypothesised that the radiographer's opinion could be 'overruled' by the radiologist who had authority to make final decisive interpretations and that this would eliminate the need for discussion / consultation and thus not increase patient transit time further.

It was hypothesised that the radiologist would operate as a 'safety net' in hierarchical double reading because they would be responsible for recognising any radiographer (false positive and false negative) errors and preventing these errors having an adverse clinical impact on patient care. It was recognised that radiologist verification (second reading) time might become protracted where radiographers made excessive judgement errors that necessitate longer contemplation and / or discussion. The second reading radiologist would be responsible for providing a 'medical' interpretation of any 'descriptive' report compiled by the radiographer in a commenting system.

4.3.2.1.2 Independent (equivalent) double reading

Double reading would be 'equivalent' where two individuals of comparable status independently (blind) read images and reach a consensus or (third party) arbitrated decision. It was hypothesised that this might occur where a radiographer demonstrates similar performance standards to a radiologist.

Theories about how they might achieve comparable diagnostic accuracy are considered in more detail below in section 4.4. Hypothetical inferences about how this might affect decision time and service cost were extracted from the data of Wivell et al. (2003) who studied equivalent radiographer / radiologist double reading in the NHSBSP.

These investigators initially conducted a pilot study where radiographers re-read a retrospective sample of 1,000 archive mammograms that had been read originally by a single radiologist; they followed this up with a real-life study where radiographers double read a prospective sample of over 54,000 cases alongside their radiologist colleagues. Although the study did not estimate the relative costs of single / double reading or of radiographer / radiologist substitution in a double reading strategy directly, they investigators did compare reading times, the basis of cost estimation used by Haiart and Henderson (1991). The three radiographers in Wivell et al.'s (2003) study had slightly longer (43 - 58 minutes) mean times for reading (100 cases) compared to their four radiologists (31 – 58 minutes) but the difference was not considered to be statistically significant. In addition to concluding that radiographers could read screening mammograms as well as radiologists (see section 4.4. below) they also concluded that it did not take them any longer to do so.

It was hypothesised in this thesis that radiographers might do the same amount of work to the same standard as radiologists and that substituting radiographers for additional radiologists in a double reading scheme of work would generate cost efficiencies because 'like-for-like' they are less expensive to train and employ.

4.3.2.1.3 Radiographer double reading

It was hypothesised in this thesis that a service with no, or not enough, radiologists to cover the symptomatic clinics might substitute two radiographers who worked together in a double reading scheme of work. This theory was based on the hypothesised results of radiographer / radiographer double reading presented by Wivell et al (2003) and the pilot study of non-discordant radiographer only reading (NDROR) conducted by Bennett et al. (2012).

Wivell et al. (2003) demonstrated that individual (single reading) radiographers could detect as many cancers as a radiologist but also, when the results of individual radiographers were considered as a hypothetical double reading pair had the potential to detect 36% (32/90) of cancers missed by a single reading radiologist.

In Bennett et al.’s (2012) study, dyads of radiographers double read mammograms with radiologists only reviewing cases where the radiographers’ double read opinion was discordant. This study demonstrated radiographer / radiographer double reading performance standards not dissimilar to radiologist / radiologist or radiographer / radiologist double reading. In this thesis it was hypothesised that substituting two radiographers for a single radiologist might be an effective strategy for managing the workload in the face of a radiologist workforce shortage. It was hypothesised also that financial savings might be generated if the cost of using two radiographers was less than that of one radiologist.

The Bennett et al. (2012) study highlighted that radiographers lacked confidence making autonomous decisions without the direct involvement of a radiologist because they requested more formal training to help them cope with this additional responsibility. The investigators concluded that any reduction of workforce cost achieved by substituting a lower paid professional would have to be considered alongside any increase in costs, both to the service and to the clients, of cautious decision making that resulted in increased recall (false positive) rates, or additional training to improve confidence. In this thesis it was hypothesised that cautious decision making about symptomatic mammograms in practitioners who lacked confidence, might result in increased numbers of ultrasound and/or tissue sampling procedures performed on cases that turned out to be normal or benign.

4.3.2.2 Radiographer single reading

Single read judgements and decisions are made autonomously without the direct involvement of the radiologist and have direct impact on patient management. Sixteen (42%) of the radiographers responding to Dixon et al.’s (2013b) survey who worked in symptomatic units stated that they were involved in single image interpretation and reporting where they took full responsibility for diagnostic decision making without involvement of a radiologist.

It was hypothesised that in the pre-screening / filtering role described above (section 4.3.1.2.1) the radiographer would operate as a single reader for normal and uncomplicated benign cases that were not passed on to a radiologist. Additionally it was hypothesised that radiographers would operate as single readers in the substitution (section 4.3.1.4) and hybrid practitioner (section 4.3.1.5) roles described above.

Kelly et al.’s (2008a) description of the appointment of a consultant breast radiographer in the north west of England explained how single reading radiographers were fully legally accountable for their practice. The professional regulatory bodies of both radiographers and radiologists are in agreement that such radiographers are accountable and responsible for their errors (RCR and SoR, 2012).

It was hypothesised that radiographers in single reading roles would need to be confident in handling this responsibility (Bennett et al., 2012; Wivell et al., 2003) if they were to avoid ‘defensive practice’ and over cautious decision making (Berner and Graber, 2008). Without confidence, it was suggested that reduced diagnostic accuracy, in particular reduced specificity, might offset cost efficiencies of replacing radiologists with radiographers.

4.3.3 Strategic organisational consequences

In addition to the professional and clinical support of medical colleagues, it was hypothesised that successful professional boundary shift was also dependent upon radiographers receiving organisational support from imaging department managers. Beyond funding training and promotion, organisational support might be demonstrated in provision of time and funding for continuing professional development (CPD) activity such as study leave, conference fees and journal and internet access. Practitioners might expect to undertake a minimum of 10 hours external continuing professional development per annum (BASO, 2005).

In return for their encouragement and support it was envisaged that service managers would enjoy flexibility of staff deployment because they had a pool of radiographic staff who could cover for (radiographer and) radiologist sickness, holidays and vacancies. Beyond the remit of this thesis, those radiographers might become involved in interpreting and reporting the full range of mammography examinations that includes asymptomatic screening of family history / and genetic mutation carriers, surveillance of patients with previously detected breast cancer or benign conditions and additional views performed for screen detected cases recalled to assessment.

Where a service did not have a shortage of radiologists, radiographer involvement in MIIR might be used as an additional resource to increase service capacity to help meet service performance (waiting time) targets. Alternatively radiographer involvement in MIIR might allow services to diversify their scope of practice because it enabled transfer of radiologist resource to develop and implement technical innovations and minimally invasive therapeutic (percutaneous excision) techniques.

4.3.4 Summary

The programme theories presented in the above section propose a variety of ways in which radiographers might become involved in symptomatic mammography image interpretation and undertake this instead of, or in addition to, radiologists.

Whilst the prevailing driver for involving radiographers was considered to be overcoming a radiologist workforce shortage, not all of these proposals addressed this problem, and some appeared to have the potential to increase radiologist workload.

Cost modelling appeared to show that replacing radiologists with radiographers had the potential to reduce service cost but this was contingent on both their diagnostic accuracy and their decision making confidence. Hidden costs associated with additional decision making time and unnecessary additional testing were identified.

Of note, most of the evidence reviewed evaluated the performance of radiographers in controlled environments which did not offer the opportunity to assess directly any impact on ‘real world’ patient or service processes or outcomes.

The hypothesised outcome footprint of the initial programme theories presented thus far is summarised in Table 4.3. The next set of programme theories considered the ‘mechanisms’ which need to come into play to enable radiographers to fulfil the roles and responsibilities described above - that is what resources radiographers need to operate competently and confidently whilst interpreting and reporting symptomatic mammograms alongside or instead of radiologists.

Table 4.3 Summary of initial programme theories about radiographer roles and responsibilities

Professional boundary change	Role	Responsibility	Potential consequences for reducing radiologist workload	Other intended and unintended consequences
Enhancement	Abnormality signalling	Hierarchical double reading Radiographer (first read) alerts radiologist to potentially abnormal images with red dot, verbal or written comment.	May reduce radiologist reading time because radiographer has already alerted them to 'true' positive (cancer) and negative (normal / benign) cases.	Directly cost neutral. Indirectly may increase costs due to additional radiographer decision time. May add additional radiologist time (and cost) for re-reading / discussing discordant cases.
Diversification	Pre- screening (filtering)	Selective single / double reading Radiographer (first read) filters out normal / uncomplicated cases that do not need radiologist interpretation	Reduces radiologist reading time by restricting workload to abnormal and complicated cases.	Threshold cost-effective depending on number of cases requiring radiologist review.
Substitution	Inter-professional double reading	Radiographer / radiologist dyads interpret independently (equivalent) or as first and second (hierarchical) readers.	Potential to increase radiologist workload for arbitration / consensus resolution of discordant cases.	Additional resource (human and financial) compared to current standard of radiologist single reading.
Delegation	Uni-professional (radiographer) double reading	Radiographer / radiographer dyads interpret independently (equivalent); (selective) radiologist review of discordant decisions	Two radiographers provide continuity of clinic service provision in absence of (single) radiologist. Cold review of discordant cases as and when radiologist available.	Threshold cost-effective depending on number of cases requiring radiologist review.
Specialisation Innovation	Radiographer single reading	Autonomous radiographer interpretation and reporting of mammography (+ / - other imaging) cases without radiologist involvement.	Reduces radiologist MIIR workload; releases them for other duties or addresses radiologist unavailability.	Cost savings if radiographer MIIR performance characteristics are the same as those of radiologist.

4.4 Theories about how radiographers learn MIIR

4.4.1 Introduction

Section 4.3 of this thesis explained the different roles in which radiographers might become involved in symptomatic MIIR and the different ways in which clinical responsibility for MIIR might be transferred or shared between radiographers and radiologists. Since the underlying purpose of mammography image interpretation is to detect breast cancer it was hypothesised that the role and responsibility that a radiographer might have would depend to a large extent on their ability to recognise abnormal mammographic appearances and to differentiate a potentially malignant abnormality from a benign condition or normal anatomical variation.

Studies of mammographic image interpretation that made direct comparisons between the performance of untrained and trained practitioners (Pauli et al., 1996b; Bassett et al., 1995), novice and experienced practitioners (Nodine et al., 2002; Lesgold et al., 1988) and specialist and generalist practitioners (Sickles et al., 2002) consistently demonstrated better performance (diagnostic speed-accuracy) in trained, experienced and specialist practitioners. This section of the thesis presents the initial programme theories that explained how radiographers might learn to interpret and report mammograms as accurately and as quickly as radiologists and how this could influence their ability to fulfil the roles and responsibilities described above. These programme theories explained how resources might affect the reasoning of practitioners at individual (micro) and professional (meso) level.

4.4.2 Substantive theories

Pauli (1993) argued that mammography image interpretation was a two-stage process comprising detection and interpretation. The terminology used to describe image interpretation in the studies reviewed whilst developing the initial programme theories was varied and inconsistent but suggested it was a three-stage process. After the detection (perception) and interpretation (cognition) stages identified by Pauli (1993) a third stage ‘action’ was hypothesised to broadly align with ‘reporting’ in the MIIR process in the symptomatic service, see Table 4.4.

Table 4.4 Terminology used to describe the MIIR process in literature reviewed

Perception	Cognition	Action
see	recognise	record
detect	characterise	note
notice	think to be	recommend
look at	consider	comment
locate	discriminate	report
identify	interpret	indicate
	evaluate	recall (patient)
overlook	apply decision criteria	provide information
	opinion	describe
visible	judge	review
evident	decide	discuss
apparent		draw attention to
in field of view	miss	identify
		alert
	categorise	
	classify	ascertain
	define	prove

Pauli (1993) suggested that detection and interpretation involved both analysis and decision making; it was hypothesised that the ‘action’ reporting stage also involved analysis and making judgements and decisions about what and how to record and communicate mammographic findings.

The following sections briefly outline four substantive cognitive theories which were fundamental to the initial programme theory. In Stage 1 of the study these were used to explain how variation in circumstances and practitioner characteristics (RE contexts) might trigger different diagnostic reasoning processes (RE mechanisms) and how this might affect the success (RE outcomes) with which radiographers, as individuals (micro level) and as a professional group (meso level) might interpret and report mammograms in the symptomatic service.

4.4.2.1 Hypothetico-deductive reasoning

Hypothetico-deductive reasoning occurs when clinical practitioners generate one or two most likely potential diagnoses (hypotheses) based on cues acquired early in the reasoning process and then prospectively ‘test’ these hypotheses by gathering selective additional information (Norman et al., 2009). Interpreting cues derived from the additional information as being either positive (supportive), negative (contradictory) or non-contributory, allows the practitioner to evaluate the consistency of their original hypotheses with the newly collected data (Patel et al., 2004).

4.4.2.2 Pattern recognition

Patel et al. (2004) contrasted this ‘backward driven’ approach, working back from a hypothesis to data collection, with a ‘forward oriented’ data-driven approach - ‘pattern matching’. Pattern matching theory is a knowledge / memory based categorisation approach explained in terms of direct automatic retrieval of memories (laid down during prior exposure) and assignment of new cases to established (diagnostic) categories (Elstein and Schwartz, 2002). Two theories which explain how new cases are matched to existing ‘memories’ have been proposed. Exemplar pattern matching is based on memorised categories derived from specific instances (or exemplars) – new cases are compared to, and only correctly recognised when they resemble, stored memories of previously encountered cases (Brooks et al., 1991). Prototype pattern matching is based on memorised categories that are abstract - individual exemplars are ‘averaged’ to create a category of ‘critical features’ (prototypes) with new cases compared and matched to the category that has the highest number of common features (Norman et al., 2007).

4.4.2.3 Heuristics and biases

Heuristics are intuitive mental ‘rules of thumb’ which may conflict with (normative) theories of rational decision making as a conscious, logical and deliberate endeavour (Gigerenzer, 2007). Bias is the systematic deviation from normative (rational) decisions. Heuristics and biases are not peculiar to diagnostic reasoning but reflect general suboptimal reasoning behaviours that people are inherently susceptible to (Bornstein and Emler, 2001). Heuristics and biases have an ecological basis and are triggered by the prevailing environment which explains why they can be domain (case and / or context) specific (Gigerenzer, 2004).

4.4.2.4 Dual processing

Dual processing is a two-system conceptualisation of judgement and choice (decision making) which blends intuitive (pattern recognition and heuristic) and analytical (hypothetico-deductive) reasoning (Kahneman, 2011; Croskerry, 2009). The theory differentiates fast ‘system 1’ reasoning which is automatic and intuitive from slower ‘system 2’ reasoning which is more deliberate and controlled. In visual diagnostic applications intuitive system 1 reasoning equates to a ‘global’ or ‘holistic’ approach and analytical system 2 reasoning involves a slow deliberate ‘focal search’ or ‘search-to-find’ approach (Heiberg Engel, 2008). Kahneman (2011) suggests that the two systems are interactive, with ‘system 2’ monitoring and controlling ‘system 1’, and are dynamic, generating different responses in different situations.

4.4.3 Programme theories

4.4.3.1 Informal experiential learning

Mammography radiographers are trained to produce images, that is to position patients and operate x-ray equipment, and check the technical quality of the image forwarded for interpretation and reporting to ensure it is fit for purpose (Allisy-Roberts and Williams, 2008). To make a correct judgement that the image is fit for diagnostic interpretation it was hypothesised in this thesis that radiographers must have some knowledge and understanding of what the 'interpreter' needs to see in the image.

The eight radiographers participating in Mucci et al.'s (1997) study had a mammography qualification but were not trained in mammography image interpretation. These radiographers had low sensitivity (68%), they did not detect as many cancers (n=14) as the radiologist (n=21), even though they considered more cases to be abnormal overall – they would have recalled 7.5% cases to assessment compared to 6.3% actually recalled by the radiologists (Mucci et al., 1997). However, the radiographers detected an additional 'interval' cancer case that had not been detected by a radiologist. This led the investigators to conclude that radiographers need not be formally trained in mammography image interpretation to be able to detect cancers that are missed by radiologists and thus have a positive impact on patient prognosis and survival (Mucci et al., 1997).

Some knowledge of normal and typical and common abnormal appearances might be gained in a formal educational setting where mammography training courses contain relevant lectures. Duijm et al. (2008) claimed that radiographers could build on this knowledge to develop image interpretation skills experientially if they were encouraged to look for abnormalities and bring them to a radiologist's attention. This would be an example of a 'commenting' abnormality signalling system as described in section 4.3.1.1 above. Holt (2006) provided evidence to corroborate this idea.

Holt (2006) reported the performance (sensitivity, specificity and reading speed) of five Canadian radiographers in comparison to two radiologists using a relatively small (n=50) test set of cases extracted from a 'diagnostic' archive. The radiographer participants had between 5 and 20 (mean 15) years of experience of acquiring mammography images but had no formal training or experience in image interpretation; in contrast the two radiologists had 25 and 30 years of experience in mammographic image interpretation.

Holt (2006) manipulated the participants’ performance data using three possible thresholds for test negative and test positive definitions. Under ‘option 1’ where only the category ‘benign - no abnormality detected, needs no follow up’ was considered ‘test negative’ and the categories ‘probably benign - may need some follow up, ultrasound or 6 month recheck’, ‘suspicious abnormality - definite follow up, ultrasound or biopsy’ and ‘highly suggestive of malignancy - definite biopsy required’ were considered test positive, mean radiographer and mean radiologist sensitivities were both 100% - the radiographers and radiologists all detected all seven cancers. Under this ‘option’, as in Mucci et al.’s (1997) study mean radiographer specificity was lower (68%) than that of the radiologists (mean 93%). Using an alternative threshold however, ‘option 2’ where ‘probably benign’ cases were also considered ‘test negative’, three of the radiographers had equal or better specificity than one of the radiologists.

Holt (2006) suggested that the impressive performance of her radiographer participants was because they worked in a unit which allowed them to initiate additional imaging in cases they ‘perceived to have an abnormality’ and which ‘encouraged them to give their opinion’ to reporting radiologists.

Overall the fifteen reviewed studies that evaluated radiographer performance against actual (immediate or delayed) patient outcome (absolute accuracy) suggested that radiographers who are trained in mammography image acquisition but not formally trained in MIIR were likely to make more errors than those who have undertaken some task-specific training. Although there was significant overlap in the results the overall mean sensitivity (ability to detect cancer) for radiographers who had undergone some MIIR training was higher than that of image acquisition radiographers with no MIIR training, see Table 4.5.

Table 4.5: Performance of practitioners with and without MIIR training

Sensitivity (%)	Untrained	Trained
Moran & Warren Forward, 2011	75.0	
Moran & Warren Forward, 2010	62.8	
Bassett et al. 1995*	82.9	
Mucci et al. 1997	68.0	
deBono et al. 2014	82.2	
Duijm et al. 2008	60.2	
Sumkin et al. 2003	71.4	
Holt 2006	91.5	
Haiart & Henderson 1991		80
Pauli et al. 1996a		72.7
Wivell et al. 2003		80.5
Bassett et al. 1995*		86.6
Tanaka et al. 2014		46.7
Dowdy et al. 1970		100
van den Biggelaar et al. 2010a		90.1
van den Biggelaar et al. 2010b		89.0
Mean	**74.3**	**80.7**

* this study compared performance before and after training.

The theoretical literature offers several explanations why radiographers without specific MIIR training might have low diagnostic accuracy.

With limited, and lack of task-specific, knowledge and no formal training or experience in interpreting the images they produce, the image-acquisition radiographer is likely to be pre-disposed to hypothetico-deductive (backward) diagnostic reasoning (Azevedo et al., 2007). Their ability to consider and confirm a correct diagnosis is limited because they can generate only a narrow spectrum of disease- and condition- specific hypotheses.

Analytical (hypothetico-deductive) reasoning in untrained and novice practitioners is deliberate and slow (Nodine et al., 2002). Moran and Warren-Forward (2010) suggested that variation in degree of experience explained why the time to read (a test set of 50) cases in their study varied by a factor of 5 (range 35-180 minutes) between their slowest and fastest participant although they observed no direct correlation between reading time and experience or between reading time and profession. By contrast the untrained and inexperienced radiographers in Holt's (2006) study took 3 times as long (mean 37, range 25-60 minutes) as their experienced radiologist co-participants (mean 12, range 10-15 minutes) to read a test set of 50 images. The researcher suggested that this might reflect lack of training, inexperience, lack of confidence and (study) performance anxiety but suggested these might reduce with more experience. It was hypothesised in this thesis that untrained radiographers might have prolonged decision times and that this had the potential to reduce throughput and increase patient waiting times with a consequential increase in service cost.

The pattern recognition ability of untrained practitioners is also weak because they have a restricted memory store of exemplars (Brooks et al., 1991) and they lack the experience to generate theoretical prototypes (Bordage and Zacks, 1984).

Clinical reasoning is impaired because the ‘recognition’ heuristic (similarity bias) which prompts intuitive and rapid disease identification is restricted to identifying the limited range of conditions encountered previously; ‘confirmation’ bias also prompts them to seek only further information (hypothesis testing) which supports their limited range of diagnoses (Norman et al., 2007). Conversely however, in the context of this thesis the presence of large, obvious cancers, as might be expected in patients referred to a symptomatic clinic, would enable the recognition heuristic to work advantageously and allow untrained radiographers to correctly identify a high proportion of abnormalities that exhibited classic ‘text-book’ appearances (Goldstein and Gigerenzer, 2002).

The impressive sensitivity of Holt’s (2006) untrained radiographers might be explained by prevalence bias because she used an enriched test set where cancer was present in 14% (7/50) of the images in comparison to a ‘real-life’ consecutive symptomatic clinical case mix where prevalence is usually less than 10% (Britton et al., 2012; Patel et al., 2000). Although Holt (2006) chose non-screening cases purposefully to inflate the number of positive (cancer) cases because she wanted to reduce reader bias against the presumption of normality (screening cases in asymptomatic low-risk women), paradoxically this might have introduced prevalence bias.

Despite high prevalence-linked sensitivity without the ability to recall in-depth knowledge about the full range of possible pathologies and their associated clinical significance, it was hypothesised that radiographers without MIIR training would be predisposed to generate descriptive reports. They would focus on visual appearances by describing what they can see because they lack the knowledge to make inferences about what the appearances represent in terms of biology / physiology and thus patient health status (Manning, 2010). Descriptive reports rely on the receiving clinician, in the symptomatic clinic this would be the surgeon, understanding the meaning of specialist terminology, or technical radiographic ‘jargon’, and being able to synthesise a description of the image with relevant clinical information for themselves to make inferences about diagnosis and patient management.

Practitioners without formal MIIR training would be expected to make a high number of mistakes and consensus opinion in the literature suggested that their overall accuracy is too low for autonomous clinical practice (Moran and Warren-Forward, 2011; Moran and Warren-Forward, 2010; Bassett et al., 1995). Whilst this precludes them from taking full responsibility for MIIR it was hypothesised in this thesis that such radiographers might be engaged in an abnormality signalling role where they shared decision making responsibility with colleagues who were trained formally and were experienced in MIIR. These hypotheses were tested in Stage 2 of the study by including one site which encouraged all mammography acquisition radiographers to participate in a written commenting system.

4.4.3.2 Formal learning

Most of the 38 radiographers who worked in the symptomatic service responding to Dixon et al.’s (2013b) survey had obtained formal university post-graduate awards including mammography image interpretation modules (n=26, 69%) or had undertaken a stand-alone module in image interpretation (n=10, 26%) and more than 60% (n=23) indicated that their training had covered both screening and symptomatic cases

Ericsson (2004a) described three elements of ‘training’ that he considered necessary for the development and maintenance of ‘expertise’ in a discipline - instruction on how to improve, timely feedback on performance and ample opportunity to repeatedly practice skill. These three elements were identifiable (Table 4.6) in the ‘methods’ sections of three papers, from those which described studies that had assessed the performance of radiographers before and / or after training (Duijm et al., 2008; Bassett et al., 1995; Dowdy et al., 1970). The remaining papers that assessed the performance of trained radiographers gave no specific detail about their training.

Table 4.6 Regimes used to train radiographers in MIIR

	Dowdy et al., 1970	**Bassett et al., 1995**	**Duijm et al., 2008**
Instruction	Reading texts Study teaching films	Didactic workshops	Instruction Regular updates Symposium attendance
Feedback	Film quiz Written examination Case review & discussion	Case review & discussion Written commenting with feedback	Case review Pathology follow up Discussion
Repetition	3 months practice	6 - 10 weeks practice	2.5 years practice

4.4.3.2.1 Instruction

In this thesis it was hypothesised that radiographers might acquire comprehensive knowledge about symptomatic breast disease and its management, and develop the necessary skills to apply this to their diagnostic reasoning and decision making in the symptomatic setting, by undertaking a formal training course which offered a combination of academic and practice based learning opportunities. It was envisaged that on completion of this a radiographer might be certified ‘fit for practice’ on the basis of successfully passing formal independent assessments of their performance.

Formal programmes of study in MIIR are provided in the UK by HEIs (universities) and are accredited by the radiographers’ Professional Body - the Society and College of Radiographers. They require the postgraduate radiographer ‘student’ to undertake a range of classroom based and experiential, workplace learning activities and they assess both their academic knowledge and understanding and their ability to apply this to the MIIR task in clinical practice.

Mucci et al. (1997) speculated that radiographer sensitivity, their ability to identify abnormality in a true cancer case, should improve with training. In this thesis it was hypothesised that a training course’s teaching, learning and assessment strategy would influence how well radiographers were prepared for a role in which they had to make accurate judgements, they had to have both high sensitivity and high specificity, and make insightful clinical decisions about patient management.

A purely didactic ‘chalk and talk’ classroom based theory driven approach would be expected to limit the student’s knowledge to that of their teachers (Ericsson, 2004a). Trainees taught purely in the classroom might be conditioned towards hypothetico-deductive reasoning and would have limited pattern recognition ability unless they were exposed to the wide range of clinical information and mammographic appearances they might encounter in authentic ‘real-life’ practice (Goldstein and Gigerenzer, 2002). Lacking a large memory store of true exemplars a student trained in MIIR this way would still be prone to errors arising from over reliance on the representativeness heuristic and confirmation bias.

A teaching and learning strategy that included supplementary use of ‘case study’ simulations (Berner and Graber, 2008) incorporating the typical range of normal variant, benign and malignant pathology encountered in symptomatic practice might assist the student to develop a wide range of exemplar memory patterns (Brooks et al., 1991) and develop prototype pattern recognition ability (Bordage, 2007). Development of theoretical prototypes would improve the student’s ability to interpret abnormalities not previously encountered because abnormality characteristics can be matched to categories of representative features rather than specific previously encountered exemplars (Bordage, 2007). Improved pattern recognition skill has the potential to increase the students ability to perceive and discriminate true abnormalities, and thus increase their accuracy as well as reduce their deliberation time (Nodine et al., 1999).

The recognition heuristic also works to the student’s advantage when teaching material is representative of the spectrum of disease encountered in real-life clinical practice (Goldstein and Gigerenzer, 2002). Availability bias (Elstein and Schwartz, 2002) prompts the recognition of conditions recently learned about but might lead to incorrect judgements if probability estimation is skewed because the training case mix does not reflect true prevalence. Typically training case sets have high disease prevalence and thus over emphasise the likelihood of abnormality encountered in clinical practice. This readily explains why students and novice practitioners have high sensitivity, they ‘overcall’ and have more ‘false positive’ cases, at the expense of lower specificity. It can be argued that training with a large number of ‘abnormal’ cases helps reduce the risk of missing significant pathology (Pusic et al., 2012) but in clinical practice high false positive rates are associated with increased human and financial costs where additional tests are performed to clarify / confirm diagnoses. Patients experience anxiety and may suffer from minimally-invasive procedure related complications; additional tests involve additional staff time and clinical resources.

Performance under ‘test’ or ‘simulated’ conditions does not necessarily translate to real-life clinical practice (Gur et al., 2008; Rutter and Taplin, 2000). Objective measures of diagnostic accuracy show performance to be better under clinical conditions than in the laboratory (Gur et al., 2008; Wivell et al., 2003). Under artificial and controlled ‘academic’ decision making conditions errors in reasoning occur because lack of direct consequence for patients and / or practitioners can reduce cognitive focus (van den Biggelaar et al., 2010b). Where learning is practice based the impact and consequences of student decision making have the potential for direct consequences on patient management. Learning in the real-life clinical setting can help reduce errors that might occur due to complacency because it occurs in an environment in which errors matter and are to be avoided (Berner and Graber, 2008). Sensitivity in particular, and with this the number of false positive judgements, might be expected to increase due to over-caution and regret bias (Worrall et al., 2009) if the student actively seeks to avoid the consequences of ‘missing’ a cancer.

The authentic clinical environment gives the student and newly qualified practitioner a realistic expectation of the time pressures on diagnostic reasoning in a busy clinic. Restricting decision time can have an independent beneficial effect, improving overall accuracy (Schmidt & Boshuizen, 1993 cited by Patel et al., 2004) because errors of judgment tend to become more likely, the true:false positive ratio reduces, as decision times lengthen (Nodine et al., 2002).

4.4.3.2.2 Feedback

Balanced positive (success) & negative (error) feedback can give a practitioner a realistic view of their performance, allow them to calibrate their judgement and decision making, and provide an opportunity for them to learn from their mistakes (Berner and Graber, 2008). If only errors are reported back, without feedback about successful cases, the error rate appears artificially inflated and can give a negatively biased perception of performance (Berner and Graber, 2008). A negative error culture has the potential to lower morale, increase work-related stress and reduce job satisfaction. Conversely, positive reinforcement of accurate decision making in the real-life clinical setting has the potential to improve the confidence of radiographers by allaying anxiety associated with the unfamiliar responsibility (Bennett et al., 2012).

In this study it was hypothesised that the performance of student practitioners would be monitored closely and that they would get balanced feedback routinely and within an organised system of work.

Knowledge of one’s own errors can improve future performance because of availability bias. Mistakes create vivid & easily recalled memories (Elstein and Schwartz, 2002). When a practitioner next encounters a similar case they are less likely to repeat the flawed reasoning that caused the previous error. However, this effect is time dependent with its impact reducing as memory fades.

Learning from mistakes is enhanced when feedback is timely (given soon after a decision error is made) and when cognitive information is provided to explain why a decision was wrong rather than simply providing information on the existence or number of errors as might occur with the provision of quantitative ‘audit’ data.

After the event judgements made retrospectively in case review and audit for example, are subject to hindsight bias. The perceived accuracy of the second / retrospective judgement is inflated and the probability of the actual diagnosis perceived to have been higher due to inadvertent synthesis of information gained subsequent to the original decision (Chapman and Elstein, 2000). Retrospective judgements are also subject to outcome bias - decisions are considered to have been better if outcomes are more favourable. These phenomena have the potential to overinflate error rates.

Monitoring and assessment of student competence includes follow up of cases to verify diagnostic accuracy either by comparing agreement with supervisor decisions or by making reference to a ‘gold standard’ pathological diagnosis. The respondents in Dixon et al.’s (2013b) survey reported that local mentoring and departmental support for their training was often sub-optimal. The benefit of practice learning would be reduced where the student was not given adequate time and / or supervision to obtain the feedback they need to calibrate their developing judgement and decision making behaviour (Berner and Graber, 2008).

Making students aware of their (potential) incompetence and / or ignorance and making them aware that they may have incomplete or inaccurate information helps avoid premature closure or ‘jumping to conclusions’ (McSherry, 1997). As a learning strategy this can prompt engagement in more comprehensive data gathering before reaching a decision. Awareness of limitations in their knowledge helps to dispel the illusion of ‘certainty’ in diagnostic reasoning and can help students identify where faulty heuristics and biases are influencing their judgements. With feedback and continued experience (Ericsson and Charness, 1994) students should learn to avoid breakdown in their clinical reasoning processes because they begin to synthesise a wide range of clinical and imaging information in order to make appropriate and insightful inferences (Payne et al., 1993).

4.4.3.2.3 Repetition

Both Bordage (994) and Norman et al. (2009) suggest that the real-life clinical workplace is the best learning environment. Extensive practice and experience with a wide range of authentic cases and the availability of immediate and regular feedback from a supervising mentor would be expected to expand pattern recognition memory stores, promote an accurate perception of probability (Gigerenzer, 2004) and foster a realistic perception of the student's own performance (Berner and Graber, 2008).

Development of skill, confidence and competence requires regular exposure and can be achieved through the practice effect and the volume effect (Ericsson, 2004a). Sickles et al. (2002) demonstrated that specialist breast radiologists who had more initial training and ongoing CPD and a higher annual mammography image interpretation caseload detected more cancers, more early stage cancers and had higher biopsy rates (symptomatic cases) but lower recall rates (screening cases) than radiologists who undertook only the regulatory minimum amount of training, CPD and cases.

BASO (2005) suggest a minimum annual caseload of 500 patients and a minimum of 2-3 sessions per week for practitioners involved in the symptomatic service. UK HEI training courses require radiographers to undertake a minimum number of real-life cases during their training which typically occurs over a single (September – May) academic year (London South Bank University, 2015; Universty of Leeds, 2013).

4.4.3.2.4 Hypothesis

It was hypothesised in this thesis that radiographers training in MIIR would undertake a formal HEI programme of instruction and assessment and practice under supervision. As a student they would 'double read' cases and share decision making responsibility with a supervising mentor. It was hypothesised that radiographers might encounter approximately 300 cases during training and would need additional experience post-qualification before they could practice independently. These hypotheses were tested in Stage 2 of the study by encouraging and prompting all participants to describe and explain how radiographers were trained in MIIR.

4.4.3.3 Progression from novice to expert

Differences in the reasoning processes of novices and experts have been described with the broad distinction being novice reasoning processes are slow, explicit and analytical and by contrast expert reasoning tends to be rapid and intuitive. Table 4.7 summarises some of the common terminologies used to contrast the two approaches.

Table 4.7: Terminology for differentiating novice and expert reasoning strategies (Heiberg Engel, 2008)

Novice – explicit reasoning	Expert – intuitive reasoning
• Slow, serial, effortful, deliberate, controlled (system 2) • Recognising separate parts • Perception of parts • Search to find • Focal search • Analytical, conscious, controlled	• Fast, automatic, effortless, associative, difficult to control or modify (system 1) • Recognising the whole • Recognition of patterns • Holistic • Global impression • Non-analytical, unconscious, automatic

As with students, novices with limited skill and experience tend to be predisposed to hypothetico-deductive (analytical) cognitive reasoning which is associated with high error rates and prolonged decision times (Nodine et al., 2002). Long inherent judgement & decision times may also be protracted because novices lack the confidence to make decisions and feel the need to consult colleagues for a second opinion. Slow conscious deliberation and error have the potential to adversely affect patient satisfaction and health status because they increase clinic transit / waiting time, and may increase morbidity and mortality which reduce quality and duration of life.

The studies that reviewed novice practitioners, those with limited MIIR training and / or experience, demonstrated low sensitivity and specificity. Although radiographer sensitivity (73 - 80%) was similar to that of radiologists (73 – 83%), their specificity (78-86%) was much lower than that of radiologists (86-95%), (Pauli et al., 1996a; Haiart and Henderson, 1991). In a radiographer who lacks ability and / or confidence, an enhanced sense of fear may generate regret bias (Worrall et al., 2009) and prompt cautious decisions which identify an excess of normal cases as abnormal (high false positive rate, low specificity) for fear of missing a cancer and / or being identified as having missed a cancer (Larrick, 2004).

This suggests that without review of novice radiographer decisions, that is double reading by a radiologist, they would subject a larger number of non-cancer cases to further tests. Continued double reporting can however generate complacency and tolerance of error (Berner and Graber, 2008). Fear or error, and thus desire to reduce error and improve performance may be mitigated in the novice if they continue to rely on the (second reading) radiologist to overrule false negative (missed cancer) cases, overrule recommendations for (unnecessary) further tests on false positive (normal / uncomplicated benign) cases and edit reports to add or alter recommendations for further patient management.

Over reliance on a radiological second opinion, as opposed to ‘working it out for themselves’’ can also condition (normalise) radiographers towards the performance characteristics of radiologists. Against the argument that this is an indicator of success is the counter claim that conformation bias, the herd / bandwagon effect, the ‘do what the majority do’ heuristic (Gigerenzer, 2004), prevents the radiographer improving beyond the performance (accuracy) of the supervising radiologist (Ericsson, 2004b).

In this thesis it was hypothesised that novice practitioners who had completed their programme of study and assessment successfully, might work in the symptomatic service alongside and under the supervision of a radiologist. These radiographers would be encouraged and supported to participate in MIIR and their confidence and diagnostic accuracy would be expected to improve with continued experience and feedback (Berner and Graber, 2008). It was hypothesised that the level of supervision of newly-qualified radiographers could be reduced over time because they would develop similar overall diagnostic accuracy and performance characteristics to radiologists. Following this ‘preceptorship’ period, the novice radiographer might assimilate into a ‘delegate’ single reading role with remote supervision. It was hypothesised that improving performance under a preceptorship scheme might alleviate any stress and anxiety in their new role and improve their confidence and job satisfaction.

4.4.3.4 Transferable learning from screen reading

Early studies of diagnostic reasoning suggested that ‘expertise’ was to some extent task and domain-specific because ‘good’ judgements in one type of clinical case were not necessarily predictive of a good judgements in another (Elstein, 2009). However it has also been suggested that expertise might be transferable if there is some skill overlap and where repetition and practice of a ‘general’ process make it available for use in a new context (Hatala et al., 2003).

By 2008 most of the 205 consultant and advanced radiography practitioners involved in NHSBSP image interpretation had achieved or were working towards formal HEI postgraduate training qualifications (Nickerson and Sellars, 2008). In clinical practice these radiographers would be expected to be reading a minimum caseload of 5000 (screening) cases per annum (Wilson and Liston, 2011). It was hypothesised in this study that mammographic image interpretation skill might be transferable and not prohibitively domain specific (Nodine and Mello-Thoms, 2010) between screening and symptomatic settings. It was suggested that using screen reading radiographers to interpret and report mammograms in the symptomatic service would reduce the need to train completely new practitioners generating time and cost savings.

4.4.3.4.1 Diagnostic reasoning

Successful performance in the symptomatic setting would depend on the ability of screen reading radiographers to overcome cognitive biases and limitations introduced by differences in the patient population and disease spectrum. These have the potential to hinder successful transfer of skill and knowledge to the new setting because they might introduce error into the diagnostic reasoning process.

Wivell et al. (2003) data suggested that screen reading radiographers have high sensitivity and might be relied upon not to miss cancers that a radiologists would detect because they are used to detecting small subtle cancers in the screening programme. By implication they might thus be expected to detect all cancers in the symptomatic service as these cancers tend to be larger because they are clinically apparent. A high prevalence of large, obvious cancers, as might be expected in patients referred to a symptomatic clinic, would enable the recognition heuristic to work advantageously and allow radiographers to correctly identify a high proportion of abnormalities that exhibited classic ‘text-book’ appearances (Goldstein and Gigerenzer, 2002). This could explain why sensitivity in the overall mixed population in van den Biggelaar et al.’s (2010b) study was higher (90.1%) than in the ‘asymptomatic’ subset of cases (77.5%).

Availability bias would increase the likelihood that screen reading radiographers had high sensitivity for small, impalpable ‘unsuspected’ cancers in the symptomatic population (Duijm et al., 2007; Wivell et al., 2003). Detecting small early stage cancers in patients with low clinical suspicion, those that have a normal or benign physical examination (P1, P2) affords them a good chance of early curative treatment. Furthermore the detection of additional small subtle cancers at sites remote from a clinically presenting cancer, that is the detection of incidental multifocal, multicentric or bilateral disease, would ensure symptomatic patients received appropriate, perhaps more extensive surgery, for example mastectomy rather than wide local excision. Long term this has the potential to improve individual and population breast cancer morbidity by increasing disease free survival and reducing recurrence and metastatic disease rates, and improve mortality (5-year and 10-year survival rates).

In the new symptomatic domain, unfamiliarity with the clinical information available and lack of exemplars for a wider range of, particularly benign, pathologies that are encountered in symptomatic referrals might induce hypothetico-deductive reasoning (Patel et al., 2004; Coderre et al., 2003) even in practitioners with extensive screening experience (Pelaccia et al., 2011). Compared to their performance in a screening population this could reduce their overall diagnostic accuracy, most notably reduce their specificity, and lengthen decision times.

Screen reading radiographers transferring their skill into the symptomatic domain would need to overcome expectation bias and its associated error in estimating probability of abnormality (Gigerenzer, 2004). False negative mistakes (missed cancers) reduce sensitivity and might occur if expectation bias skews their judgements towards ‘normality’ because the radiographers are used to a high prevalence of normal cases in the screening population and are conscious of the need to control recall rates in that setting. There is however evidence that overcompensation might occur - that conscious awareness of a higher prevalence of malignancy in the symptomatic population skews expectation bias towards ‘abnormal’ judgements, this results in more false positive cases and reduced specificity (van den Biggelaar et al., 2010b).

With training and practical experience in the detection of small, subtle clinically occult cancers as present in the screening population, and exposure to an extensive range of ‘normal’ variant appearances, the specificity (ability to correctly identify cases without cancer as ‘normal’) of experienced screen reading radiographers should however be better than that of completely novice MIIR practitioners with limited overall experience.

4.4.3.4.2 Hypothesis

In this thesis it was hypothesised that experienced screen reading radiographers might undertake a pre-screening role where they filtered out normal and ‘uncomplicated benign’ cases. This would limit their MIIR to the type of cases they were used to reading in the screening programme and thus had relevant exemplars for rapid pattern matching (Brooks et al., 1991) and recognition heuristics that would increase both their accuracy and reasoning speed (Gigerenzer, 2004).

In section 4.3.1.2 it was suggested that clinically equivocal (P3), suspicious (P4) and overtly malignant (P5) cases might be preferentially directed to radiologists and that radiologists might review any P1 and P2 cases that radiographers did not recognise as normal or overtly benign. This approach would overcome low specificity in the screen reading radiographer because it would limit over investigation of false positive cases (Pauli et al., 1996a).

The hypotheses that the knowledge and skill of NHSBSP screen reading radiographers might be transferred successfully into a symptomatic MIIR setting and that this might enable them to undertake a pre-screening / filtering role were tested in Stage 2 by recruiting participants from sites that provided combined (screening and symptomatic) services.

4.4.3.5 Expertise

There is very little literature about radiographers who might be considered mammography image interpretation ‘experts’ and whose ‘consistently superior performance’ (Ericsson, 2004a) might allow them to replace radiologists in a substitute role in symptomatic services. Ericsson (2004) suggested that expertise typically takes a period of 5 – 10 years to develop but in the studies reviewed, the MIIR training and experience of radiographer participants varied from two weeks to only a year (Table 4.8).

Invariably the studies that compared radiographer performance to that of radiologists used experienced breast radiologists as the ‘gold standard’. Although this might seem an unfair and perhaps theoretically flawed comparison, it is hypothesised in this thesis that radiographers need to match the performance of characteristics of the current ‘standard of care’, that is the standards achieved by experienced radiologists, if they are to replace them without adverse impact on clinical patient outcomes.

Table 4.8 MIIR training and experience of radiographer participants

	Location	MIIR training / experience
UK screening		
Dowdy et al. 1970	USA	6 months
Haiart & Henderson 1991	UK	6 months
Bassett et al. 1995	USA	6 weeks
Pauli et al. 1996a	UK	2 weeks
Wivell et al. 2003	UK	Postgraduate certificate
van den Biggelaar et al. 2010a	NL	1 year training and experience
van den Biggelaar et al. 2010b	NL	9 months (500 hours)
Tanaka et al. 2014	Japan	BSP certification (with image perception)

The development of mammography image interpretation expertise is associated with high diagnostic accuracy and expeditious diagnostic reasoning – improved decision speed / accuracy (Nodine et al., 1999).

Wivell et al. (2003) suggested that once they had completed training and a supervised post-qualification preceptorship period the speed-accuracy of trained NHSBSP screen reading radiographers was not significantly different to that of radiologists. Their study demonstrated how training enabled radiographers to reach similar sensitivity to radiologists and how continued experience helped to improve their specificity.

Two radiographers who had obtained a university postgraduate certificate in mammography image interpretation and analysis participated in an initial retrospective reading exercise using a prevalence enriched test set of 1000 cases. Each radiographer individually identified all the cancers detected by the original radiologist (single) reader (similar sensitivity) and between them identified 36% of the interval cancer cases missed by the original radiologists. In this initial experiment radiographers would have recalled 3.9% more cases to assessment than the radiologists did (lower specificity). Subsequently when three trained radiographers read 54,000 cases over a 3.5 year period in a real-life setting, no significant differences between radiographer and radiologist cancer detection (sensitivity) or recall performance (specificity) were demonstrated.

Wivell et al. (2003) demonstrated no statistically significant (p=0.377) inter-professional difference in the reading times of experienced radiographers and experienced radiologists although their raw data showed that the radiographers on average (mean) took 6 seconds longer to interpret each case. This difference equates to an extra 2 minutes in a clinic performing 20 mammograms per session. It was hypothesised that the inter-professional difference might be greater in the symptomatic service because the cases would be more complex clinically, the radiographer must make a differential diagnosis not just detect abnormality and the task involves deciding what information to include in a written report.

4.4.3.5.1 Diagnostic reasoning

In an arguably similar visual diagnostic domain to mammography image interpretation, Heiberg Engel (2008) noted that novice practitioners interpreting breast pathology slides more often used a slow deliberate ‘focal search’ or ‘search-to-find’ (system 2, analytical) mode of reasoning compared to experts who tended to use a ‘global’ or ‘holistic’ (pattern recognition) search mode. In addition the expert practitioners also appeared to cross-check their ‘intuitive’ diagnostic conclusions by employing a final ‘search-to-find’ strategy – an example of the ‘system 2’ monitoring function described in Kahneman’s (2011) dual processing theory.

Dual processing enhances the cognitive processes of expert practitioners by optimising the blend of intuitive (heuristic) and analytical (hypothetico-deductive) reasoning (Kahneman, 2011; Croskerry, 2009). This helps them recognise the ‘satisfaction of search’ heuristic, avoid premature closure and carry out more comprehensive knowledge seeking to reach correct conclusions (Gigerenzer, 2004).

In mammography image interpretation dual processing typically involves a ‘global discovery’ phase in which visually conspicuous lesions are rapidly recognised followed by a slower ‘focal, search and identify’ phase in which harder to discern and equivocal or ambiguous lesions are detected (Nodine et al., 2002). Nodine et al. (2002) demonstrated that experts, who they defined as experienced and undertaking 3000 – 5000 cases per annum, had a shorter ‘global discovery’ phase (25 seconds) compared to novices, defined as trainees with experience of less than 1000 cases, (40 seconds). This study also demonstrated that experts detect more true lesions than novices (71%, 46% respectively) in the global discovery phase of the reasoning process.

Pattern recognition theory explains expeditious reasoning in experts in terms of new memories being laid down and older ones being reorganised or fading away. The expert’s extensive experience enables them to construct a large comprehensive and well-organised memory store of previously encountered exemplars and characteristic theoretical prototypes.

The operation of ‘fast & frugal heuristics’, mental shortcuts such as recognition and availability heuristics and use of ‘optimising search and stopping rules’, also explains why experts can make judgements more quickly and reduce their overall decision time (Gigerenzer, 2004). After demonstrating that longer decision times were associated with an increased number of errors, Nodine et al. (2002) suggested that experts terminate (are satisfied with) their (visual) ‘search’ at the point where their decisions (about focal areas of interest in the image) are still resulting in more true- than false-positive judgements.

4.4.3.5.2 Feedback and calibration

It was hypothesised in this thesis that the diagnostic reasoning of radiographers with extensive experience in MIIR would be well-calibrated because they continued to seek feedback on their performance post-training and preceptorship. A realistic awareness of their own strengths and limitations would allow them to distinguish cases that could be diagnosed quickly and easily from exceptional cases that required more deliberation (Berner and Graber, 2008). A heightened appreciation of potential and actual errors in their own practice should help dispel the illusion of diagnostic certainty, reduce any complacency and prompt continued knowledge seeking behaviour (Berner and Graber, 2008).

It was hypothesised that radiographers undertaking symptomatic MIIR in an autonomous independent single reporting role might obtain feedback on their own performance, and that of others by participating in peer review activities such as individual and / or service audit and clinical error meetings. Symptomatic services in the UK do not have a tradition of rigorous audit as exists in the screening service and the symptomatic performance of radiologists is not scrutinised routinely or formally (Britton et al., 2012). It would be logical for radiographers that were substituting for radiologists performing MIIR in symptomatic clinics to also attend MDT clinical discussion meetings so they could follow up the cases they had interpreted and reported. Positive reinforcement of accurate decision making in the real-life clinical setting has the potential to improve the confidence of radiographers in an independent substitute role because it might allay anxiety associated with the unfamiliar responsibility of autonomous decision making (Bennett et al., 2012).

Raising practitioner awareness of the potential for error, its clinical impact and the ability to reduce error might generate unease and instil a desire for error reduction (Berner and Graber, 2008). Case discussion, or root cause analysis, helps practitioners understand how their own mistakes, and those of others, arise and how they can be prevented (Graber et al., 2005). This can lead to a pragmatic understanding that diagnostic errors may be due to decision errors or be chance occurrences (bad luck) and that errors are not the same as, and do not always correlate with, adverse events / poor outcomes (Elstein, 2009; Berner and Graber, 2008). In particular this approach has the potential to develop a practitioner's confidence in making a 'not cancer' judgement and thus improve specificity.

4.4.3.5.3 Preferential detection behaviour

In addition to the phenomenon of inter-observer variation described above (see section 4.3.2.1) individual radiologists exhibit 'preferential detection behaviour', that is their individual personal memory stores and individual biases and attitudes generate a consistent response for 'different types of depictions of cancer' (Gur et al., 2008). There was evidence in the studies reviewed to suggest that preferential detection behaviour might exist at a professional level and pre-dispose radiographers and radiologists to detect different types of cancers.

Duijm et al. (2008) and Wivell et al. (2003) both demonstrated that radiographers preferentially detected more 'good prognosis' *in situ* (early pre-invasive) and smaller (less than 15 mm diameter) invasive cancers than radiologists. Wivell et al. (2003) speculated that this might be because radiographers typically undertake a more rigorous external HEI training programme than radiologists who only undertake experiential learning with mentorship and supervision during a period of (specialist registrar) secondment (BASO, 2005; RCR, 2003).

In a double reading scheme of work this might suggest that combining the diagnostic opinions of radiographer and radiologists would add value over and above that derived from (uni-professional) double reading.

However by comparing performance over the first and the last 30,000 cases during a four year study period, Eve et al. (2002) demonstrated that preferential detection of large, high grade tumours by radiologists and small cancers by radiographers reduced over time, although preferential detection of microcalcification (associated with early pre-invasive cancer) persisted in radiographers.

Wivell et al. (2003) suggested that over time radiographers and radiologists working (double reporting) together learn from each other and this cancels out any differences. Payne et al. (1993) suggests that this is due to adaptation of heuristic behaviour. Gigerenzer (2004) description of social conformation bias (the herd or bandwagon effect), a heuristic (sub-conscious intuitive) tendency to mimic behaviour observed in peers, provides a plausible theoretic explanation for reducing inter-professional variation over time.

Encouraging radiographers in an autonomous role to validate their performance (objectively) against actual cancer status using patient follow up, rather than (subjectively) by reference to radiologist decisions (surrogate outcome), might help them avoid ‘gravitating to a common mid-point’ (Gigerenzer, 2004) where they learn to make the same mistakes as radiologists. This approach also has the potential to enable radiographers to exceed the performance standards of radiologists who might have trained or supervised them (Ericsson, 2004a).

4.4.3.5.4 Volume and practice

Maintenance and improvement of skill, confidence and competence requires regular exposure. It was hypothesised in this thesis that radiographers might develop and maintain their expertise through practice and volume effects (Ericsson, 2004a). In accordance with BASO (2005) guidelines radiographers replacing radiologists in the symptomatic service would need a minimum caseload of 500 (non-screening) cases per annum and a minimum of 2-3 (half day) sessions per week to maintain their competence. It was also hypothesised that maintenance of competence in screening

MIIR would be desirable and thus they would additionally require access to 5000 (screening) cases per annum (Wilson and Liston, 2011).

Double reading increases the volume of cases interpreted and reported by individual practitioners and thus has the potential to improve pattern recognition skill because it provides additional exemplars and material for prototype building. Double reading would enable radiographers to see the work of others and get peer feedback by comparing their own judgements to those of colleagues. Equivalent double reading might involve practitioners in discussions to resolve discordant opinions (two readers disagree) and is an additional resource for learning. Double reading need not be formally constituted – it might also occur informally and sporadically if practitioners encounter a perplexing case and seek a second opinion.

Cornford et al. (2011) and Pauli et al. (1996b) demonstrated that constant increases in individual volume (number of cases) were not always associated with corresponding increases in practitioner accuracy. This suggested that there is perhaps an optimal workload-practitioner ratio which could maximise the diagnostic accuracy of the service. It was considered that substituting some radiographers into the MIIR role might improve overall service accuracy where the demands of an excessive caseload might be reducing the accuracy of over-worked radiologists (Cornford et al., 2011; Pauli et al., 1996b).

It was envisaged that one of the unintended consequences of involving radiographers in MIIR would be to reduce the opportunity for radiologists to undertake MIIR and that this might eventually diminish the competence and skill of experienced radiologists (Ericsson, 2004a) and inhibit training opportunities for new radiologists (Johansen and Brodersen, 2011). The feasibility and attraction of substitution was therefore anticipated to be site specific dependent on local availability of radiologists and local service demand. It was hypothesised that substitution might occur successfully at sites where there was a shortage of radiologists and / or where demand outstripped current capacity.

4.4.3.5.5 Hypothesis

The survey conducted by Dixon et al. (2013b) revealed that some UK radiographers involved in symptomatic MIIR had undertaken their training more than 10 years ago (n=9, 24%) and that most respondents had at least 6-10 years of experience (n=16, 42%). The average workload indicated by these respondents exceeded the NHSBSP screen reading requirement by 44% (2200 cases over the 5000 minimum) and was more than double (1020) the recommended volume (500) of symptomatic cases.

This data suggested that there might be a body of radiographers practising MIIR in the UK who would be considered to have, or be approaching ‘expert’ status. It was thus hypothesised that these ‘expert’ radiographers might substitute for radiologists and assume responsibility for symptomatic MIIR without medical supervision.

4.4.3.6 Professional culture

4.4.3.6.1 Overconfidence and metacognition

Berner and Graber (2008) suggested that over-confidence in medical practitioners can render them susceptible to errors arising from pervasive arrogance and unconscious cognitive incompetence. In contrast, radiographers are recognised to have a tradition of self-deprecation and humility, perhaps derived from their conventional subordinate role with radiologists (Nixon, 2001).

This difference in professional background and outlook might predispose radiographers to lack confidence and overestimate the potential for uncertainty & error in themselves (and others). A welcome consequence of this would be that they exhibit knowledge seeking behaviour and gather more comprehensive data to avoid making errors. At micro level a heightened sense of cognitive weakness might explain why radiographers tend to take longer to look at and think about cases and seek more clinical information, to avoid premature closure for example. Deliberate and analytical reasoning in such situations prolong decision, and thus patient waiting / clinical transit times, but might be justified on the basis of error reduction (improved accuracy) and reduced radiologist workload (reduced second opinions).

At meso level radiographers might prefer to more readily seek the feedback and second opinion of colleagues. At macro level radiographers might seek to attend study days and engage with literature in order to increase their knowledge and understanding and improve their judgement and decision making skills in an attempt to reduce their risk of error.

Radiography education focuses heavily on reflective practice which enables professionals to learn from their experiences (Jasper, 2003). The purposeful consideration of prior experience, to facilitate understanding and modification of future practice that characterises reflective practice (Jasper, 2003), is akin to the psychological concept of metacognition - the ability to know how well you are performing, when you are likely to be making accurate judgements and when you are likely to be making errors (Kruger and Dunning, 1999). Metacognition is an important intellectual characteristic that can help radiographers recognise situations where they have incomplete or inaccurate clinical information or where their medical knowledge is limited such that their diagnostic reasoning / synthesis breaks down or their heuristic judgements and decisions are faulty.

4.4.3.6.2 Decision support tools

In contrast to their medical radiology colleagues, it was hypothesised that non-medical radiographers are likely to place greater reliance on decision support mechanisms, such as clinical guidelines, local protocols and (computer based) automated prompts. Compliance with decision support tools tends to reduce reasoning times because individuals spend less time deliberating about cases, helps standardise practice bringing commonality and reliability to decision making, and aligns practice to the prevailing evidence base which optimises patient outcomes (Berner and Graber, 2008). Availability of decision support should reduce the need for radiographers to access second opinions from the supervising radiologist; this would reduce overall decision, and thus patient clinic transit time.

4.4.4 Summary

The literature reviewed in the above section suggests that mammography image interpretation is a complex diagnostic reasoning process which is influenced by a wide variety of cognitive and psycho-social factors. Existing decision making theory suggested that resources such as instruction, feedback and practice influence the accuracy and speed with which radiographers can interpret symptomatic mammograms.

It was hypothesised from this that training and prior experience would be key determinants of the role and responsibility a radiographer might have in symptomatic MIIR. The initial programme theories explained above, configuring the conditions and characteristics which might trigger successful involvement and the consequences over and above those described in section 4.3 are summarised in Table 4.9.

In the next section of this chapter, programme theories about the influence of the rapid access clinic environment and a multidisciplinary approach to clinical care (contexts) on the roles and responsibilities of radiographers involved in symptomatic mammographic image interpretation are presented.

Table 4.9 Summary of initial programme theories about radiographer attributes

Training and experience	**Diagnostic speed accuracy compared to radiologist**	**Potential role and responsibility**	**Triggering conditions**	**Potential Consequences**
Image acquisition only Untrained in MIIR	Lower sensitivity (<70%) Lower specificity Slower	Red dot First (double) reader Flag potential abnormality	Encouraged to recognise abnormalities Feedback on performance	Increased cancer detection No additional (direct) cost or time
Experiential learning in MIIR	Equivalent or higher sensitivity (100%) Lower specificity (<70%) Slower	Commenting First (double) reader Describe abnormality	Encouraged to offer preliminary opinion Feedback on performance	Increased cancer detection Hidden cost (additional) time – may be offset by potential to initiate additional mammographic views and streamline patient journey
Formal external training and practical experience in NHSBSP screen reading	Equivalent or higher sensitivity (100%) Specificity and speed may be lower for symptomatic cases	Pre- screening Single read normal / uncomplicated cases First (double) read abnormal cases	Standard template reports for normal / uncomplicated cases Protocol for double reading abnormal cases not suspected clinically Availability – co-location of screening and symptomatic services	Expedite patient pathway Increased detection of small / subtle cancers No additional radiographer training cost or time

Contd.

Table 4.9 contd.

Training and experience	Diagnostic speed accuracy compared to radiologist	Potential role and responsibility	Triggering conditions	Potential Consequences
Formal external training in symptomatic MIIR Student / newly qualified	Sensitivity equivalent Specificity equivalent or slightly lower Slower	Delegate First reader – double reading Preceptorship period with reducing supervision	Academic and real-life clinical practice learning Contemporaneous balanced feedback	Unnecessary tests (additional time & cost) for excess false positive cases Initial increase in radiologist workload (supervision) Eventual reduced radiologist workload (remote supervision)
External HEI Course Experience Expertise	Sensitivity and specificity equivalent or higher Speed equivalent	Substitute Independent single reader	Rigorous combined screening & symptomatic training and assessment 5 – 10 years real-life clinical practice Exceed minimum volume recommendations Balanced feedback and reflective practice Participate in MDT case discussion Ongoing learning from CPD activity	Reduced need for radiologist De-skilled radiologist workforce Cost savings

4.5 Theories about MIIR within a multidisciplinary team

4.5.1 Introduction

Section 4.3 of this thesis explored a variety of potential roles that radiographers might have in symptomatic MIIR and suggested different ways in which responsibility for MIIR might be transferred or shared between radiographers and radiologists. The possible consequences of the different role and responsibility combinations were explored, in terms of radiologist workload and service cost for example. Section 4.4 of the thesis explained how radiographers might acquire the knowledge and skills that would enable them to undertake MIIR and how individual characteristics, particularly training and prior experience, were likely to impact their ability to recognise and differentiate mammographic abnormalities. It was hypothesised that such characteristics would trigger different roles and responsibilities for different practitioners and the consequences of the different radiographer decision making behaviours were predicted in terms of service and patient outcomes.

The next section of the thesis considers the influence of the real-life clinical environment within which radiographers would practice symptomatic MIIR. The programme theories presented in this section relate to immediate differential diagnosis and report writing in the ‘one-stop’ rapid access clinic, incorporating MIIR into the ‘triple assessment’ protocol and diagnostic decision making within a multidisciplinary team.

4.5.2 Differential diagnosis and immediate reporting

A written report is the traditional way in which interpretation of diagnostic imaging is communicated to referring clinicians (Bassett, 1997). In the one-stop symptomatic clinic the professional undertaking MIIR must provide a report for the clinician (surgeon) with overall medical responsibility for the patient (Kelly et al., 2008a) and must do this immediately whilst the patient is in the department – a practice known as ‘hot’ reporting.

Mammography reports have to guide clinicians to appropriate patient management, avoiding ambiguity and subtle nuances that might result in inappropriate treatment or inadequate follow up (Homer, 1984). It was hypothesised in this thesis that radiographers who shared MIIR responsibility with radiologists, in an abnormality signalling role for example, might produce a simple ‘report’ restricted to a ‘normal / abnormal’ rider and a brief description of its location and visual features, to which a second reading radiologist would add a level of suspicion for cancer (M1-5) and any necessary recommendations for further imaging or biopsy (BASO, 2005).

Conversely, when radiographers assumed independent responsibility for MIIR, in a substitution role for example, it was hypothesised that they would need to produce a report that was indistinguishable from that of a radiologist (Culpan, 2006).

Radiographers without task-specific report writing training, novices and those with limited experience are likely to have a tendency for descriptive (rather than interpretive) reports (Culpan, 2006). It was hypothesised that this might include even experienced screen reading radiographers who were only used to indicating the location of a perceived abnormality on a pictorial icon. It was hypothesised that novice and inexperienced practitioners might be supported to successfully undertake the symptomatic reporting task by providing local guidelines, protocols or standard templates to guide the content and style of their reports.

As a radiographer’s knowledge and understanding of symptomatic breast disease increases, their ability to synthesise visual (image) and clinical (disease) information should improve and help them make insightful inferences and appropriate judgements (Gigerenzer, 2002). It was hypothesised that the reports of experienced radiographers in substitution roles would indicate the reason for referral, provide a succinct description of overall breast composition, identify any abnormal or suspicious area on the mammogram and describe its appearance using standardised terminology, provide an overall impression and / or a ‘level of suspicion’ category (M1-5) and advise if biopsy or other follow up is required (Willett et al., 2010; Bassett, 1997; Homer, 1984).

4.5.2.1 Implications for screen reading radiographers

As alluded to above radiographers diversifying their practice from screen reading to symptomatic MIIR would be expected to lack skill in report writing. It was hypothesised also that they might lack skill in differential diagnosis as their screen reading role required them only to discriminate normal / pathognomonic benign cases from those with potential malignancy without attempting any further disease characterisation. In the symptomatic setting there is a wider disease spectrum than radiographers would encounter whilst screen reading and radiographers involved in MIIR in this service need to allocate a categorised estimate of the likelihood that the abnormality is cancer (M1-5).

The ‘category effect’ is a potential source of bias which might introduce error into the reasoning of radiographers who are used to making dichotomous decisions. Category effect suggests that specificity might be compromised because of a tendency to over-estimate probability across a larger number (four rather than one) abnormal groups (Redelmeier et al., 1995). The effect might bias the radiographer to redistribute some of the normal (M1) / benign (M2) cases that required no further investigation into higher suspicion groups (M3-5) for which further investigations were conducted. A higher number of 'false positive' decisions would be associated with unnecessary additional testing of normal cases, over investigation of benign disease, incur additional (human and financial) cost and potentially increase diagnostic morbidity (procedure related complications).

These programme theories are summarised in the form of CMO configurations in Box 4-1.

Box 4-1 CMO configuration – differential diagnosis and report writing

Characteristics (C)		**Reasoning and resources (M)**		**Ensure appropriate patient management and follow up (O)**
Untrained	→	Detection and visual description of abnormality *Double reading*	→	Supplement with radiologist medical interpretation (M1-5) and recommendations
Novice Screen readers	→	Content and style guided by protocols and templates *Double reading*	→	Radiologist verifies or amends as above
Trained and experienced	→	Insightful synthesis of clinical and imaging information *Autonomous single reading*	→	Reports indistinguishable from radiologist
Screen reader	→	Category effect reduces specificity; over-diagnosis of abnormality *Filtering*	→	'Positive' cases reviewed by radiologist to avoid over investigation of normal and benign disease

4.5.3 Triple assessment

Mammography image interpretation in the symptomatic service cannot be considered in isolation from the other components of triple assessment: clinical examination, additional imaging and tissue sampling. This section of the thesis considers how radiographers involved in MIIR might access, use and transfer information along the triple assessment 'chain' of diagnosis. It was hypothesised in this thesis that radiographers undertaking the MIIR 'task' might access triple assessment information generated by colleagues and might need to pass on MIIR information to colleagues performing ultrasound and tissue sampling examinations. It was hypothesised alternately that radiographers who had specialised in breast imaging might be multiskilled and be able to generate clinical and use MIIR information themselves. The two alternative hypotheses were anticipated to have different consequences for radiographer reasoning (at cognitive or micro level) and for patient experience (at organisational or meso level).

4.5.3.1 Diagnostic reasoning

4.5.3.1.1 Use of clinical information

Sequential consideration of test results can trigger ‘ordering’ effects (Bergus et al., 1995). This suggests that MIIR in the symptomatic setting could be influenced by the availability of additional information from the patient’s clinical history and the results of a physical examination - the P1-5 classification assigned by the examining physician, performed before imaging. Following on, this also suggests that availability of information from the mammogram has the potential to influence interpretation of the results of subsequent (ultrasound and tissue sampling) tests.

The ‘anchoring’ effect describes how an estimate of the probability that an image abnormality is malignant might be influenced by this earlier subjective test result because it is resistant to adjustment by synthesis of new information (Kahneman et al., 1982). It was hypothesised that this effect might lead novice practitioners to demonstrate confirmation bias (Kern and Doherty, 1982) and premature closure or satisficing (Freedman and Osicka, 2010) because they pre-judged the diagnosis (on the basis of the P1-5 classification) and reasoned by verification rather than falsification (Keren and Teigen, 2004).

It was hypothesised that expert practitioners might actively try to reduce the impact of ordering effects by interpreting images ‘blind’, before considering the patient’s clinical history and surgeon’s physical examination findings .

4.5.3.1.2 The multiskilled radiographer

It was hypothesised in this thesis that radiographers who substituted in the ‘role’ of the radiologist would have specialised in breast imaging and would dedicate 100% of their time to this single clinical application (breast diagnosis). In a substitution ‘role’ these radiographers would have skills and knowledge across the full range of the discipline’s diagnostic tests encompassing those derived from traditional radiographer and radiologist practice, ultrasound examinations and image guided tissue sampling for example, and might even have skill and knowledge in some tasks and roles conventionally in the domain of the surgical and nursing profession - physical breast examination for example. It was anticipated that such radiographers might need at least ten years of practice to develop expertise equivalent to that of the respective medical and nursing staff in each discipline (Ericsson and Charness, 1994).

Many of the radiographers involved in symptomatic MIIR who responded to Dixon et al.'s (2013b) survey stated that they were involved in other triple assessment diagnostic tests, see Table 4.10. One respondent specifically commented that:

> *'Most of my symptomatic reporting is done alongside performing breast ultrasound, ultrasound reporting and when required biopsy' [ID 4090].*

Table 4.10 Involvement of radiographers in triple assessment tests

	Undertake regularly	**Undertake occasionally**	**Qualified but do not undertake**	**Not qualified to do this**	**No response**
Symptomatic mammography	21 (55%)	7 (18%)	8 (21%)	1 (3%)	1 (3%)
Breast ultrasound – symptomatic	22 (58%)	1 (3%)	1 (3%)	10 (26%)	4 (10%)
Clinical evaluation of the breast	12 (31%)	3 (8%)	1 (3%)	17 (45%)	5 (13%)
Image guided tissue sampling	28 (73%)	1 (3%)	1 (3%)	6 (16%)	2 (5%)

Immersion in a single area of clinical practice would give the multiskilled clinical specialist radiographer wide-ranging knowledge; it was conjectured that this would help them avoid premature closure when interpreting mammographic appearances because they would be aware of, know the value of, and thus seek out and incorporate more knowledge into their decisions. Their intra-speciality diversity and wide ranging experience of breast diagnosis should underpin insightful synthesis of information and appropriate inferential reasoning. From this platform it was hypothesised that their diagnostic accuracy would be high, with both high sensitivity for cancer detection and more crucially high specificity to exclude accurately non-cancer patients from unnecessary further testing and inappropriate treatment.

It was envisaged that the radiographer with an extensive and diverse range of qualifications and experience in image-based breast diagnosis might practise in a trans-disciplinary capacity across the patient's entire diagnostic journey. In this way their performance might be synergistic - the 'whole' performance of one individual having the potential to exceed the 'sum of the part performances' of multiple professionals for whom MIIR and / or breast diagnosis represented only a proportion of their diverse workload.

The multi-skilled practitioner operating in this way would perform all the necessary diagnostic tests sequentially throughout the chain of diagnosis and might reach a 'summative' overall diagnosis. They would need to be aware of the 'conjunction fallacy' to avoid overestimating the probability of a diagnosis when two (or more) test results were concordant (Elstein and Schwartz, 2002). It was not clear how ordering effects, such as anchoring and adjustment described above, might affect the reasoning of such a practitioner. The individual tests could not be interpreted 'blind' but it was not clear how this might influence risk of error. Would practitioners more or less readily disagree with themselves if they encountered a discordant result, than they would if the result was discordant with the result of another test performed by a different practitioner?

4.5.3.2 Patient centred care

The hypothesis that a multiskilled specialist practitioner could perform all the triple assessment tests for an individual patient suggested a holistic and patient centred approach that would offer 'continuity' of care. It was hypothesised that reducing the number of healthcare professionals involved in the diagnostic pathway would also reduce the risk of communication breakdown and thus faulty reasoning due to inaccurate or incomplete information.

As explained earlier (see section 4.3.1.5.2) it was envisaged that the multiskilled clinical specialist radiographer undertaking a range of 'higher' order clinical tasks might no longer be the same person (radiographer) who performed the 'technical' mammogram acquisition task. Direct contact with the patient, during mammography image acquisition affords the radiographer unique insight and offers opportunities to collect additional (psychosocial) information about patient health and family circumstances, from 'social' conversation and non-verbal / visual cues, for synthesis into diagnostic reasoning (Manning, 2010). It was anticipated that loss of this opportunity for direct contact and engagement in 'social' conversation overcome because the multiskilled clinical specialist radiographer has extended contact whilst performing a physical examination, ultrasound and / or tissue sampling procedures.

Sibbald et al. (2004) suggested that continuity of care is likely to be valued by patients, associated with higher patient satisfaction and might improve health outcomes. It was hypothesised that continuity of care provided by a clinical specialist radiographer would improve diagnostic accuracy because information was transferred along the chain of diagnosis comprehensively and accurately.

It was hypothesised radiographers might develop rapport and empathy with patients as a consequence of sustained direct contact and that this might prompt them to act as patient advocate in MDT discussions promoting patient centred decision making (Lamb et al., 2012).

The above programme theories are summarised in the form of CMO configurations in Box 4-2.

Box 4-2 CMO configuration triple assessment

Context		Mechanism		Outcomes
Prior information Novice Expert	→	Ordering effects Blind (image) review	→	Verification error Reduced risk of bias
Multiskilled	→	synthesis of information synergy of knowledge	→	Improved accuracy Imaging diagnosis
Holistic practice	→	continuity of communication continuity of care empathy / rapport	→	Advocacy Patient centred decision making

4.5.4 MDT membership and participation in clinical decision making

Provision of a non-screening (symptomatic) breast service revolves around multidisciplinary care (BASO, 2005). Decision making processes in multidisciplinary teams are usually dominated by surgical and medical expertise (Kidger et al., 2009; Taylor and Ramirez, 2009; Lanceley et al., 2008) and subject to medical hegemony (Devitt et al., 2010; Kidger et al., 2009; Taylor and Ramirez, 2009; Coombs and Ersser, 2004). Traditionally allied health professional groups find it difficult to participate (Devitt et al., 2010; Taylor, 2009). The literature search identified no evidence specifically about radiographer involvement in MDTs, and if, or how they contributed to case discussion and clinical decision making.

It was hypothesised in this thesis that to successfully substitute in the role of a radiologist in symptomatic clinics radiographers involved in MIIR would need to be autonomous and independent members of breast care MDTs. Kelly et al.'s (2008a) account of the role of a consultant breast radiographer suggested that this would involve attending MDT meetings, participating in case discussions and advising the MDT about further imaging work-up of indeterminate, suspicious or discordant triple assessment cases.

4.5.4.1 Legitimate team membership

In addition to changing their mammographic imaging role and responsibility it was hypothesised that the social status of radiographers in the workplace would have to change to enable them to function as a member of the MDT. Most (79%) of the radiographers responding to Dixon et al.'s (2013b) survey believed that involvement in symptomatic MIIR enhanced their status with members of the breast care MDT.

Pioneers of new roles, the first practitioners to undertake a brand new role and thus break new ground, lack role models and behavioural precedents (Turner et al., 2007). It was hypothesised that radiographers in the innovative 'hybrid' role, new either to them personally or to the organisation, might feel isolated and their allied health professional background might impede their ability to contribute to MDT discussions and decision making (Devitt et al., 2010). As a consequence it was envisaged that full membership of the MDT and involvement in MDT clinical decision making might remain in the domain of the radiologist.

It was hypothesised that successful integration into the MDT might occur where radiographers were encouraged to attend MDT meetings, allowed to participate in clinical discussions and trusted to offer opinions and advice. In such circumstances it was envisaged that the development of a team identity and its associated collegiality, might improve the confidence of radiographers. It was considered that contributing to clinical decision making and being recognised and respected as legitimate MDT members by their peers would be a source of job satisfaction and improve the morale of radiographers in new and emerging roles. In the initial programme theory it was suggested that an established multiskilled specialist radiographer with expertise in symptomatic MIIR might successfully challenge a tendency for medical hegemony because they had the confidence to defend their decisions. If the radiographer who has performed and / or interpreted the mammogram is included in MDT case discussions, their first-hand knowledge of the patient and their images might help to ensure that clinical decision making was based on synthesis of accurate and complete information.

These theories are summaries in Box 4-3.

Box 4-3 CMO configuration - MDT membership

Context		**Mechanism**		**Outcomes**
Encouraged to attend meetings		Team identify		Clinical management informed by accurate and comprehensive information
Allowed to participate in case discussions	→	Collegiality	→	Improved job satisfaction and morale
Trusted to offer opinions and advice		Collaborative decision making		Increased confidence

4.5.4.2 Diagnostic reasoning

Most (n=36) respondents involved in symptomatic MIIR in Dixon et al.'s (2013b) survey confirmed they had the opportunity to attend MDT meetings as a CPD activity. It was hypothesised that even passive attendance at multidisciplinary (case discussion) meetings would be a valuable source of experiential learning for all radiographers involved in symptomatic MIIR

Attending the MDT meeting would enable radiographers to observe mammography images from cases they had been involved in and cases interpreted and reported by others. The opportunity to see more images, and correlate them with follow up, should help develop pattern recognition skill because it enables practitioners to build more diverse and complete memory stores of exemplars and theoretical prototypes (Elstein and Schwartz, 2002). In turn this should enhance diagnostic accuracy because it increases ability to diagnose difficult / new conditions.

At the MDT meeting, radiographers would also have the opportunity to observe the variation in the judgement and decision making of individuals across and within the professional groups and be exposed to both errors and their clinical consequences. Obtaining balanced (positive & negative) feedback on all cases from a recent clinic has potential to improve diagnostic reasoning because it fosters a realistic awareness of a practitioners own performance, and that of others. Feedback on performance should increase practitioner awareness of both the potential to make errors (self and others) and the ability to reduce them and might create uneasiness and motivation to try to reduce errors.

Exposure to a wide variety of associated clinical information (other tests results and pathology follow up) will increase radiographer's knowledge about breast pathology and its management. Greater clinical knowledge and an increased understanding of the consequences of image based diagnosis for subsequent patient management, treatment choices and eventual health outcome (morbidity and mortality) will allow the radiographer to synthesise (visual) imaging and clinical (disease) information more effectively in order to make more insightful judgements about disease probability (Gigerenzer, 2004). This should help generate an accurate spectrum of most likely diagnoses and increase the precision of diagnostic category allocation (M1-5).

Radiographers who attend MDT meetings will be more aware of the value of additional information (additional mammography images / other tests) which should improve their ability to make clinically useful and patient centred recommendations.

Awareness of the consequences of a cancer diagnosis has however the potential to generate ‘regret’ bias. Regret bias might predispose radiographers to subject a greater proportion of patients, who do not have cancer, to further tests and investigations unnecessarily to avoid the consequences (human and financial) of missing a cancer. Additional testing would have undesirable consequences - patient anxiety, procedure related morbidity, increased consumable and practitioner costs.

The potential ways in which attending MDT meetings can improve the accuracy of radiographers are summarise in Box 4-4.

Box 4-4 How attending MDT meetings might help improve radiogapher accuracy

Resource		Effect on reasoning processes
Observing images	→	Improves pattern recognition
Obtaining balanced feedback on recent cases	→	Develops a realistic awareness of capability of self and others Realise potential for error and develop desire to reduce error
Access to clinical and pathological information and patient follow up	→	Improves synthesis of information and improves probability estimation

4.5.4.3 Group decision making

Group decision making, as occurs in clinical multidisciplinary teams, is susceptible to a range of social influences which can both undermine and enhance the decision making process (Larrick, 2004).

It was envisaged that radiographers who undertook symptomatic MIIR autonomously would be expected to explain and defend their judgments and decisions to others in the MDT forum. Where decisions of clinical practitioners are open to the critical review of colleagues accountability can motivate by pre-empting self-criticism - fear of ‘failure’ prompting individuals to make more effort, take more time and / or seek more information to avoid social humiliation (Larrick, 2004). A desire to create a favourable impression and avoid embarrassment might however lead to social desirability / conformance bias, or the ‘herd effect’, introducing errors into individual reasoning processes because decisions are influenced by the desire to meet the expectations of the ‘audience’ and / or align with group norms (Larrick, 2004). It was envisaged that radiographers might be tempted to withhold or misrepresent information that did not fit with the judgements of other team members, that they might anchor (on the judgements of others) in order to avoid social ‘rejection’ by the group.

Group decision making provides a forum for error checking and can improve diagnostic accuracy because complementary perspectives, and a diverse body of experience, are aggregated. The composition and background of the group however is important – too much similarity, shared training, experience and discussion can lead to cohesion and the possibility of shared blind spots which generate ‘shared’ errors (Larrick, 2004).

The hypotheses about the potential influence of MDT participation on the (micro) decision making processes of radiographers involved in symptomatic MIIR are summarised in Box 4-5

Box 4-5 Consequences of group decision making

Context		**Mechanism**		**Consequences**
Autonomy	→	Accountability Fear of failure	→	Increased decision time Increased caution Increased use of addition tests
Collective decision making	→	Social desirability bias Conformation bias Herd effect	→	Normalisation Failure to challenge group decisions
		Error checking Aggregation of diverse knowledge and skill	→	Improved accuracy
		Cohesive knowledge and skill	→	Shared (blind to) errors

4.5.4.4 Social learning

The influence of team working on radiographer involvement in symptomatic MIIR was underestimated during initial articulation of programme theories. One possible explanation for this might be that the programme theories drew on existing studies which were in the main, conducted under ‘laboratory style’ conditions. This approach failed to capture the situational influences of the naturally occurring environment (Aitken and Mardegan, 2000). In this thesis that excluded the situated nature of MIIR in triple assessment and multidisciplinary care.

Analysis of evidence collected during Stage 2 of the study (see Chapter 5, section 5.2.3.3) suggested two ideas that were not considered in the initial programme theories:

- ‘horizontal’ accountability for clinical decision making, and thus error, might operate at ‘group’ (MDT) rather than individual (practitioner) level;
- ‘collaboration’ and ‘collective’ decision making occurred informally during MIIR and involved a wide range of colleagues.

These ideas were incorporated into programme theory at the end of Stage 2. Stage 3 of the study tested the hypotheses that:

- collective decision making is intrinsic to symptomatic MIIR and extends beyond formally constituted double reading;
- radiographers involved in symptomatic MIIR might operate within a new paradigm of professional accountability where success, but more importantly failure (error) was ‘everyone’s and no-one’s’ (individual) responsibility (Goodwin, 2014).

These new hypotheses drew on social learning theory. ‘Community of practice’ theory offered an explanation that becoming a legitimate member of the MDT involved the radiographer in a ‘learning’ journey (Lave and Wenger, 1991), progression along which improved their knowledge, skill and confidence through regular interaction with colleagues (Wenger, 1998).

4.6 Chapter 4 summary

The existing literature on radiographer involvement in interpretation of mammograms was heavily biased to a breast screening context and focused predominantly on diagnostic accuracy outcome measures. However, this literature suggested there might be a variety of ways in which the knowledge and skill of radiographers and radiologists could be harnessed and applied to the interpretation and reporting of mammograms in the symptomatic service. Several different ways in which radiographers might assume or share the role and responsibility for symptomatic MIIR with radiologists were hypothesised and their consequences mapped onto service, practitioner and patient outcomes.

Limited UK evidence about radiographers interpreting and reporting mammograms in a non-screening (diagnostic / symptomatic) setting was found. A single practitioner case study (Kelly et al., 2008a) and two surveys demonstrated that this is happening and that operational practices vary (Rees, 2014; Dixon et al., 2013b).

Two non-UK research teams have studied radiographer performance using non-screening cases (van den Biggelaar et al., 2010a; van den Biggelaar et al., 2010b; Holt, 2006). Despite involving only small numbers of participants (3, 2, and 5 respectively), both studies were encouraging because the radiographers had high cancer detection rates and were considered to be a potentially cost-effective alternative to a radiologist. The ways in which radiographers might learn to interpret and report mammograms to a similar standard to that of radiologists were hypothesised and mapped to the theories about potential roles and responsibilities.

The theory-driven realistic evaluation method of Pawson and Tilley (1997) offered a broad approach for pulling together the topic specific literature with a wider body of evidence related to medical decision making, diagnostic reasoning and the mammographic image interpretation performance and practices of radiologists. Using researcher expertise to provide additional foreknowledge and professional insight it was possible to hypothesise causal relationships that identified how the various roles and responsibilities, different levels of expertise might ‘play out’ in the real life setting of multidisciplinary NHS service provision.

The initial programme theories presented in this chapter have identified what symptomatic service provision problems, for example medical workforce shortages, productivity limitations, financial constraints might be solved by which organisational and human resource and choices and what prevailing conditions and characteristics would be required for this to be successful. Some of the unintended consequences of involving radiographers in symptomatic MIIR have also been identified.

The programme theories articulated in this chapter of the thesis were tested and refined in Stages 2 and 3 of the study using field based empirical methods (Pawson and Tilley, 1997). In Stage 2, theories about role enhancement (red dot, commenting and double reading), diversification (pre-screening by NHSBSP screen reading radiographers) and specialisation (fulltime breast imaging and multiskilling) were tested and revised using unstructured interview data from radiographers and radiologists working in services which involved radiographers in symptomatic MIIR – see Chapter 5.

In Stage 3 of the study, evolving theories about the development of expertise, team working and role innovation were tested and refined further using data from observation of radiographers engaged in symptomatic MIIR in clinics and MDT meetings, and additional data collected using semi-structured post-observation interviews – see Chapter 6.

Chapter 5 Testing and development of programme theory

5.1 Introduction

This chapter presents Stage 2 of the study. In Stage 2 of the study the initial programme theories articulated in Stage 1 (see Chapter 4) were tested and refined using original data from programme stakeholders.

The programme stakeholders who contributed data were radiographers and clinical lead radiologists at a purposive sample of hospital sites which already involved radiographers in symptomatic MIIR. Qualitative data (verbal descriptions) were collected using unstructured group and individual interviews.

The participant data were critically examined to identify where they supported and where they were incongruent with the initial programme theories. The IPT was then modified to reflect how local circumstances and individual practitioner characteristics at the sites studied had influenced the involvement of radiographers in symptomatic MIIR and to reflect 'real world' consequences.

The first section of this chapter (section 5.2) describes and justifies the research methods employed; the second section (5.3) presents the results. The initial section of the results (section 5.3.1) illustrates the diversity of practice encountered at the study sites and provides the reader with an overview of participant characteristics. The depth of information provided about the study sites and participants is constrained by ethical obligations to preserve their anonymity but still provide an insightful perspective which gives meaning to the reader.

Following this the results are organised into four sections. The first two sections report 'atypical' findings each encountered only at one single site:

- a single site case study which critically examines programme theory related to radiographer involvement in a 'commenting' system (section 5.3.2);
- a single site case study critically appraising the involvement of radiographers in a formal double reporting system (section 5.3.3).

The second two sections report aggregate findings that appeared to have generalisability across all sites:

- a critical analysis of the way that 'screen reading' influences the involvement of radiographers in symptomatic MIIR (section 5.3.4);

- a critical evaluation of the evolution and function of the innovative hybrid practitioner (section 5.3.5).

The final section of this chapter (5.3.6) presents a preliminary discussion of the findings of Stage 2 of the study. This explains how the Stage 2 results were used to confirm and refine the initial programme theories presented in Chapter 4. The final section of the chapter (section 5.4) identifies the revised and new programme theories that were tested and explored further in Stage 3 of the study.

5.2 Methods

5.2.1 Sampling strategy

Target participants were radiographers and radiologists involved in MIIR in NHS symptomatic breast clinics in the UK.

Statistically (probability) driven sampling with a large representative sample is often considered to confer generalisability (Silverman, 2013) but non-probability sampling with low participant numbers was preferred in this study to help discover and explain (rather than measure) important new insights (DePaulo, 2000). Non-probability purposive sampling was also preferred to probability sampling because the intervention under study was relatively new and involved a relatively small number of sites and individuals. A purposive sample of participants and hospital sites was chosen to reflect the range of roles, responsibilities and characteristics identified in the initial programme theories. Probabilistic (random) sampling was considered unlikely to identify the variety of participants described in the programme theory or capture unexpected processes not amenable to statistical prediction (Manzano-Santaella, 2011).

A sample of ‘intrinsic case studies’ (sites and people) was selected for their unique ability to provide insight into the programme theories being developed (Holloway and Wheeler, 2002). A wide geographic footprint and recruitment from sites remote from the researcher’s immediate location were feasible within the study timescale and because external funding had been secured.

Convenience (nominated) samples can limit generalisability but external validity, or transferability (Bryman, 2008) was underpinned by carefully guided and justified sampling and an analytical model that conferred validity on individual cases (Silverman, 2013) and by rigorously linking the empirical findings to the existing theories which underpinned the IPT (Skjørshammer, 2001).

Expressions of interest to participate in the study had been sought from radiographers who responded to a previous survey (Dixon et al., 2013b). An electronic copy of the Participant Information Sheet (PIS) was sent (emailed) to a convenience sample of five radiographers who had expressed interest in this way and a nominated sample of five other radiographers the researcher had a prior connection with and knew they worked in departments that fitted the study inclusion criteria (Bryman, 2008; Holloway and Wheeler, 2002). Recipients were asked to circulate the PIS to all radiographer colleagues involved in symptomatic MIIR in their department and to the clinical lead radiologist for their service (snowball sampling). The PIS invited radiographers and radiologists who wanted to participate to contact the researcher directly by email and / or telephone.

Following direct contact with the researcher, nine sites were recruited to the study, one radiographer approached did not respond to the initial invitation. One site (site 5) subsequently withdrew from the study due to local service re-configuration. All participating sites were NHS Trusts in England and included three sites in Yorkshire, two in the Midlands and one each in Lincolnshire, Lancashire and the South West. Three sites provided only symptomatic breast services the remaining five sites were co-located screening and symptomatic services. Site characteristics are summarised in Table 5.1.

Table 5.1 Recruitment site characteristics

Site identifier	**Hospital description** **Population served; Cancers detected (annual in PCT)**	**Breast imaging service**
Site 1	Large university teaching hospital 750000; 500	symptomatic service only
Site 2	Large district general hospital 500000; 260	symptomatic service only
Site 3	Large district general hospital 600000; 330	combined screening / symptomatic service
Site 4	District general hospital 350000; 140	symptomatic service only
Site 6	Large university teaching hospital 700000; 350	combined screening / symptomatic service
Site 7	University teaching hospital 450000; 180	combined screening / symptomatic service
Site 8	University teaching hospital 8a - main city hospital; 500,000: 500 8b - district general hospital; 260,000; 300	combined screening / symptomatic service
Site 9	Large district general hospital; 510000; 280	combined screening / symptomatic service

All radiographers involved in symptomatic MIIR that volunteered to participate at each site were included in the study; one radiographer who was eligible for the study at Site 2 declined to participate. At each site a medical / strategic organisational perspective was obtained by recruiting the clinical lead radiologist for the symptomatic service.

5.2.2 Data collection

Qualitative data (verbal descriptions) were collected using small group and individual interviews. Each participant was involved in a single interview. Local interviews were chosen over centralised focus groups to minimise the time commitment of participants and ensure that the data reflected individual and local perspectives and diversity rather than professional consensus views (Sim, 1998).

Interviews were conducted using a minimalist passive approach (Jones, 2004) to encourage participants to ‘tell their story’ of how radiographers (they) had become involved in symptomatic MIIR. Participants thus described, in their own words, how they were able to interpret and report mammograms, reach a diagnosis, what factors made their decision making processes ‘work’ well, what factors sometimes caused the processes to ‘go wrong’, what (adverse or beneficial) consequences there had been to involving radiographers in the decision making process in their experience. A topic guide based on the IPT was used to frame probing questions to elicit more detail and depth of information and to facilitate a more ‘active’ interviewing approach for the participants who were reluctant to talk spontaneously - see Box 5-1. Guided questions, although more specific, were of open style to stimulate the respondents’ thinking and incite answers relevant to the research topic.

Box 5-1 Stage 2 interview topic guide

<u>Questions</u>

1. Please tell me how radiographers and radiologists are involved in symptomatic mammography image interpretation in your department.

2. Thinking broadly, about personal, organisational and external factors:
   - what allows / helps / is required for you / radiographers to work effectively in the role?
   - what sort of things hinder / prevent you / radiographers from working effectively in this way?

<u>Topics of interest that may arise and will be probed for more detail:</u>

Can you tell me a bit more about… / Can you give me a specific example of…
- training & experience - competence, speed-accuracy, feedback, interest / aptitude
- professional background - medical / non-medical - dominance, confidence, regulation, accountability
- organisation issues – workforce, workload, finance, multidisciplinary team work
- external factors – technology, patient perspective

Interviews were conducted on NHS hospital premises in the imaging department at the participant's normal place of work, at a mutually convenient location (departmental office / meeting room) and time (during the normal working day 8am – 6pm). Travelling to participants involved greater time commitment from the researcher however the cost of interviewing four participants at each of the nine sites was likely to be less than paying 36 participants to travel to focus groups (Kidd and Parshall, 2000).

One radiographer at each site acted as local lead / liaison radiographer and co-ordinated arrangements for data collection (booking interview rooms). For ethical reasons and to encourage organisations to support the study interview times and places were arranged with participants so that the interviews did not adversely impact on service provision. Since the unit of analysis for this stage of the study was the 'site', where more than one radiographer volunteered to participate, a single group interview was offered; individual interviews and multiple small group interviews were undertaken where it was not operationally feasible to access all members of staff at the same time. At each hospital site only one radiologist (the clinical lead) was interviewed.

All interviews were digitally audio-recorded and transcribed verbatim (by the researcher) to create an authentic, accurate and permanent record of dialogue for analysis that was available for independent third party scrutiny (Silverman, 2013).

A total of 30 interviews were conducted between November 2013 and April 2014. Eight of these involved individual radiologists, 16 were conducted with individual radiographers and six involved a small group of two or three radiographers. The average duration of the interviews was 49 minutes (range 23 - 79 minutes) giving a total of 1469 minutes (24.5 hours) of interview data for analysis.

At the end of their interviews all participants confirmed that they were interested in receiving a summary of the research findings and that they might be interested in participating in later phases of the study.

5.2.3 Data analysis

5.2.3.1 Guiding principles

Use of a systematic, robust and comprehensive data analysis method helps to instil confidence in practitioners and (funding) policymakers when considering the implementation of research findings (Ritchie and Spencer, 2002). Interview data is usually analysed using conceptual and thematic methods (Long and Godfrey, 2004). In this study a combination of framework (open coding) and thematic (axial and selective coding) methods were used for data analysis. Coding (sorting) was managed within NVivo®.

Framework analysis is a relatively new qualitative analysis technique with origins in social policy (Furber, 2010). Qualitative data analysis techniques are typically flexible and creative (Holloway and Wheeler, 2002) and in addition to capturing *a priori* themes arising from the initial programme theory the framework technique allowed the addition of (new) categories and themes emerging from participant narratives (Rabiee, 2004).

Data analysis methods need to be coherent and consistent with research aims, questions and knowledge claims made (Holloway and Todres, 2005). RE has its own distinct set of guiding principles which fundamentally require data to be examined in configurations of 'mechanisms' with their triggering 'contexts' and 'resultant outcomes'. Connecting strategies were used during axial coding to explore key relationships that tied the data (categories) together (Maxwell, 2012) – in a RE this combined the data as CMO configurations. This approach encapsulated the complexity of the problem being studied and captured the interdependent relationships that existed between individual and institutional agency, structure and process (Pawson and Tilley, 1997).

As with all qualitative approaches, data analysis was iterative and occurred contemporaneously with data collection. This allowed theoretical data sampling by modifying the prompt questions used in the interviews, to capture additional data to help refine and enrich emergent ideas.

5.2.3.2 Open coding

Having conducted and transcribed all the interviews the researcher was familiar with substantive data content. First level (open / descriptive) coding of transcripts was performed using a preliminary coding framework consisting of categories and themes derived from the initial programme theory (Table 5.2).

Three early transcripts were open coded independently by the researcher and two project supervisors to increase the robustness of data analysis. Following this, preliminary analytical discussions were conducted to confirm that the researcher's interpretations were congruent with the independent evaluations.

Subsequent coding and initial data analysis was performed by the researcher. Data analysis was augmented through discussion and feedback with project supervisors at regular (monthly) intervals. The open coding framework was modified iteratively to capture additional nuances of the real world experiences described by successive interview participants.

Table 5.2 Initial coding framework

Contexts	**Mechanisms**	**Outcomes**
Recognition of knowledge and skills • Mammography image interpretation • Report writing Reward • Motivation • Incentive	Professional boundaries • Commenting • Screening to symptomatic • Specialisation – fulltime • Specialisation – multiskilled • Hybrid substitute	Service provision • medical workforce shortage • capacity / demand – referrals • logistics o digital technology • cost

Trust to undertake
• Extra examinations
• Diagnosis
  o Communicate with patient
• Manage clinic
• Communication with MDT
	Responsibility
	• Double reading
	• Single reading
	
	• Collaborative decision making
		Patient benefit
		• access / waiting lists
		• experience
		  o transit time
		• accuracy of cancer detection

Support with
• Training
• Experience
• Autonomy
• Feedback on performance
• Decision support media
• Encouragement or resistance
• Evidence base
	Behaviour processes
	• Diagnostic reasoning theory
	• Diagnostic accuracy
	  o Errors
		Practitioner
		• interest / realising potential
		• recruit and retain
		• morale – confidence & anxiety
		• patient involvement
		• team spirit
		• radiologist – job satisfaction, attitude
		  o safety net

5.2.3.3 Axial and selective coding

Second level (axial) coding was used to organise data in the separate ‘open’ coded categories and themes into CMO configurations. In practical terms this was possible because the categories and themes in the analysis framework were not mutually exclusive and data had been open-coded into multiple categories and contributed to multiple themes.

Selective coding of data relating to particular CMO configurations was summarised using the 'one sheet of paper' method (Ziebland and McPherson, 2006). This method helped to map the data to the complexity of the programme theory and was a useful process for broadening the researcher's analytical thinking about how the new data enriched and expanded the original causal relationships that had been hypothesised.

5.2.3.4 Presentation of results

5.2.3.4.1 Case studies

Case study research has its own rigorous methodology (Yin, 2009) but can be used alongside other methods to explore a specific person, site or situation or a 'bounded' series of such (collective case study) in depth (Cresswell, 1998). The results include three intrinsic case studies (sites) chosen because of their uniqueness (Cresswell, 1998) – 'a commenting case study' (Site 1), 'a delayed second reading case study' (Site 2) and 'a filtering case study' (Site 6). These case studies were interesting because they illustrated atypical findings (Holloway and Wheeler, 2002). The results also contain what were considered to be two collective instrumental case studies each illustrating typical findings about a phenomenon being studied (Cresswell, 1998) – 'the influence of screen reading' and 'the hybrid practitioner'.

5.2.3.4.2 Data extracts

The results section of the thesis presents data extracts, segments of the participant transcripts, to illustrate and develop arguments about programme theory. The quotations used have been abridged by the researcher so that they only contain the participant dialogue. The excerpts reproduced in the thesis do not faithfully represent the linguistic form or interactive nature of interview discourse; pauses, repetitions and identification of places and people have been excluded, grammar and spelling errors have been corrected.

Manipulation of the data in this way introduces researcher subjectivity and is a potential threat to study validity (Maxwell, 2012). It is argued that this approach is in keeping with the realist research design - researcher identity and perspective being valuable resources for acquiring and making sense of the data (Maxwell, 2012). The approach adopted contrasts with that used in purely narrative and ethnographic qualitative studies which require more faithful adherence to participant testimony (Atkinson, 1995).

In the text a series of dots (…) indicates where some of the participant dialogue has been excluded; parentheses (   ) are used where the researcher has altered the text, most commonly to replace generic pronouns, to make sense of the quote for the reader.

Participants are identified by their site, their anonymous study number and a brief descriptor of their professional characteristics; radiographer participant study numbers are prefixed with the letter ‘G’, radiologists by the letter ‘L’.

5.3 Results

5.3.1 Diversity of practice and practitioners

In accordance with the purposive sampling strategy the ways in which radiographers were involved in symptomatic MIIR varied across the eight study sites from which participants were recruited. The detail of the variation that was encountered however was much greater that had been anticipated in the initial programme theories about how roles and responsibilities might be transferred or shared between radiographers and radiologists.

Table 5.3 gives a brief description of the sites studied, their respective service characteristics and outlines the way in which radiographers were involved in symptomatic MIIR, briefly describing the respective roles and responsibilities of radiologists and radiographers at each site.

The superscript numbers identify five main programme ‘interventions’ that were encountered with the footnotes indicating where the associated data are discussed in the subsequent results sections of the thesis.

Table 5.3 Symptomatic MIIR roles and responsibilities of participants

Site identifier & description	**Radiographer involvement in symptomatic MIIR**	**Radiographer and radiologist roles and responsibilities**
Site 1 - Large university teaching hospital Symptomatic service	Hot **commenting**[1] Hierarchical double reporting	All assistant radiographic practitioners and practitioner and advanced practitioner radiographers provide interpretive comment on images they acquire. Radiologists consider comments but are responsible for definitive interpretation and report.
Site 2 - Large district general hospital Symptomatic service	Cold (delayed) second reading **Equivalent double reporting**[2]	2 advanced practice and 1 consultant radiographers interpret and report all symptomatic mammograms up to 3 weeks after they have been interpreted and reported by a radiologist at the time of the patient clinic attendance. Discrepant (positive) cases are recalled for further evaluation.
Site 3 - Large district general hospital Combined service	Hot, **single autonomous reporting**[3]	(1 of) 3 radiologists, 2 advanced practice and 1 consultant radiographers interpret and report all symptomatic mammograms at the time of the patient clinic attendance.
Site 4 - District general hospital Symptomatic service	Hot, single autonomous reporting[3]	(1 of) 1 radiologist, 2 advanced practice and 1 consultant radiographers interpret and report all symptomatic mammograms at the time of the patient clinic attendance.
Site 6 Large university teaching hospital combined service	**Filtering**[4] Cold, autonomous single reporting Hot, autonomous single reporting	Patients attend symptomatic clinic; categorised by surgeon on basis of physical examination. P1 / 2 (suspected no / benign disease) – attend again for mammogram which is interpreted and reported by (any 1 of) 2 radiologists, 1 advanced practitioner and 2 consultant radiographers after patient has left department. P3 - 5 (possible malignant disease) – attend again for all imaging +/- tissue sampling; all imaging interpreted and reported by (any 1 of) 2 radiologists and 2 consultant radiographers at time of patient attendance.

Contd.

Table 5.3 contd.

Site identifier & description	**Radiographer involvement in symptomatic MIIR**	**Radiographer and radiologist roles and responsibilities**
Site 7 - University teaching hospital Combined service	Hot, single autonomous reporting[3]	(1 of) 3 radiologists and 1 consultant radiographer interprets and reports all symptomatic mammograms at the time of the patient clinic attendance.
Site 8 - University teaching hospital Combined service 8a main city hospital 8b –district general hospital	Hot autonomous, single reporting[3] **Hot, hierarchical** radiographer / radiographer or radiographer / radiologist **double reporting**[5]	(1 of) 4 radiologists and 3 consultant and 1 trainee consultant radiographers interprets and reports all symptomatic mammograms at the time of the patient clinic attendance. During busy clinics at Site 8b, 1 of 3 advanced practice radiographers may provide a provisional (first) interpretation and report; consultant radiologist or radiographer is responsible for definitive interpretation and report.
Site 9 - Large district general hospital; Combined service	Hot autonomous, single reporting[3]	(1 of) 4 radiologists, 1 consultant and 2 advanced practice radiographers interprets and reports all symptomatic mammograms at the time of the patient clinic attendance.

[1] see section 5.3.2
[2] see section 5.3.3
[3] see section 5.3.5
[4] see section 5.3.4.1
[5] see section 5.3.6.1

Thirty eight practitioners participated in the study. Eight (8) participants were clinical lead radiologists (one at each site). Thirty (30) participants were ‘radiographers’ for the purpose of this study - one of these was a non-graduate ‘assistant’ radiographic practitioner and thus not eligible for regulatory registration as a ‘radiographer’. Her inclusion meant that the professional status of the ‘radiographer’ participants in the study reflected the full range of the 4-tier non-medical workforce structure (see Table 5.4)

Table 5.4 Professional status of radiographer participants

Site identifier **Practitioner grade**	**1**	**2**	**3**	**4**	**6**	**7**	**8**	**9**	**Total**
Consultant radiographer - CR (Band 8)	-	1	1	1	2	0	4	1	**10**
Advanced practitioner - AdvP radiographer (Band 7)	3	1	2	2	2	1	3	2	**16**
Radiographer practitioner mammographer (Band 5 – trainee; Band 6 – PgC)	3	-	-	-	-	-	-	-	**3**
Assistant radiographic practitioner – ARP (Band 4)	1	-	-	-	-	-	-	-	**1**
Total	**7**	**2**	**3**	**3**	**4**	**1**	**7**	**3**	**30**

The professional characteristics, site and study numbers used to identify each of the radiographer participants are described in Table 5.5.

Table 5.5 Radiographer participant characteristics

Study identifier	Site	Professional characteristics
G02	7	Experienced advanced practitioner – multiskilled in breast imaging
G03	3	Experienced consultant radiographer - multiskilled in breast imaging including some experiential learning in MRI image interpretation
G04	3	Experienced advanced practitioner – sonographic background; no mammography image acquisition training or experience
G05	3	Experienced advanced practitioner – multiskilled in breast imaging; training in ultrasound tissue sampling
G06	8	Advanced practitioner – mammography image acquisition and MIIR competence
G08	2	Experienced consultant radiographer - multiskilled in breast imaging
G09	2	Experienced advanced practitioner - multiskilled in breast imaging; no screen reading experience
G11	4	Advanced practitioner – mammography image acquisition and MIIR competence; no screen reading experience
G12	4	Advanced practitioner – mammography image acquisition and MIIR competence; no screen reading experience
G14	4	Experienced consultant radiographer - multiskilled in breast imaging including MRI image interpretation
G15	9	Experienced consultant radiographer - multiskilled in breast imaging
G16	9	Experienced advanced practitioner – mammography image acquisition and MIIR competence
G17	6	Experienced consultant radiographer - multiskilled in breast imaging
G18	6	Experienced consultant radiographer - multiskilled in breast imaging
G22	9	Experienced advanced practitioner – mammography image acquisition and MIIR competence
G23	6	Experienced advanced practitioner – multiskilled in breast imaging; training in ultrasound tissue sampling
G24	6	Experienced advanced practitioner – mammography image acquisition and screen reading competence
G26	8	Experienced advanced practitioner – mammography image acquisition and MIIR competence
G27	8	Experienced consultant radiographer - multiskilled in breast imaging
G28	8	Experienced advanced practitioner – mammography image acquisition and MIIR competence
G29	8	Experienced consultant radiographer - multiskilled in breast imaging
G30	8	Experienced consultant radiographer - sonographic background; multiskilled in breast imaging
G31	8	Trainee consultant radiographer – experienced and multiskilled in breast imaging; undertaking final (research) component of MSc
G32	1	Experienced advanced practitioner – multiskilled in breast imaging; radiographic lead for symptomatic service;
G33	1	Experienced advanced practitioner – multiskilled in breast imaging
G34	1	Experienced advanced practitioner – multiskilled in breast imaging
G35	1	Newly appointed trainee in mammography image acquisition
G36	1	Advanced practitioner – mammography image acquisition and breast ultrasound competence; undertaking formal MIIR training
G37	1	Locum radiographer – mammography image acquisition and tissue sampling competence
G38	1	Assistant radiographic practitioner – vocational qualification in mammography image acquisition

The results of Stage 2 are now presented in four sections. The first section (5.3.2) draws on the data from Site 1 where all radiographers, irrespective of MIIR training and experience, were involved in a 'commenting' system. The second section (5.3.3) presents data from Site 2, the only site to operate a formal equivalent radiologist / radiographer double reading system in the symptomatic service. The third section (5.3.4) uses a composite case study approach drawing on data from all sites to demonstrate how NHSBSP screen reading training and experience influenced the involvement and performance of radiographers in symptomatic MIIR. The fourth and final section (5.3.5) again presents composite data from across all sites to illustrate how radiographers were able to function in a single autonomous reporting role as a substitute for a radiologist.

The results sections relate to the initial programme theories as shown in Table 5.6.

Table 5.6 Mapping of results sections to initial programme theory

Theories about: **Results:**	**Role**	**Responsibility**	**Learning**	**Team working**
A commenting case study (section 5.3.2)	Role enhancement	Hierarchical double reading	Experiential	Provisional descriptive report for radiologist
A delayed second reading case study (section 5.3.3)	Substitution	Equivalent double reading	Formal Experiential	Verify or amend radiologist's free text report - mammogram only
The influence of screen reading (section 5.3.4)	Role diversification - filtering Delegation	Single reading Hierarchical double reading	Transferable Novice to expert	Standard template reports to surgeons for normal / uncomplicated cases Abnormal cases passed on to radiologist
The hybrid practitioner (section 5.3.5)	Delegation Substitution Specialisation Role innovation	Single reading	Formal Expertise Culture	Create free text report - differential diagnosis based on all imaging Include recommendation for further management

5.3.2 A commenting system case study

None of the radiographers who participated in this study were involved in a formal ‘red dot’ (normal / abnormal sorting) system but Site 1 operated a formal ‘commenting’ system. At this site in addition to acquiring symptomatic mammograms and evaluating their technical quality all radiographers had additional responsibility for evaluating the clinical information in their images and offering a preliminary diagnostic opinion.

This quotation from the interview of the clinical lead radiologist at this site explained the difference between the radiographer’s traditional ‘technical’ image acquisition role and their extended role involvement in image interpretation:

> *I have always worked with radiographers who have been enthusiastic and involved in what they are doing…not just taking nice pictures but understanding what the pictures were showing and how that impacted on patient treatment…the first thing is that a mammogram has to be technically correct in terms of pectoral muscle and nipple in profile and infra-mammary fold but that should become standard fairly quickly, and then I think you are expecting (radiographers) to look at the normal anatomy and pathology. [Site 1 L13 radiologist]*

The seven radiographer participants at this site comprised: an assistant radiographic practitioner (G38, ARP), a newly recruited radiographer practitioner yet to embark on mammography (image acquisition) training (G35), three experienced (advanced practice – AdvP) radiographers with external (HEI) MIIR qualifications (G32, G33, G34), one radiographer currently undertaking a HEI MIIR qualification (G36) and one locum experienced mammographer without an MIIR qualification (G37). All these practitioners, by virtue of their employment in this department were providing a preliminary clinical opinion (written comment) about the images they acquired and forwarding this to the radiologist who was responsible for making a definitive interpretation and compiling a report for the clinicians. The data collected helped to define and characterise how the different radiographer practitioners functioned in the role and explain in what circumstances and through what processes radiographers were enabled, or had difficulty encompassing their new responsibility.

In the IPT it was suggested that radiographers who did not have formal MIIR training might be able make interpretive comments about images because the basic concepts of image interpretation were introduced to them during their mammography (image acquisition) training. The following quotations from the interviews of two advanced practitioners confirmed that practical training in mammography image acquisition also incorporated informal image interpretation training at this site:

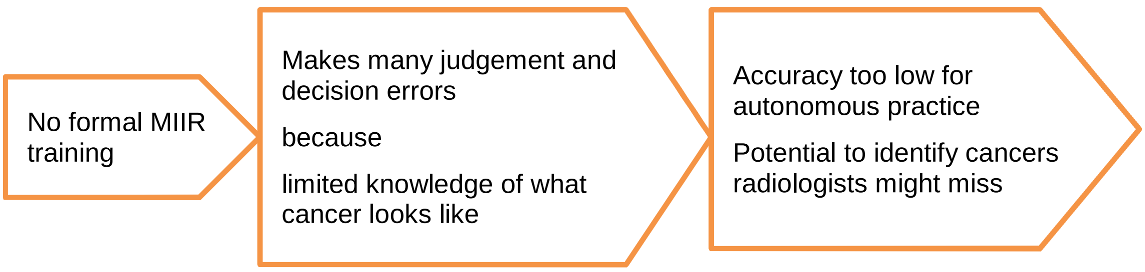
> *I will go with (trainee mammographer) and look at the mammograms… we incorporate looking at the mammograms as part of the training, it's not just do the mammogram and pick up the next one, it's 'go and have a look, what do you think?' [Site 1 G36 AdvP]*

> *Together with doing the mammogram they also, the same day as they start doing that they also learn how to look at a mammogram and make observations. [Site 1 G34 AdvP]*

The above data was an example of radiographers with different skills, knowledge and experience working together and making collective decisions about mammography appearances. Sharing responsibility with members of the (intra-professional) radiographic team who had more experience seemed to enable those without task-specific formal training to be involved in symptomatic MIIR.

The IPT hypothesised that radiographers without formal training in MIIR would make multiple judgement and decision errors because of their limited knowledge and skill. As a result it was predicted their diagnostic accuracy would be too low to function in a 'single reading' role but if involved, as at Site 1, in a double reading role with radiologists, their experiential learning might enable them to detect some cancers that the radiologists might miss if interpreting images alone, see Figure 5.1.

Figure 5.1 IPT - No formal MIIR training



The evidence from the radiologist at Site 1 concurred with this hypothesis – she believed that involving radiographers in commenting helped to improve her diagnostic accuracy. In this quotation she explained how, overall as a service they might find more cancers (improve sensitivity) because radiologists re-examined cases they believed to be normal when radiographers had commented on a potential abnormality:

> *We are in the industry of finding subtle things and two pairs of eyes have got to be better than one pair of eyes… occasionally I look at a film and think that's fine and then I see the note 'calcification' and I think 'Oh right, OK, right, let's go and look at that again'. [Site 1; L13 radiologist)*

Contradicting the IPT assumption that review of radiographer decisions identified radiographer error, (see below), this statement implied that review might help to identify radiologist error. The radiologists read the images ‘blind’ initially, then looked at the radiographer’s opinion and re-examined areas that radiographers considered might represent small and subtle abnormalities that they had overlooked.

The Site 1 data suggested it was unlikely that inexperienced and junior radiographers involved in commenting but without formal MIIR qualifications contributed to increased sensitivity because they made ‘over-cautious’ decisions. Inexperienced and lower grade radiographers lacked confidence and were anxious about interpreting and commenting on mammograms on their own but sought the second opinion of another radiographer before committing themselves to a written comment for the radiologist. This was illustrated in the following two extracts from the ARP interview:

> *I am not always sure what I am actually looking at…so I have… not found it a struggle but I don’t feel like I am confident yet… I have had no experience and no training into looking at what I am looking for… so it's a bit scary to be honest. [Site 1; G38 ARP]*

> *I will always get somebody to come and look at the films with me especially because I am unsure of what I am writing. And I just ask them to sit with me and I ask them ‘have I described this right? Have I missed anything?’ or if I think there is something there I will ask them I’ll say ‘does that look like anything?’ [Site 1; G38 ARP]*

The second quotation provided another example of intra-professional collaboration and collective decision making between radiographers. Although aware that her opinion would be double checked by a radiologist, the ARP described consulting with more experienced / senior members of her own profession before passing her comments on to the radiologist.

The IPT hypothesised that with continued practice, experience and CPD activity the knowledge and skill, and thus the diagnostic accuracy, of radiographers without formal training in MIIR would improve through experiential learning. The ARP provided an example of this type of ‘learning on the job’, following up cases, and explained how she expected additional experience to improve both her knowledge and her confidence:

> *I am going to start making little notes of patients just for my own peace of mind and my own confidence, to follow up and see if I have done it right or wrong; that’s what my little notepad is there for… I am gaining more knowledge and experience… I’m trying to concentrate on getting more experience and building my confidence [Site 1; G38 ARP]*

The data collected at Site 1 confirmed that MDT meetings were a valuable opportunity to obtain feedback about cases but revealed that they were not accessible to all radiographers. The team leader explained the logistic reasons for this:

We have a rota…we have 2 MDTs a week, unfortunately one is on a lunch time so we can't force people to go. So if you only work that day and another day when there is not an MDT you can't go because you need your lunch, you can't be forced to go so you don't have the opportunity to go. [Site 1 G36 team leader].

The radiologist explained how this barrier might be overcome and feedback obtained because people that were at the meeting could share information about diagnostic outcomes and clinical management decisions using electronic and paper resources:

The decisions of the MDT are put real-time into (the electronic patient record) and we also record them on hard copy. So that means people that weren't at the meeting, by the end of the meeting have, back in the department a written record. So people that have a case that they were unsure about can reference the MDT notes… that works well. [Site 1 L13 radiologist]

This was an example of radiographers, radiologists and other members of the multidisciplinary breast care team sharing information resources and working together to try to improve the performance of the diagnostic team as a whole.

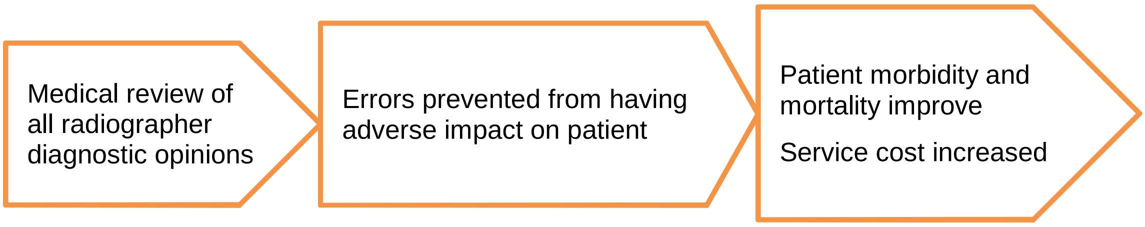
Participant G36 was currently undertaking a formal MIIR course. She explained the influence of this on her practice:

It's the little things that you don't realise you don't know… you learn things that you never really thought about…I'm much better at trying to pick things out now… prior to (starting the MIIR course) most of my interpreting mammograms was stuff that I picked up on the job. I feel like I am giving them more information on the yellow comments sheet now rather than being a bit vague and thinking 'oh someone else will looks at it'… I am thinking more about the patient journey as a whole… 'does this need any extra views? Does it need any extra scans?' and I am definitely picking up on more subtle things than I have before. [Site 1 G36 trainee MIIR radiographer].

This evidence suggested that a formal structured external learning programme gave radiographers a greater understanding of the patient's diagnostic journey as a whole. This participant seemed to imply that her formal training prompted her to think more about what other diagnostic tests might be needed and thus what she might need to initiate, or recommend in her reporting 'comments', in contrast to relying on a radiologist to make the decision and tell her to carry out the tests.

All mammograms at Site 1 were interpreted and reported officially by radiologists. In the IPT it had been suggested that medical review protected patients from the adverse impact of radiographer errors but because this involved 'double' reading overall service cost would increase (see Figure 5.2).

Figure 5.2 IPT - Medical review (double reading) of all cases



The radiologist at Site 1 confirmed that all radiographers' comments were reviewed by a radiologist. She explained how their system of double reporting was 'hierarchical'. In this quotation she described the radiographer's report as having 'provisional' status because the radiologist was ultimately responsible for making the definitive diagnostic judgement:

> *There have always been radiographers involved in writing provisional reports, a provisional report on a sheet, a written report on a sheet that's the kind of first report. So what I do is I look at the films, I look at the referral card, so what the problem is. I look at the films I look at the radiographic comment and then I make a report… I have the final say. [Site 1 L13 radiologist]*

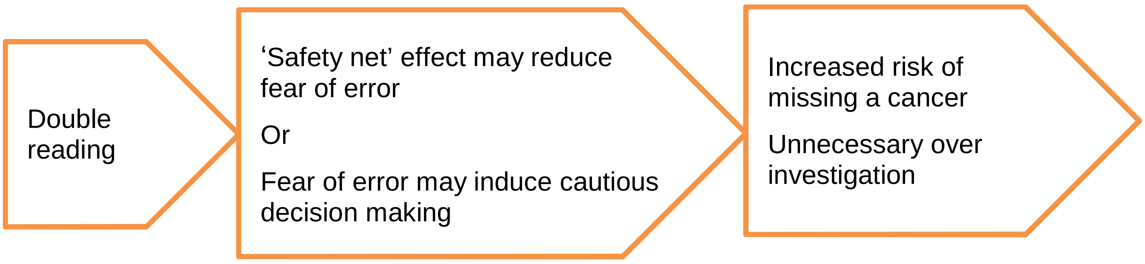
The radiologist's evidence illustrated how their system preserved a power differential between the two professions and limited the radiographers' responsibility.

One radiographer highlighted the risk that radiologists might begin to over-rely on always having a preliminary opinion from a radiographer and pointed out that this might lead to radiologists not identifying cancers that radiographers had missed. This risk was minimised because radiologists knew they could trust the more experienced radiographers and had to be more cautious about junior / less experienced ones:

> *The comment will prompt them to look at these areas, hence possibly speeding up their reporting but it could also possibly be a distraction because there could potentially be something that the radiographers have missed. The radiologist can't just take that for granted, they still have to look. I think they trust the radiographers who have been in the game a long time, they trust more what they have done and they will question more from Band 4 (ARP) and Band 6 (non MIIR trained) practitioners…. I think that's natural, the more experience you have you are going to be trusted more. [Site 1 G34 experienced AdvP]*

The IPT suggested that radiographer's decision making might be influenced by 'fear of error' because a second person was looking at the images and that this might affect their sensitivity for cancer detection and / or the likelihood that they would perform additional (unnecessary tests) – see Figure 5.3.

Figure 5.3 IPT - Fear of error



Lack of confidence and fear of error, both anticipated and actual errors, was apparent in the following testimonies of participants who were not trained or experienced in MIIR but believed they were obliged to participate in the commenting scheme:

> *I am scared of writing down something that's not right… I don't want to miss something and write that I haven't seen anything when there could be something there… I really need to ask a lot of questions. [Site 1 G35, trainee mammography practitioner]*

> *When I missed something that was very spiculate in a woman that was, young with very dense breasts, and it wasn't very obvious to me, it was awful. It made me go home and feel as though I didn't want to come back … it did, it really scared me because I felt responsible for missing something. [Site 1 G38 ARP]*

The first quotation contradicted the hypothesis that radiologists might be perceived as a 'safety net' and that this might reduce radiographer sensitivity. Evidence from this site suggested that radiographers were concerned not to use the 'fall back' position that they were not supposed to know, and call something normal or benign. Inexperienced and untrained practitioners seemed burdened by responsibility, they were fearful of missing a cancer and the consequences of this; the second quotation illustrated how their confidence and morale could be undermined when this happened.
The data from these radiographers, suggesting that they felt insecure in their 'ignorance' was incongruent with that of the radiologist. She expressed the opinion that the role of 'first read' radiographers was to 'flag up' potential abnormalities even though they might turn out to be nothing without fear of (false positive) error. This quotation from her interview clarified that inflated sensitivity in radiographers was not a problem and appeared to suggest that radiographers in this role might be encouraged to make over cautious decisions (more false positive diagnoses):

> *I think there will be more instances where something is commented upon (by a radiographer) and I decide on reflection that we are not going to take it further, you know it's there but I think it's benign or I don't think it's changed significantly. [Site 1; L13 radiologist]*

Morbidity associated with false positive radiographer judgments was not completely avoided in the commenting system at Site 1 because radiographers had the authority to make decisions about acquiring extra mammographic images, which incurred additional radiation exposure, before the images (and their comments) were passed to the radiologist for medical review. This was illustrated in the following quotation:

> *Some things you can see on your screen in the room when you do your mammogram… so if there is something obvious and it needs a lateral I would do it straight away. [Site 1 G33 experienced AdvP]*

The performance of unnecessary additional tests or investigations arising from inexperienced and assistant radiographic practitioner interpretations was mitigated because these practitioners conferred with more senior, advanced practice radiographers or medical colleagues first, as explained by this senior AdvP participant:

> *The ARPs and Band 6 (practitioner) will always ask for advice from the advanced practitioner of what's the next step to take. [Site 1 G34 AdvP]*

A further example suggesting that radiographer decision making autonomy was also stratified according to risk related to invasive tissue sampling. The radiographer quoted below explained how she might recognise that a patient needed a biopsy but could only 'recommend' this in her comments;

> *If you think it needs a biopsy, you say so…. it helps them decide whether they think an image-guided biopsy or whether a clinical biopsy will be more suitable….the radiologist will ask the advanced practitioner 'can you biopsy it?' and they will go through the films together. [Site 1 G36 AdvP]*

At Site 1 patients were thus protected from the adverse consequences associated with (minimally invasive) tissue sampling procedures because even the most experienced advanced practitioners did not have organisational authorisation to initiate minimally invasive clinical procedures. Medico-legally they could only do this when directed to do so by a radiologist and when a radiologist was present in the department.

This situation contrasted with data from most of the other sites studied where trained and experienced radiographers had been developed into consultant practitioner (CP) roles because they did not have enough radiologists to cover this aspect of their service. By way of illustration – this quotation from a CP radiographer participant a Site 6 describes how her professional boundaries had extended to encompass autonomous interpretation of mammograms and proceeding with whatever additional imaging and image-guided tissue sampling tests she considered to be appropriate without involving a radiologist:

> *You are reporting the mammogram, overall reporting the ultrasound scan, doing the biopsies and finalising recommendations as to what else needs to be done [Site 6 G18 CP]*

One Site 1 participant explained how patients could be inconvenienced because tissue sampling procedures were delayed, carried out at another attendance, on days when there was no radiologist available at their initial attendance because the scope of responsibility of radiographers was limited at this site:

> *There are certain days of the week when we have no radiologist… it is down to the radiographers… if we have no doctor then the patient cannot have a biopsy…we have to rebook patients for biopsy if we see the need for biopsy. [Site 1 G34 AdvP]*

The radiographers' scope of practice at this site had not extended to initiating and performing tests of a 'clinical' nature traditionally undertaken by radiologists. Role extension was limited to initiating further tests of a 'technical' nature – initiating and performing extra views - tasks and responsibilities within the traditional scope of their own practice.

In the IPT it was suggested that allowing radiographers to collect more diagnostic information by initiating additional imaging would reduce patient waiting times. The radiographers at Site 1 believed that patients benefitted from reduced clinic transit times because they did not have to wait for radiologists to see their images before additional necessary imaging was performed, as illustrated in the following quotation:

> *We look at the mammograms, we interpret the mammograms… if you happen to see anything you can just go and do extra views, go and scan that area, you know autonomously, it's not like you have to ask, you know so it is… I think it saves time, it's better for the patient journey because the last thing they want to be doing is going back and forth and back and forth. [Site 1 G36 AdvP].*

The radiographer participants at Site 1 identified an additional psychological benefit for patients. The team leader and one of the experienced AdvP radiographers explained how patients might be less anxious when radiographers initiated extra tests immediately after their initial mammogram compared to when they were performed after a time delay and at the request of 'a doctor'.

> *It's got a knock on effect for the patient…rather than having to wait for the radiologist to report it… so anxiety, you do raise patient anxiety no matter what you do extra… but at least it's not a delayed… and we can talk to them more to explain what you have seen. [Site 1 G32 Team leader]*

> *I think it causes less stress to the patient because it comes over as being needed to be done at the time, not something that someone's said 'oh, there is something wrong with that… call her back in and do some more'… for the ladies it's much nicer just to carry on and do one or two extra views as if it's just normal…it's less traumatic for your patient. [Site 1, G33 AdvP]*

The Site 1 participants felt that streamlining the patient's journey in this way offset any increase in decision making time associated with two people interpreting the mammogram. This was illustrated by one of the experienced AdvP radiographers:

> *If you look at a mammogram and decide it needs a lateral and an extended CC, it means the patient hasn't gone back and waited to be reported and the radiologist calls them back and says 'can you do something else on this patient'. It's been done in one time slot which saves time. [Site 1, G33 AdvP]*

Any additional time associated with 'double' reading, including radiologist re-reading and discordant read resolution time, was minimised at Site 1 in two ways. Firstly because the first reader (radiographer) opinions were passed on in writing using a proforma 'yellow comments sheet' and secondly because the second reader (radiologist) had authority to overrule the first reader's opinion and make the definitive decision without holding a (consensus) discussion (hierarchical double reading).

The yellow comments sheets were supposed to serve as a feedback tool because there was space for radiologists to annotate when they 'agreed' and 'disagreed' with the radiographer's opinion. The following data extracts illustrated that both radiographers and radiologists were aware of the potential value of this:

> *There is an opportunity to say whether we agree or disagree with the radiographer report. I think they will tell you that we are not very good at filling that in, but hopefully if we disagree, we fill it in. [Site 1, L13 radiologist].*

> *On the yellow form it says 'does the report agree with the radiologist?' It's a yes or a no, if it is 'no' the radiologist should come to us. It has fallen a bit away… so it is something that we have discussed in our staff meeting, asking for the radiologists to be more on the ball about doing it. [Site 1 G34 AdvP]*

In day-to-day practice the radiologists did not seem to consider it important to fill them in as a routine. The radiologist went on to suggest that she and her colleagues were more likely to make radiographers aware of their errors, 'disagreements', when they occurred , than routinely provide balanced feedback for them to access at a later date:

> *Hopefully most cases are discussed at the time… if you've got a one-stop clinic then you have got the radiographer there so if there is a discussion or a discrepancy then that should be apparent, you know in the moment [Site 1, L13 radiologist].*

Feedback from radiologists featured in the IPT, its proposed effect being to increase radiographer knowledge, skill and confidence and thus improve their decision–speed accuracy. These quotations illustrated how feedback tended to have a negative bias, identifying errors and how the radiographers were not always aware when radiologists confirmed accurate decisions. The radiologists approach might be justified on the basis that it appeared to be in keeping with substantive theory suggesting that learning from mistakes is enhanced when feedback occurs soon after a decision error is made and when it is accompanied by an explanation of why a decision was wrong. However, enactment of an inter-professional power differential might also be inferred because radiologists sought out radiographers to point out their mistakes face-to-face in comparison to letting them access balanced feedback routinely through an inanimate audit tool.

Despite the official system not working as intended, there was evidence that the day-to-day informal feedback relationship between radiologists and radiographers was in fact mutually respectful. One of the radiographers seemed to convey a sense of respect and support from the radiologists when she described this process:

> *Most of the radiologists are really good – they are really good at giving you feedback. They don't ever talk to you like you are stupid if you have missed something. We are really lucky that we have got a good relationship with the radiologists. It does feel very respectful, like there is a lot of respect between the radiographers and the radiologists … everyone's opinion does matter which is really good. It doesn't feel like you are being criticised as such, it's more constructive… none of us get it right 100% all of the time. [Site 1 G36 AdvP trainee MIIR]*

Radiographers also got feedback on mammogram comments from their colleagues who performed ultrasound examinations, as explained in this data extract:

> *The ARP and the Band 6 get feedback as they go along because the radiographers who do the ultrasound will always look at what has been written and feedback: 'you might have missed this', 'you maybe should have described that', 'I don't agree with that– this looks normal, you exaggerated it, it's important to not over-report it'.[Site 1 G34 AdvP]*

Typically these radiographers were the more senior practitioners with the most experience. The following data extract illustrated how peer-to-peer learning could help inexperienced radiographers make better judgements about mammogram appearances in the future:

> *At the moment we have got quite a lot of new staff here and they are getting on really well and they are learning, they are picking up things quickly. But you always have to say… if I think they might have missed something or if I think they may have over-reported or if I think they have done really well… we feedback to them … that's a way that they learn. [Site 1; G34 AdvP]*

This evidence was insightful because it illustrated how a radiographer giving feedback to a fellow radiographer focussed on both positive as well as 'negative' feedback - telling colleagues when they had done well in addition to pointing out their errors.

The IPT had hypothesised that extending the radiographer's role to include image interpretation and reporting would affect their job satisfaction and that this might be influenced by whether or not the system was voluntary and / or associated with any motivational rewards.

Invariably the radiographers at Site 1 explained that the commenting task made their job more interesting, the following quotation being a representative example:

> *I think it makes my job more interesting…. if you are writing it down you have to think of the right words, you can't just look at it and think 'ooh, that looks a bit funny', you have to describe it and use the right words to describe it which is good… good for your enjoyment really… it is an extra task, it does make everything take a bit longer I think but I think it's a valuable part of the job. [Site 1; G33 AdvP]*

The newly recruited radiographer whilst expressing some anxiety, still acknowledged that it made her job more rewarding:

> *I suppose because you are adding that little bit of input from yourself, from what you think and your opinion, it's making it more interesting. I think it's more interesting because it's not just simple x-raying and letting them go and forgetting about that patient. Definitely in that respect it's really good for job fulfilment purposes… but it's just scary for me at the minute... but I think it's good, definitely. [Site 1; G35 newly recruited mammography trainee]*

Her anxiety appeared to stem from a perception that the system was only nominally voluntary and the prevailing belief of all radiographers at Site 1 that they were expected to participate irrespective of experience or training. The perceived obligation to participate in commenting was of particular concern to the locum radiographer and the assistant radiographic practitioner at the site. Both these participants were experienced and used to acquiring mammographic images autonomously but seemed to feel out of their depth and unsupported about extending their role to encompass the MIIR commenting task:

> *Terrified... I'd never had any experience you know … it really scares me. [Site 1 G35 trainee Band 5 radiographer]*

> *I'm not qualified in image interpretation…. and because I have never film read it was really awkward …. I'm not happy, you know…. when I'm not even a film reader. [Site 1 G37 locum radiographer]*

These quotations seemed to suggest a cultural assumption at Site 1 that image acquisition training and experience automatically affords knowledge and skill in image interpretation. This evidence illustrated how problems might occur when radiographers who train in a department that does not involve them in MIIR move to work a department where this is the normal expectation.

There was no financial or career incentive for the radiographers at Site 1 to be involved in commenting – providing a preliminary opinion that a radiologist could overrule was not associated with additional status in terms of pay or grading. The team leader and MIIR trainee explained how career progression was limited because ultimate responsibility for definitive official interpretation and reporting remained with radiologists:

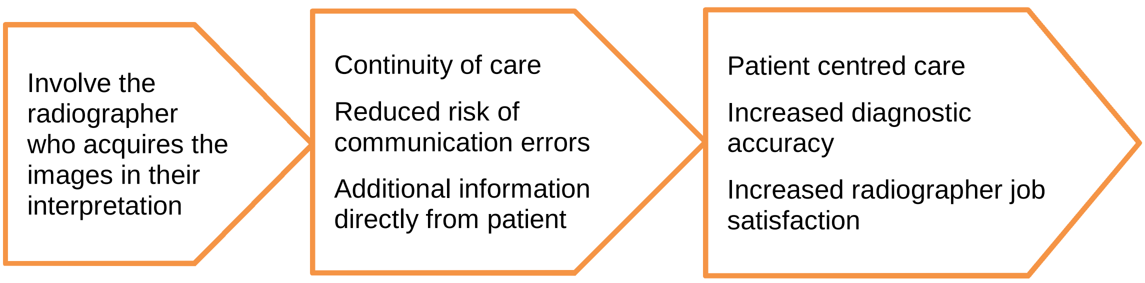
> *From a managerial point of view these are 'comments' because the grading of the radiographer depends on how much they can report… Band 6 radiographers make comments, it's not a report. [Site 1 G32 team leader]*

> *I am a Band 6 … I think the reason is because the radiologist has the final say, the responsibility is taken out of our hands if you get my drift…. as far as I am aware with me doing this (MIIR) course … the advanced practitioner (Band 7) is more geared towards biopsies… I think once you start doing biopsies that's when they will up you to an advanced practitioner. [Site 1 G36 MIIR trainee]*

None of the radiographers suggested that lack of additional pay for undertaking the additional commenting task influenced how conscientious they were or how accurate their opinions might be.

It was hypothesised in the IPT that involving the practitioners who acquired the mammography images in their interpretation might promote a more patient centred model of care – see Figure 5.4. The argument for this was based on the assumption that continuity of care had the potential to reduce communication errors along the chain of diagnosis and would give radiographers the opportunity to relay additional information acquired directly from patients.

Figure 5.4 IPT - Patient centred care



At Site 1 continuity of care only occurred where the radiographer performing and commenting on the mammogram was also competent to undertake the ultrasound and / or tissue sampling examinations. The data from this site also revealed that direct contact with patients could sometimes involve radiographers in disclosure of results.

The following quotation suggested that this responsibility was added even more stress to the role for inexperienced junior radiographers:

> *Sometimes yes, you have to say something… normally I would say there is a little extra density that I just want to make sure is glandular … when I'm doing extra views … I used to find it very stressful but now I'm older and I've done it a lot of times I don't find it as stressful as I used to... I think you have to judge it, you have to know what they want to know, you have to tell them just the right amount. [Site 1 G33 AdvP]*

At Site 1 risk of communication errors along the diagnostic chain appeared to be reduced not necessarily because the same radiographer undertook all examinations but because radiographers made comments in paper format (the yellow comments sheet) and this was passed on to practitioners performing successive examinations later in the diagnostic chain. In addition, practitioners were also able to discuss cases directly with each other because they congregated in a shared communal workspace between examinations.

The data from Site 1 revealed a further patient benefit to involving radiographers in symptomatic MIIR that had not been considered during articulation of the IPT. Both the radiologist and the radiographers at Site 1 believed that radiographers who interpreted images became better at producing images of a high technical standard:

> *I think you get better quality radiographic examinations if people are looking at them in a searching way… from people who are reporting because you notice if it's blurred or mal-positioned much better than you do if you are not reporting it because you are looking at it on a proper reporting workstation. It's particularly true in mammography that undoubtedly some things like blur you won't notice unless you are on a reporting workstation... so you get better quality images. [Site 1 L13 radiologist]*

Further literature review suggested that images of a high technical standard, where patient positioning, breast compression and geometric sharpness are optimised, might translate into diagnosis of earlier diagnosis of cancer (Rauscher et al., 2013; Taplin et al., 2002).

In summary the data collected at Site 1 where the role of all radiographers was diversified to include commenting about mammography images demonstrated that:

Involving all radiographers in MIIR (commenting):

- might streamline the patient journey through clinic because radiographers could initiate and perform additional investigations instead of waiting for doctors to request them;

- added interest to the radiographer’s work and increased their sense of value and job satisfaction even in the absence of professional gain (promotion) and financial reward;
- promoted in-house peer learning because junior and inexperienced radiographers consulted more senior and experienced colleagues;
- would not result in continuity of care unless the radiographers had the necessary skills to perform additional (ultrasound / tissue sampling) examinations;
- might reduce the risk of communication error or omission because practitioners used a written form of onward communication;
- might limit the ability of radiographers to improve where they could not get balanced feedback on their performance;
- caused stress and anxiety in inexperienced / unqualified radiographers because they felt compelled to participate but needed substantial support from more experienced colleagues;

In addition the data suggested that involving all radiographers in MIIR (commenting)

- had the *potential* to increase cancer detection because radiographers might draw radiologists’ attention to cancers they miss on their own;
- *might reduce* patient waiting / clinic transit time because radiographers initiated and performed additional investigations instead of waiting for doctors to request them;
- *might not* prohibitively increase overall decision time (patient clinic transit time) because hierarchical second reading enabled the first reader to be overruled without the need for consensus discussion to resolve discordant opinions.

5.3.3 A delayed second reading case study

The IPT suggested that double reading, where the diagnostic decision making process is shared between two practitioners, helps to improve diagnostic accuracy.

The hypothesis that radiographers might replace a ‘second’ radiologist, and that radiographer / radiologist ‘double reading’ of symptomatic cases might improve cancer detection (sensitivity), was critically examined further using data from participants at Site 2. Site 2 was a relatively large district general hospital but only provided a symptomatic service. They had three ‘reporting’ radiographers who had all undertaken an external HEI course in MIIR and had been involved in double reporting symptomatic cases for over 5 years. With the exception of the commenting system described above (section 5.3.2) this was the only site that operated a formal 'double' reading system for symptomatic cases.

At Site 2 a radiologist interpreted and reported mammograms in the rapid access clinic (hot reporting) with one of the advanced or consultant practitioner radiographers 'second' reading the images later in the week (cold reporting). The following quotations from the Site 2 radiologist and AdvP radiographer explained the local rationale for this:

> *We have a system of double reporting of all the symptomatic clinic mammograms … any disparity or things that could be missed in the heat of the one-stop clinic get flagged up … its worth doing just to put everyone's mind at rest. [Site 2; L07 radiologist]*

> *A breast radiologist… in the clinic, is seeing a patient, doing a biopsy, going back down the corridor, reporting that, doing the (histology) pots and everything else... next patient through… it's the pressure… by double reporting and looking at it cold later… it's better for the patient... somebody else is looking at it in a quieter environment… it's best for the patient… and the radiologist. [Site 2; G09 AdvP]*

These participants believed that the environment of the rapid access breast clinic was uniquely chaotic and made it difficult for single reading radiologists to detect every small, subtle, unexpected and incidental cancer. The data from this site suggested that the system could improve diagnostic accuracy and increase the confidence of radiologists.

The participants did not have any robust quantitative data to support their claim that the system was clinically effective, as illustrated in the following interview dialogue with the CP radiographer participant:

> *(Interviewer: How many patients do you think you find something on? Do you know?)*

> *I don't think I've ever stopped to count it. [Site 2 G08 CP]*

> *(Interviewer: For the one-stop clinic, what's the value of the second report?)*

> *We had a couple certainly this last month… that we've found cancers on … [Site 2 G08 CP]*

Her colleague corroborated the impression that increase in sensitivity might be marginal:

> *Yes... to be honest with the one-stop clinic it's not usually that many. If we're honest, it's not that many. [Site 2 G09 AdvP]*

Despite not knowing how many cases were recalled by second reading radiographers the CP pointed out how additional abnormalities tended to be subtle and incidental, but nevertheless still clinically significant:

> *Generally with the one-stop clinic if we find anything it tends to be on the other side, something on the contralateral breast that's very subtle. [Site 2 G08 CP]*

In the following data extracts the participants drew on substantive cognitive theory to explain why this happened:

> *We've had a few cases of very fine microcalcification… often in the asymptomatic breast… so sort of back to this 'satisfaction of search' business... obviously you see the cancer.. you're drawn to it.. you look at it and you don't ignore the other breast … but you don't give it quite as much time as you should do. [Site 2 L07 radiologist]*

> *I think you can get side tracked… if you get a referral for a patient that says they have got a P5 (malignant) lump right breast… there might be something very, very subtle on the other side that, in the heat of the moment you may completely overlook. Not because you don't want to see it or you haven't looked… you just don't register it and when you are doing it in the calm, dark room with your cup of coffee – you probably will find it. [Site 2 G08 CP]*

Despite the fact that some patients might benefit from the detection of missed cancers, the data revealed that the system had several unintended consequences.

The following interview extract illustrated how patients could be falsely reassured and discharged from the one-stop clinic only to be recalled at a later date, told that something might have been missed and that they needed further tests:

> *If a patient has come to a clinic and been told that everything is absolutely fine and they've been discharged… and then we second look at it and we actually see something… a calcification or something.. and we need to call these patients back now… they have gone off from clinic thinking 'ooh great, I'm absolutely fine.. fantastic' and then suddenly …[Site 2 G08, CP]*

The potential adverse impact of this was exacerbated by the delay that might be involved. This was explored in the following interview discourse:

> *(interviewer) What's your turnaround time then?*

> *It's usually about 2 – 3 weeks. [Site 2 G08, CP]*

> *At the moment its a couple of weeks – we're behind. It's usually less – its 2 weeks or less. If we're all... if we can get onto it, and get going. If they put extra clinics in and things like that, then things start to slip. [Site 2 G09, AdvP].*

In one 'clinically spectacular' case recalled, the clinical significance of delayed detection even for patients who had a cancer detected initially was illustrated:

> *We've even had a patient that's had a cancer… and we've found one on the other side... that was very subtle. And she'd had her surgery on her first side by the time we recalled her for her other side. Well she had to have a second operation later on. [Site 2 G08, CP].*

Another participant went on to explain how diagnostic delay could be extended because sessions were lost to non-working days:

> *… we keep up to most things within a couple of weeks… the follow-up ladies get a sheet that says up to 4 weeks… we did the 4 weeks because of things like bank holidays and Christmas… and New Year having 2 bank holidays … it was easier to say 4 weeks, rather than its 2 weeks for the rest of the year, might be 4 weeks. [Site 2 G09, AdvP]*

Further evidence from the participants suggested that their double reporting system was compromised because delays were due to inadequate resourcing:

> *I think we could do with another reporter. It's alright while we are all here but when one of us is off… it falls behind - our report turnaround time lengthens. [Site 2 G08 CP]*

> *we haven't got enough reporting monitors… you could actually have, even if you're off, one of us doing the clinic with the radiologist… but the problem is, like this afternoon, you've got a radiologist on one monitor dealing with patients, you've got two radiographers with a follow-up clinic on the other monitor, so we have no monitor to report on…. it's more of an equipment issue. [Site 2 G09 AdvP]*

The second quotation suggested that personnel issues might be overcome, and that if there was enough equipment available in the clinic environment, cases could be double 'hot' reported whilst the patient was still in the clinic.

Although one of the participants had explained how routine follow up (surveillance of previously diagnosed and treated patients) patients were warned about the delay in their results, this contrasted with the situation for symptomatic clinics. The CP radiographer participant explained that the reports issued by the radiologists in the one-stop clinics indicated that '*this report is provisional until a second report has been added' [Site 2 G08 CP].* The advanced practitioner suggested that surgeons needed to tell patients *'your mammograms will be looked at by another person and until then it's still provisional' [Site 2 G09 AdvP];* she confirmed when pressed, the implication that these patients were largely unaware that they could be recalled at a later date. The radiologist suggested that '*in spite of us repeatedly telling them… the breast surgeons are completely oblivious to it' [Site 2 L07 radiologist].*

Although this study did not collect data from patients directly, the participants shared their experiences of patient reactions to delayed recall. The following example suggested again that, in the absence of formal independent corroboration, recall bias limited subjective memory to extreme cases:

> *(interviewer) How do patients react to being recalled?*
>
> *Sometimes they are a bit angry. [Site 2 G08 CP]*
>
> *One in particular – had a complete paddy – that was the husband… then she joined in. [Site 2 G09 AdvP]*

Formal double reporting of symptomatic cases was unique to this study site and the participants recognised their ‘outlier’ status. The following data extract suggested that the system was triggered by a desire for improved accuracy and enabled because the department believed they had enough staff to deliver it:

> *I think its when screening started to double report and double reporting became the ‘gold standard’… you might as well try and do it. It depends on your manpower constraints but we seem to manage to do it with the staff we’ve got… I think it can be seen as a luxury for the one-stop breast clinics, I’m not aware of anywhere else that’s double reporting (symptomatic cases). [Site 2 L07 radiologist]*

The following two data extracts, from comparative sites that did not operate double reporting concurred with this view:

> *We would prefer to double read the (symptomatic) clinic mammograms but haven’t got the staff and resources. I think in an ideal world we would double read everything… I think it would improve our performance. [Site 3 L10 radiologist]*
>
> *We are only single reading symptomatically. I know initially there was a move to do double reading, before my employment, but it's never happened… we haven’t got enough members of staff. [Site 4 G14, CP]*

A final series of data extracts were used to critically examine the hypothesis that radiologists and radiographers who shared responsibility for symptomatic MIIR might also share accountability. The following interview quotations appeared to support this theory:

> *It's a joint responsibility. It's not a second report in as I am checking you, it's not I am checking the first report – it's not that. They are independent… stand on their own merit… both reporters take equal responsibility for the result. [Site 2 G08 AdvP].*
>
> *It's a group responsibility, we all support each other and if things are missed, hopefully they are caught in the safety net and it's a learning episode, it's a learning sort of thing…everybody does benefit from it. [Site 2 L07 radiologist]*

As in the previous section of the study results, the second quotation illustrated how feedback on errors was a valuable resource for experiential peer learning.

The next quotation however suggested paradoxically that radiographer professional boundary encroachment into radiologist territory was more limited. Accountability for the clinical impact of radiographer decisions about 'missed' abnormalities appeared to remain with radiologists because radiographers brought symptomatic cases they disagreed to the attention of the (first) reporting radiologist:

> *We then put an addendum on with either 'agree with above' or if we have any comments, we put whatever we think is maybe different, and then we'll speak to the radiologist concerned and arrange to bring the patient back if we agree that's appropriate. [Site 2 G08 CP]*

This evidence implied that radiographers did not have the power to alter patient management because they were not allowed to initiate recall and extra tests for symptomatic patients without the agreement of a radiologist.

This quotation also seemed to support an initial programme theory hypothesis that double reporting would increase radiologist workload because they had to arbitrate discordant cases. At Site 2 radiologists covered a half-day session every week where recalled patients were re-evaluated. Recalled patients originated from family history and annual surveillance cases as well as from the symptomatic service and given the small number of symptomatic case discrepancies estimated to occur, the overall increase in radiologist workload from this source was likely to be to minimal.

<u>In summary.</u>

In line with the initial programme theories, the Site 2 evidence demonstrated that radiographers trained and experienced in symptomatic MIIR could substitute in the role of a second radiologist and participate in inter-professional double reading.

At the case study site where this occurred, participants claimed that responsibility for diagnosis and accountability for error was shared by radiologists and radiographers because they interpreted cases independently. However, second reading radiographers discussed discrepant symptomatic clinic cases with the original reporting radiologist who thus appeared to retain professional jurisdiction over final decisions which would affect patient management – recall and initiation of further tests.

Radiographer second reading seemed to be associated with diagnostic delay which inevitably would have adverse psychological consequences, and sometimes adverse clinical consequences, for patients. The use of double reporting was associated with increased human and technical resource; limited resource availability was considered to exacerbate diagnostic delay.

These results are summarised in Figure 5.5.

Figure 5.5 Summary of Site 2 findings

Justification of the clinical impact of the system operated at Site 2, in terms of improved diagnostic accuracy was limited to anecdotal evidence. The data did not allow evaluation of the resource costs of radiographer / radiologist double reporting in comparison to single radiologist reporting.

5.3.4 The influence of screen reading

The term 'diversification' was used to describe how a radiographer with training and experience in 'reading' mammograms (sorting into normal and abnormal categories) in the NHSBSP might extend this skill into a different context to enable them to interpret and report mammograms (reaching a differential diagnosis and giving management recommendations) in the symptomatic service. It was proposed that screen reading radiographers would be able to do this because their knowledge and skills were transferable to the symptomatic domain.

In the IPT it was suggested that radiographers who had screen reading training and experience might undertake a 'pre-screening' or 'filtering' role in the symptomatic service or might undertake a ‘delegated’ MIIR role working under the direct supervision of a radiologist.

5.3.4.1 A filtering case study

This ‘filtering’ programme theory had suggested that radiographers with screen reading experience might ‘read’ the mammography images for all symptomatic patients and take responsibility for interpreting and reporting normal and uncomplicated benign cases as a ‘single’ reader; they would recognise these cases because these would be the same type of cases that they were used to ‘returning to routine recall’ in the screening programme. The theory went on to hypothesise that when they judged an image to be abnormal they would pass this on (to the radiologist) for a second, definitive interpretation and report because they did not have experience of differential diagnosis and report writing. This system was not encountered at any of the sites studied.

At the time of data collection Site 6 was not offering a ‘one-stop’ clinic where symptomatic patients received triple assessment (clinical, imaging and tissue sampling examinations) at a single clinic visit. The site had been operating a system similar to the ‘filtering’ system envisaged in the initial programme theory but operated it to ‘filter’ the performance of mammograms – not the interpretation and reporting of them. The system was explained by one of the advanced practitioners in the following data segment:

> *When the ladies come to the clinics in out-patients they are graded clinically from a P1 to a P5. Any lady that is a P1 or P2 is booked on a clinic for the advanced practitioners – either to have just ultrasound or a mammogram and ultrasound. The consultants (radiographers and radiologists) don’t get involved in those clinics. Anything that is graded a P3,4,5 is put on a separate consultant-led clinic so if it requires a biopsy it could be done at the time. In the P3-5 clinic we’d do the ultrasound but we wouldn’t be doing any (symptomatic mammogram) reporting. [Site 6 G23 AdvP]*

The P1-P2 mammograms were reported after the patient had left the department (cold reporting); one of the other advanced practitioners explained how they had been excluded from this as numbers of radiologists increased and consultant radiographers had been introduced at the site:

> *As we got more radiologists and the consultant (radiographers) came on board… the symptomatic reporting is more or less up to date…. and with having the locum radiologists as well over the last couple of years, they have kept the numbers down. So the need for (advanced practitioners) to do has sort of disappeared, unfortunately… it would be*

nice to take part in the other side of reporting but it's not necessary at the minute. [Site 6 G24 AdvP]

The symptomatic service at Site 6 was due to change to one-stop rapid access clinics in the near future. A consultant radiographer explained that no individual advanced practitioner had the full range of skills to undertake and report all examinations in such a clinic:

There are some who are pure sonographers, some who can do ultrasound guided biopsies, some that do clinical examination to support assessment clinics and one that can do screening and symptomatic reading, but not biopsies. [Site 6 G17 CP]

She went onto explain the role of the consultant (radiographer or radiologist) in the new clinic and suggested that because they were 'fully staffed' there would be no role for the advanced practitioner in symptomatic MIIR:

You report the mammogram, do the ultrasound, or (an advanced practitioner) may scan for you, if you are busy doing a biopsy… but you do the report… you are reporting the mammogram, overall reporting the scan, doing the biopsies and finalising recommendations as to what else needs to be done… we are fully staffed… hopefully there will be two consultants in the clinic and they will be more than capable of picking up the amount of mammogram reports it generates. [Site 6 G17 CP]

At Site 6 the trigger for 'filtering' cases in the service to date had not been lack of symptomatic MIIR competence in radiographers, but lack of ability to also undertake the ultrasound and tissue sampling procedures required for P3-5 patients. The operation of 'multiskilling' as a trigger for radiographer involvement in symptomatic MIIR is discussed in more detail in Section 5.3.5.3 below.

5.3.4.2 Transfer of skill across clinical domains

The IPT explained how screen reading radiographers might diversify their practice to include symptomatic work and what the consequences of this would be. It was suggested that a radiographer with only screen reading training and / or experience might behave as a 'novice' practitioner in their new symptomatic role and thus practice under supervision in a delegated role. Formal delegation of symptomatic MIIR from radiologists to radiographers was not encountered at any of the sites visited other than for the supervision of 'novices' immediately following successful completion of an external formal training course (see section 5.3.4.2.5).

This section of the thesis examines evidence about screen reading experience contributed by participants from all sites. It adds further insight into how knowledge and skill from screen reading influenced symptomatic MIIR practice. Cross-case comparative analysis of the evidence from participants recruited from three sites that provided only a symptomatic service (Sites 1, 2 and 4) and five which provided combined screening and symptomatic services (Sites 3, 6, 7, 8 and 9) added further depth to the analysis.

This section of the results also presents analysis of data about diagnostic error in the symptomatic service, which in contrast to the NHSBSP does not have a robust system of service or individual performance audit (section 5.3.4.2.6). The revelation that accountability for MIIR might be held at group rather than individual level was explored further in Stage 3 of the study.

5.3.4.2.1 Logistics

At the three sites that undertook symptomatic work only (Sites 1, 2 and 4) the radiologist(s) and at one site (Site 4) the consultant radiographer, worked at additional sites where they read screening mammograms. The radiologist at Site 2 explained that rotating all radiographers to the screening unit was not operationally feasible and that he did not consider it necessarily useful:

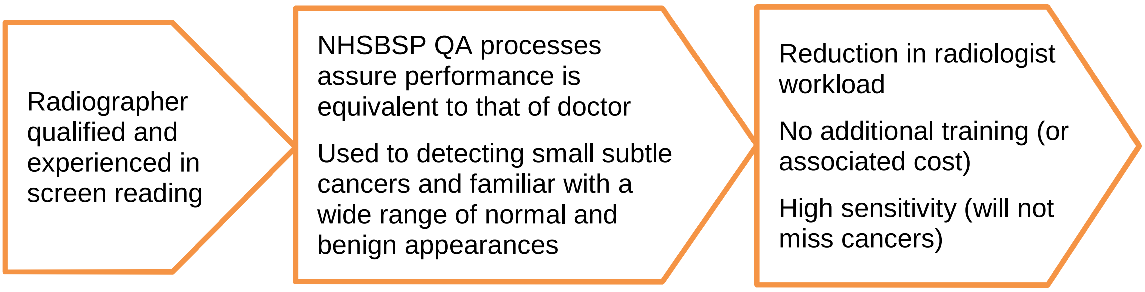
> *We're dependent on (the screening) service having space, capacity or need for someone else to go… unless (our radiographers) are going to be fully integrated into the (screening) service then you are just doing it for it's sake… one half day a month… they are not going to feel part of that unit, they are not going to get much in the way of feedback... will they go to the MDT… you end up not achieving very much. [Site 2 L07 radiologist]*

At the other five participating sites the radiologists, consultant radiographers and some of the advanced practice radiographers, were involved in both screen reading and symptomatic MIIR.

5.3.4.2.2 Sensitivity

It was hypothesised that radiographers who were trained formally and were experienced in screen reading might be trusted to take on some of the work of the radiologist in the symptomatic service where NHSBSP quality assurance systems ensured their ability to differentiate potential cancers cases from normal and benign pathology cases was at least equivalent. It was argued that radiographers working in the screening programme would have good sensitivity. They should not miss small, subtle clinically occult (incidental) disease in symptomatic patients because these would be the type of abnormalities they were used to recognising and cancers in the symptomatic service would be clinically apparent by definition and therefore more likely larger and easier to detect – see Figure 5.6.

Figure 5.6 IPT - Diversify role of screen reading radiographer



The two evidence extracts below confirmed the IPT hypothesis that image interpretation knowledge and skill were transferable between screening and symptomatic domains and that screen reading experience gave radiographers good sensitivity:

> *I think actually reading the mammogram itself … we could probably all look at it screening or symptomatic, and have the same opinion because it's a mammogram. [Site 6; G23 AdvP]*
>
> *Screening abnormalities tend to be a lot more subtle… so I think possibly you might look for smaller things and be more concerned over smaller things… big things are always easier to see… and I think the subtle things are the difficult things to see, with screening you don't tend to get big cancers. [Site 2 G08 CP]*

The next two quotations also supported the hypothesis that differences between screening and symptomatic cases would pose difficulties for screen reading radiographers because they would not be familiar with the diverse range of clinically significant pathological features, other than those associated with cancer that presented through the symptomatic service:

> *With screen reading on the whole you are just looking for things that are suspected cancer while symptomatic can be anything and everything. [Site 8, G06 AdvP]*
>
> *You have to think about anatomy, you have to think about pathology – so it's a whole new ball game… people have to have a far better understanding of breast pathology in symptomatic. [Site 1 G34 AdvP]*

The study evidence revealed that it was common in departments that provided a combined service for radiographers to gain the majority of their early mammography image interpretation experience in screen reading. Participants explained how they needed additional training and experience when they moved into symptomatic MIIR because the symptomatic image interpretation and reporting task was different to that in screen reading. The following examples highlighted how these radiographers needed a wider abnormality classification taxonomy and had to produce a written report for symptomatic cases:

> *All of a sudden you find you are doing symptomatic ones where you are not just picking them out, you are actually having to describe them and then give a sort of presumptive diagnosis of what it might be or whatever, and give it an R value [Site 3; G03 CP]*
>
> *With screening all you do is normal / recall – that's the only report you write – you don't have to be descriptive… in symptomatic you have to write a written report for a clinician. [Site 2; G08 AdvP]*

The data confirmed that one of the intended consequences of screen reading was inclusion in NHSBSP quality assurance processes; this appeared to 'kite-mark' the quality of the radiographers' work. These data extracts demonstrated that in some cases this external monitoring provided radiographers with evidence that they achieved higher standards than their radiologist colleagues:

> *A radiographer can actually have better results than the radiologist… you have got PERFORMS, you have got QA results and everything…you see that the radiographers are performing as good as, or better. [Site 8 G30 CP]*
>
> *I do very careful audits every year of all the breast cancers the unit picks up, so I know exactly which film readers, what their detection rate, what their educational (error) rate is and the consultant radiographer and the advanced practitioners are if anything better than the radiologists in that respect, certainly no worse. [Site 9; L15 radiologist]*

One of the reasons radiographers might have achieved higher standards was because they appeared to be getting more overall experience, they seemed to do more cases than radiologists, because they worked in the breast service full-time, this is discussed in more detail in section 5.3.5.2.

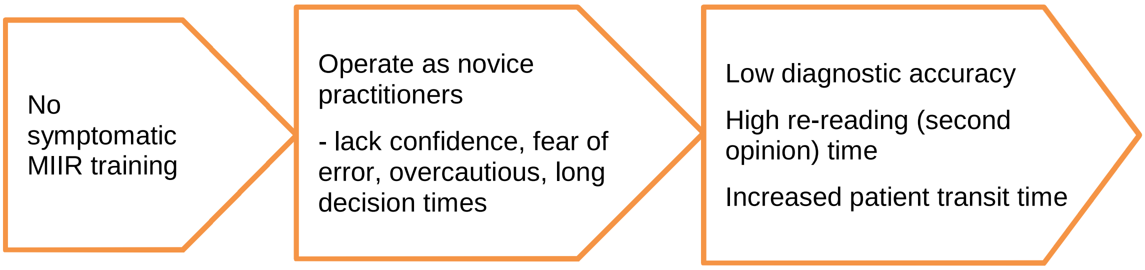
The evidence suggested that NHSBSP quality assurance (QA) resources were also a source of in-service training. These quotes, from participants working at sites that only provided a symptomatic service demonstrated how valuable they found it to nevertheless have access to the PERFORMS resource:

> *We all take part in PERFORMS… they are all screening cases but it's a yardstick to measure yourself against because otherwise it's very difficult to audit people's ability… so we all do PERFORMS … [Site 02 L07 radiologist]*
>
> *We do the PERFORMS every 6 months which is a learning tool … because that is looking at images and it's actually writing down an opinion and seeing what you can see and seeing an opinion against (a gold standard opinion… it was for breast screening people originally but we wanted to use is as another learning tool. [Site 4 G12 AdvP]*

5.3.4.2.3 Specificity

The IPT had suggested that screen reading practitioners starting to undertake symptomatic cases would have low diagnostic accuracy and slow decision times because they lacked confidence in the new domain, had a bias towards false positive decisions and / or would seek lots of (radiologist) second opinions. In turn it was hypothesised that this would increase patient clinic transit times and service costs – see Figure 5.7.

Figure 5.7 IPT- Lack of symptomatic training and experience



The data provided some evidence of over-cautious decision making in radiographers with a screen reading background, but this quotation from the interview of the radiologist at Site 7 highlighted that this was not necessarily undesirable, at least initially when diversifying into symptomatic work:

> *She did have a high-ish recall rate but I thought in the one-stop clinic that doesn't matter …there is a higher incidence of cancer anyway so that'll be fine. If your recall rate is 10% and the incidence of cancer in the one-stop clinic is 10% it's not so bad…I don't think it's as bad in the symptomatic clinic to be slightly over calling much better than slightly under-calling, which would be a disaster. [Site 7; L01 radiologist]*

The last comment implied that it would be of greater consequence for a radiographer to miss a cancer in a patient who had presented clinically than in one who attended a screening programme.

The radiographer study participants who were trained and experienced in screen reading seemed to have a cognitive advantage, particularly over colleagues who were trained and experienced in symptomatic work only, because they were familiar with a range of normal and clinically insignificant benign appearances. This is illustrated in the following evidence examples:

> *The readers who don't do screen reading … pick up on more little bits and pieces and ask for more ultrasounds whereas myself [consultant radiographer], and the radiologist who does screening, we all tend to say 'oh that's benign' and just move on very quickly. [Site 4; G14 CP]*

> *I've not done breast screening… calcifications… I am getting better but I think I am least confident about – knowing whether they are things that need to be investigated or not… I am not as confident [Site 4; G12 AdvP]*

These radiographers explained how screen reading improved the specificity and confidence of radiographers interpreting symptomatic cases and how this affected the use of further tests.

5.3.4.2.4 Decision speed

The CP radiographer at Site 4 expressed the opinion that screen reading experience might confer a decision making speed advantage also:

> *I haven't measured it actually but I think our reporting in a symptomatic clinic is faster as well. Yes I am sure it is, me and the radiologist who do screening, I am sure we report faster than the ones that don't. I think that's because they have never been forced to do 160 mammograms in a session. [Site 4; G14 CP]*

In contrast however, an AdvP radiographer who could do both, but mainly did screen reading, suggested alternately that symptomatic MIIR speed was related to task-specific experience:

> *Maybe if I had more experience of reporting …I would be quicker … I guess those who do symptomatic reporting all the time would say 'well I can do it in 20 minutes', yes you probably can because you are used to doing it – you are doing it all the time but I am not. [Site 6; G23 AdvP]*

Evidence from two radiologists corroborated this latter view; overall the data appeared to suggest that symptomatic experience, of report writing in particular, contributed to increased reporting speed:

> *It's something of a personal thing… some people routinely write longer reports than others… newer readers are slower …you get quicker and peak at about 9 years. [Site 3; L10 radiologist]*
>
> *(Radiographers) get quicker and you certainly see that in one-stop clinics…the ability to make their decisions comes quicker with experience…their reports are more succinct as they become more experienced... their reports become a little bit more concise with experience, they are quicker at it, they are more confident with it. [Site 9; L21 radiologist].*

The radiologist at Site 3 made a direct reference to the hypothesis that patient waiting times in the rapid access clinic would be increased because some radiographers were slow or needed to obtain a second opinion. In this quotation she compared their performance to that of radiologists:

> *They are just as skilled as the radiologists…some of them are a little less confident so knowing they are the single reader they will ask for back up if they have anything they are at all uncertain about …some of them are a little bit slower but again that's not a problem – it just means the clinic runs half an hour late – it's not a big issue. [Site 3; L10 radiologist]*

This evidence identified how lack of confidence making decisions independently (single reading) could increase decision times but that extended reporting times were not necessarily a problem at operational level. The following conversation between two AdvP radiographers which occurred during data collection at Site 8 illustrated how a complex interplay of psychosocial factors affected the decision making of individual practitioners in screening and symptomatic settings:

> *I am a slower screen reader than I am a symptomatic reader because of the consequences of bringing someone back…. I'm certainly fairly confident with my screening practice … we have also got the safety net of the second read… which I suppose from my point of view it's odd that I feel more confident to read symptomatic….[Site 8; G26 AdvP]*
>
> *I was going to say the opposite… my symptomatic takes me much longer to think and word a symptomatic report… I get a bit anxious… I feel a bit of pressure to do it quick in rapid access and I am not necessarily quick because I am not so confident I suppose... I feel that I go slower at hot reporting symptomatic… I think that's a confidence thing. [Site 8 G06 AdvP]*

As well as reiterating the effect of confidence and experience, the above data illustrated how radiographers' decision speed was influenced by whether they were making decisions alone or with colleagues. The IPT had suggested that radiographers might experience stress and anxiety taking sole responsibility for making autonomous decisions about (some) cases because they were used to sharing responsibility about screening cases which were all double read. The Stage 2 evidence appeared to substantiate this idea but revealed that anxiety in the symptomatic setting could also be triggered by operational and environmental pressures and by consideration of the consequences for the patient.

The IPT had explored the potential for patient transit time and service cost to increase because a proportion of radiographer cases would be 'double read'. In the pre-screening / filtering programme theory this was because radiographers interpreted and reported normal cases and passed cases they interpreted as abnormal to radiologists for definitive interpretation and reporting. Although none of the participants in this study operated in this way they commonly talked about radiographers (and radiologists) seeking second opinions, from radiologists and from other radiographers.

In the IPT it was suggested that a second reader's role was to reduce morbidity because they vetoed additional tests that were unnecessary (false positive cases). This example from the study data illustrated how second opinions from radiologists who participated in both screening and symptomatic MIIR could 'rule out' normal variant or clinically insignificant benign pathology suspected by radiographers who only had experience of symptomatic cases, and thus improve specificity:

> *I think we might find that occasionally (radiographers) might call up things that we might look at carefully and then on reflection decide not to action further. [Site 1; L13 radiologist]*

This radiologist went on however, to illustrate that seeking second opinions to improve specificity was a normal feature of MIIR practice, irrespective of clinical or professional background:

> *If there is a dubiety then that's the kind of case that I might ask one of my colleagues about… that's just part of the way we work… you ask colleagues about things… we use it to reduce the number of interventions that we do on patients. If you see calcium and you think 'I don't actually think that's changed significantly and I don't think we should intervene', that's the kind of case that you share with colleagues… it's a way of reducing the number of investigations you do. [Site 1; L13 radiologist]*

At Site 4 the AdvP radiographers were not experienced in screen reading but single read symptomatic cases. In this example the more senior CP radiographer, who had experience and continued to practice in screen reading, explained how she had tried to reduce the number of unnecessary recommendations for ultrasound made by her colleagues:

> *I've tried over the years, to say 'that's benign, that's fine'. The mechanism to improve it would be to probably drag them through into the ultrasound room and say 'look – you've picked up on this, it's benign' and do that repeatedly. [Site 4; G14 CP]*

This evidence supported the hypothesis that radiographers without screen reading experience were less able to recognise and / or readily dismiss a wide range of normal and uncomplicated benign appearances. This appeared to be a generalisable finding, a similar opinion being offered by one of the two Site 6 CP radiographers:

> *We personally feel that screen reading is essential because it gives you a large volume of cases. You have to decide that a lot of pathologies that you are seeing are benign and not recall them… it gives you confidence in your symptomatic work. [Site 6 G17 CP]*

In the Site 4 example above, informal feedback did not appear to be improving the performance of the AdvP radiographers. Their limited 'normal' and 'uncomplicated benign' pattern recognition memory seemed to have a more powerful effect on their interpretive judgements than feedback on performance.

5.3.4.2.5 Mentoring and preceptorship

When describing the historical journey of moving screen reading trained radiographers on to symptomatic cases it was common for them to have undergone a period of formal mentorship. Radiologists had monitored their performance and supported them until they had acquired additional knowledge about the wider range of pathologies encountered, had developed report writing skills and had become confident about autonomous decision making.

There was some evidence that this behavioural learning approach led to ‘conformation bias’ - radiographers learned to make the same judgements, exhibit the same decision making behaviour, and implicitly made the same mistakes, as radiologists. This illustrative extract came from the interview with the radiologist at Site 6:

> *When they first started… initially they sat with me…then they started doing their own… they would make reports and then I would go over them and say ‘I agree’ or ‘this is what I would have said’ and give it back to them. They would go over it and pick up some points that they thought would be helpful… we were together in the same building and in the same department and it was easy to discuss things. In a way, the problem was that the person became a ‘mini-me’ and did everything exactly like me. [Site 6 L19 radiologist]*

Over time, with a regular minimum caseload of symptomatic work, it was hypothesised that such radiographers would develop their own knowledge and skill and gain the confidence to ‘hold their own’ when they disagreed with radiologists. There was evidence of this in an extract from the joint interview of the CP radiographers at Site 6:

> *It’s very difficult if (a radiologist) won’t listen to you… because neither of us will tell you that it’s OK if we don’t believe it is… so we have had some run-ins when we disagree with their decision. [Site 6; G18 CP]*

> *In most cases you end up taking over the case and doing it yourself, because if you don’t believe it (is normal) somebody has got to action it. [Site 6; G17 CP]*

> *It's quite difficult to fight your corner on some of these issues of perception if you are on your own. [Site 6 G17 CP]*

The last quotation implied a sense of collegiality in the two CP radiographers and suggested that their diversified new role was sometimes still contested at the inter- (radiographer/ radiologist) professional boundary.

Several departments operated a formal period of supervision or mentoring even for radiographers who had undertaken an external MIIR training course that had included symptomatic cases. Some sites had formalised this as ‘preceptorship’ and incorporated an internal audit of practice. The radiographers at Site 4 had difficulty justifying its use other than a formality to comply with local Trust governance policy:

> *They go through an audit process at this hospital where they have to have 50 patients with agreement with a second film reader and that’s either got to be a consultant radiographer or a radiologist… this is post –qualification… I struggled with that I must admit when I first came here …I thought it was a bit harsh really to go through a university course and then make somebody go through an audit as well. [Site 4; G14 CP]*

> *It sounded silly to begin with I must admit it is like jumping through hoops…but I think it is just to prove to them that you are up to the standard that the hospital want you to be. [Site 4; G11 AdvP]*

At Site 9 the CP radiographer was more enthusiastic about the purpose of preceptorship and its value in relation newly qualified radiographers developing confidence in autonomous decision making:

> *I introduced a preceptorship scheme for newly qualified film readers because I wasn't happy that they were allowed to just start, I didn't think it was good for the department or the individual to branch out into symptomatic reporting straight away. So we introduced preceptorship where they would work alongside somebody in the one-stop clinics who would be checking their reports. And after 6 months if we all found that we were very happy with what they were doing we signed them off and sent a certificate through to the governance unit in the hospital. [Site 9; G15 CP]*

This quotation illustrated how the newly qualified practitioners had to prove their ability in the local workplace and gain the acceptance of others before becoming fully-fledged members of the symptomatic reporting team. This was considered to be an example of social learning within a 'community of practice' (Wenger, 1998). This idea was explored further in Stage 3 of the study (see Chapter 6).

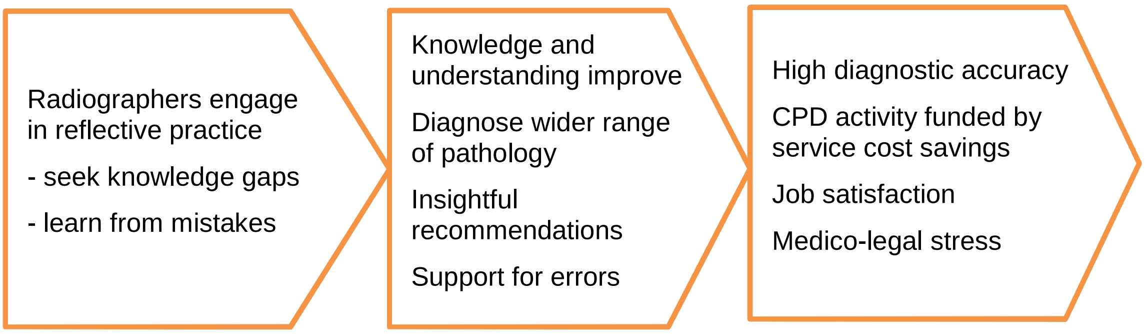
Although the IPT had suggested that preceptorship after formally assessed external training might perpetuate slow and overcautious decision making, because all decisions were still reviewed by a more senior / experienced practitioner, the participants in the study offered sound rationales for preceptorship audits: they:

- enabled radiographers with training and experience in screen reading only to acquire knowledge and skills in symptomatic MIIR experientially;
- developed confidence in autonomous single reading and developed competence in report writing where radiographers had not encountered these aspects of the role as trainees and/or in screening practice;
- assured continued competence of dual qualified radiographers when they had post-qualification experience in screen reading only;
- assured the quality of practitioners locally when they had not been trained in-house.

5.3.4.2.6 Reflective practice, audit and error

The IPT had suggested that different professional backgrounds and training would result in radiographers and radiologists exhibiting different decision making behaviours. These theories explained how radiographers might have a better idea of their own strengths and weaknesses and would be conscientious about improving their knowledge, understanding and confidence. It was hypothesised that allied health professionals were less likely to be overconfident decision makers and would have developed a strong culture of reflective practice. With a realistic perception of their own performance, it was hypothesised that reflective practice might trigger CPD activity to identify and address knowledge gaps and seek out and learn from mistakes - see Figure 5.8.

Figure 5.8 IPT- Reflective radiographer practice



Reflective practice

The study data supported the theory that radiographers had a culture of reflective practice. The radiographers voiced a strong desire to follow up their cases and constantly referred to the opportunities for learning that existed in the practice environment.

Radiographer participants of all grades and levels of experience referred to continuous experiential learning using phrases such as:

- ‘*you are always learning’* [Site 2; G08 CP];
- *‘it's a learning curve’* [Site 3; G04 AdvP];
- ‘*I check that I was either right or I was wrong … I think it's part of my CPD’* [Site 4; G12 AdvP];
- ‘*it's learning… cementing their abilities, just learning and cementing everything’* [Site 4; G14 CP].

One CP radiographer clearly articulated the philosophy of reflective practice that existed in radiographers:

> *It is about being honest with yourself, ‘could I have done something better?’, ‘would I do the same again?’, ‘what can I learn from this process?’, ‘what can I do to it to make it better next time?’, ‘what can I teach my colleagues from this?’ [Site 6; G18 CP]*

This is another example where a radiographer alluded to the ‘social’ nature of learning that was occurring in her day-to-day practice – she wanted to share her mistakes, and the learning that followed to improve the practice not only of herself but of her colleagues and thus of the ‘team’ as whole.

Radiographers described how reviewing and reflecting on their performance:

- helped them overcome weaknesses

  'I have realised I've never been particularly good with very small asymmetries…. so I am much better at trying to pick them out now' [Site 1; G36 Band 6 MIIR trainee];

- helped develop their confidence

  '(feedback) would give you confidence.. you have got evidence to support your ability, that tends to give you confidence' [Site 8; G31 trainee CP];

and

- how they learned from it

  'It helps me improve my practice' [Site 3; G05 AdvP].

Audit

However, in contrast to the routine service and practitioner surveillance that occurs in the NHSBSP, participants explained that it was difficult to collect reliable performance data about symptomatic cases because there was no obligation to, and no robust system for, identifying false negative (missed cancer) cases.

Nevertheless, the radiographers' data demonstrated that self-audit (following up and learning from their cases) was a useful CPD activity and was '*an expectation when you are an advanced'* [Site 1; G36 Band 6 MIIR trainee] or consultant practitioner.

In the absence of systematic audit processes in the symptomatic service the radiographers described how they had developed informal systems that enabled them to record cases to follow up later, they would '*keep a note'* [Site 1; G33 AdvP, Site 9; G22 Band 6] or '*stick a sticker in a book'* [Site 4; G11 AdvP] or they recorded cases in '*a big diary'* [Site 4; G12 AdvP] or on '*a spreadsheet on the computer*' [Site 6; G24 Band 6 screen reader]. These in-house informal systems for auditing practice often fell down because radiographers did not have time to access follow up information because the clinics were too busy, they had a reporting back-log, worked part-time or worked across split sites.

Mistakes and error

At all eight sites from which practitioners were recruited to the study, the prevailing culture towards mistakes was overwhelmingly supportive. There was an overall perception that '*it's inevitable that you will make mistakes'* [Site 3; G04 AdvP] but that *'It's good to be told, so that you can learn… accept it, and move on'* [Site 3; G05 AdvP].

Radiographers and radiologists were keen to avoid classifying mistakes as ‘errors’ and used a variety of alternative terminology - ‘*a learning thing’* [Site 1; G33 AdvP], ‘*a learning episode’* [Site 2; L07 radiologist], ‘*learning opportunities’* [Site 6; G18 CP], ‘*educational cases’* [Site 9; L21 radiologist], *‘discrepancies’* [Site 8; L25 radiologist], ‘*not really mistakes… under-calling things... subjectivity of perception… there wasn’t anything missed’* [Site 9; G15 CP].

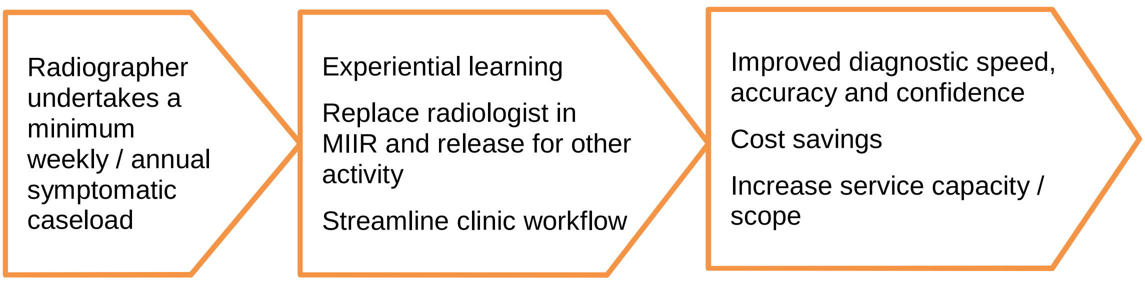
Participants talked about mistakes being brought to the attention of those responsible in a ‘*constructive’* [Site 1; G36 AdvP team leader], ‘*supportive’* [Site 2; L07 radiologist] or ‘*honest, open and fair’* [Site 6; G18 CP] manner avoiding any sense of ‘*blame’* [Site 1; G33 AdvP] or ‘*criticism’* [Site 1; G36 AdvP team leader] and avoiding feelings of ‘*stupidity’* [Site 1; G36 AdvP team leader] and ‘*discomfort*’ [Site 6; G18 CP]. Processes for addressing errors were described as ‘*un-hierarchical’* [Site 2; L07 radiologist], with no ‘*finger pointing’* [Site 6; G18 CP] or ‘*fear of recrimination’* [Site 2; L07 radiologist].

The study data suggested that radiographer and radiologist participants perceived responsibility for mistakes to be at ‘*team’* [Site 3; G03 CP] or ‘*group*’ [Site 2; L07 radiologist] level and learning to be facilitated in ‘*close knit’* teams that felt ‘*free to comment on each other’s practice’* [Site 8; L25 radiologist]. This team philosophy and the concept of shared accountability was explored further in Stage 3 – see chapter 6.

5.3.4.2.7 Service consequences

It was hypothesised that the successful diversification of screen reading radiographers into symptomatic practice would enable them to do some of the work normally undertaken in rapid access clinics by radiologists. It was envisaged that this might have intended consequences at different stages of the ‘implementation’ chain. That is at micro (individual) and meso (service) levels for example, as illustrated in Figure 5.9.

Figure 5.9 Consequences of diversifying role of screen reader



The study data supported the hypothesis that involving radiographers in symptomatic MIIR enabled services to increase capacity to meet increasing demand in the face of medical workforce shortages. These two representative quotations, one from a radiographer and one from a radiologist, summed this up:

> *If the radiographers didn't report this Trust would just fall over ... It's indispensable. I don't think we can not do it. The (symptomatic) service wouldn't function. [Site 2; G08 CP]*
>
> *We wouldn't be able to function at the level we do with the number of radiologists that we have if we didn't have our radiographers involved in the symptomatic service as well. [Site 3; L10 radiologist]*

Task and role substitution are discussed further in Section 5.3.5.4.

5.3.4.2.8 Summary

The initial programme theory that screen reading radiographers might diversify into a 'filtering' role in symptomatic mammography image interpretation was not supported by the data. The data did however provide evidence that knowledge and skill gained in a screen reading role were transferable and influenced the performance of radiographers interpreting mammograms in the symptomatic setting. The analysis was enriched by including a sample of participants with a history of introducing screen reading radiographers into the symptomatic service, participants from sites which only provided a symptomatic service and participants from sites which provided combined screening and symptomatic services.

The Stage 2 data supported the hypotheses that screen reading radiographers undertaking symptomatic practice:

- should have good sensitivity because they were used to detecting small, subtle abnormalities such as microcalcification, asymmetric density and architectural distortion;
- required a period of additional training and / or supervision (preceptorship) to enable them to acquire further pattern recognition skills because they were not familiar with the wider range of mammographic appearances and pathology encountered in a clinically symptomatic population;
- required a period of additional training or supervision (preceptorship) because they were not used to making a differential diagnosis or communicating their findings in a written report;
- should have reasonable specificity because they were subject to NHSBSP recall rate audit which required them to recognise and dismiss a wide range of normal and clinically insignificant benign appearances;
- might have slower decision speeds than radiologists because they lacked confidence in autonomous / independent (single reader) decision making;

The data suggested that participation in screening and symptomatic services was:

- facilitated where services were co-located on a single site;
- facilitated where practitioners were skilled in other triple assessment examinations;
- prioritised for radiologists and consultant radiographers;
- enhanced by participation in NHSBSP QA and training (PERFORMS);
- sustained through informal performance monitoring and peer support.

5.3.5 The hybrid practitioner - a new type of worker

This final section of the Stage 2 results presents critical analysis of the data used to test initial programme theories about specialisation and multiskilling. It incorporates exploration of programme theories about the development of expertise and role substitution and was the source of revised programme theories about role innovation and new programme theories about multidisciplinary team working that were tested and refined in Stage 3 of the study.

5.3.5.1 Specialisation

Specialisation was defined by Nancarrow and Borthwick (2005) as the ‘adoption of an increased level of expertise in a specific disciplinary area’. The evidence presented below demonstrated that this was a fitting description of the professional boundary changes that had occurred for the radiographer participants in this study who had undertaken formal postgraduate training and accumulated a considerable amount of practical experience in diagnosis of breast disease.

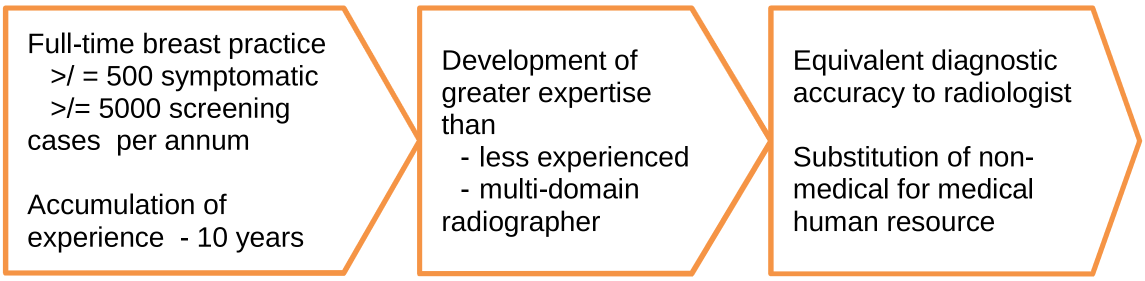
The critical analysis of Stage 2 data presented below suggested that there were two dimensions to specialisation for radiographers in this study. Firstly, radiographers appeared to have developed expertise in breast disease diagnosis because they dedicated their practice exclusively to this clinical domain and ceased to image other areas of the body (see section 5.3.5.2). Secondly, radiographers appeared to have acquired expertise across the entire diagnostic patient journey and thus had a scope of practice defined by clinical, as opposed to technical boundaries (see section 5.3.5.3). These findings represented a new professional paradigm for radiographer role development and appeared to be key characteristics that allowed radiographers to substitute for radiologists in the symptomatic breast service (see section 5.3.5.4).

5.3.5.2 Dedicated practice and development of expertise

Based on the substantive theory of ‘deliberate practice’ (Ericsson, 2004a) the initial programme theory had suggested that beyond instruction and feedback, development of expertise required repetition. It was hypothesised that radiographers would require a minimum (annual / weekly) caseload to become and remain competent in symptomatic MIIR and that expertise might develop with the accumulation of practical ‘experience’ over a period of up to 10 years.

Professional guidelines for radiologists suggested a minimum practice requirement of at least 500 cases, equivalent to approximately 2-3 clinics per week if they were working in the symptomatic service (RCR, 2003). It was hypothesised that radiographers undertaking symptomatic MIIR would also need to meet this requirement and in addition, if they were also to remain involved in screen reading they would have to meet the minimum caseload requirements of the NHSBSP – 5000 cases per annum. It was envisaged that, along with their existing image acquisition role, this might require whole time equivalent working in breast imaging. Figure 5.10 illustrates the CMO configuration for this theory.

Figure 5.10 IPT CMO - full-time (dedicated) practice



The participant data confirmed that minimum numbers (volume and practice) contributed to the development of both cognitive skill (pattern recognition) and affective skill (confidence). This was illustrated in the following quotation from one of the AdvP radiographers at Site 4 in response to the prompt ‘do you think you get to interpret and report enough cases?’:

> *Perhaps not… (I’d like to do) a little bit more… I probably do about 2 or 3 sessions a week which is probably about 30 a week… just to get your confidence and recognition… I’d say you need more… so that we know benign features straight off - pattern recognition. [Site 4 G11 AdvP]*

The evidence from the CP radiographer participant at the same site confirmed that the amount of time radiographers could dedicate to MIIR affected how quickly they developed competence. In this next data extract, talking about length of training time, she compared the historical situation where it was more common for breast imaging radiographers to work also in general imaging departments, with current practice where radiographers were more likely to restrict (dedicate) their practice to the breast domain:

> *It depends how long, how many times they are rostered… looking back at the ones that have gone through they did quite a lot of (general image acquisition) and worked part-time in the breast unit, so it probably took them 3-4 months working part-time. Now it's different because the film readers are working much longer hours in the breast unit than they were. [Site 4; G14 CP]*

One of the AdvP participants at this site explained how she had recently changed her working practices and no longer worked across two departments. In the following quotation she described how she expected that spending all of her time in breast imaging would allow her 'master' the discipline:

> *I needed to concentrate on one aspect of my job… because I was doing cardiology downstairs and that was expanding and then up here everything wanted to be expanded... I came to a realisation that I can't do it all. I've got to narrow... you have got to have so much to be competent. To a certain extent you can mix and match and become de-skilled… I was doing too much and not being a master of any. So hopefully I will be happier just concentrating on one aspect – the breast as opposed to everything. [Site 4 G11 AdvP]*

Dreyfus and Dreyfus (2008) defined mastery as the final stage of skill acquisition through instruction followed by experience. They suggest it was a characteristic of the strongly motivated expert dedicated to excellence and dissatisfied with merely engaging in accepted practice.

A further study participant, from Site 8, who worked alongside three other experienced radiographers in established consultant practitioner roles, explained why she had moved from a smaller hospital where she had a dual role working across the general & breast imaging domains, to this larger site where she could restrict her practice and train to be a consultant practitioner in breast imaging. Again she described how she expected dedicated practice to help her develop expertise:

> *I've come from a very general department where I was in charge of the breast service part of it… I didn't want to be a 'jack of all trades' any more I wanted to be good at one thing. I'd had enough of doing all the general radiography so that's what I thought… learn a lot about one thing, become an expert at one particular field. [Site 8; G31 trainee CP]*

The Site 4 AdvP participant quoted earlier explained how radiographer involvement in MIIR was restricted at her site, a small District General Hospital (DGH) which provided a symptomatic service only, because each practitioner needed a minimum number of cases to maintain competence:

If all of us reported then you wouldn't have that amount of throughput for yourself to keep up your competencies. We have an assistant practitioner who does the mammograms… her mammograms are very good…because she does them all the time, rather than us if we were mixing and matching. [Site 4 G11 AdvP].

The quotation above was a concordant description of the reconfiguration of radiographer professional boundaries hypothesised in the initial programme theory (see Figure 4.6, p.59).

At Site 4 a consultant radiographer and two advanced practice radiographers interpreted and reported mammograms independently during symptomatic clinics – a role that would have been undertaken traditionally by a radiologist. The interview testimony quoted illustrated how the radiographers involved in symptomatic MIIR had diversified their practice to include roles traditionally in the 'clinical' domain of radiologist but were also giving up roles at the 'technical' end of the practice spectrum, traditionally in the domain of the radiographer, to assistant practitioner colleagues.

The radiologist at Site 2 alluded to the potential causal relationship between dedicated practice and involvement in MIIR as he described the scope of practice of radiographers involved in breast imaging at his site:

Some (radiographers) do breast and general. There are three or four part timers either part time totally mammography (image acquisition) or part time within a whole time contract with general work. The three radiographers that do (mammography) reporting are full time staff within the (breast) department [Site 2; L07 radiologist]

This quotation illustrated not only that the radiographers involved in MIIR had dedicated their practice solely to breast imaging, but also that they worked full-time.

The evidence presented above suggested that radiographers working in smaller departments with a low overall caseload, and those who worked part-time substantively or because they also worked in other (non-breast) areas of the imaging service might need to 'super' specialise - restrict their practice within the breast domain, to ensure adequate volume to maintain competence. This might explain why different radiographers had different (single) advanced practice skills (image interpretation OR ultrasound OR intervention) rather than a range of skills (image interpretation AND ultrasound AND intervention). Data analysis about theories pertaining to further triggers for, and the consequences of uni-skilled and multi-skilled practitioners are discussed in the Section 5.3.5.3.

Restricting scope practice appeared to have been a free choice for the Site 4 participant quoted above but she had also been motivated by reward. This was succinctly illustrated when she was asked why she had chosen breast over a cardiology specialisation:

> *Downstairs (cardiology) was a Band 6 and here it's a Band 7. [Site 4 G11 AdvP]*

In contrast, the following example illustrated how the ‘choice’ of a CP radiographer at Site 9 had been driven by her manager:

> *I was doing general radiography and obstetric and gynaecology (ultrasound) together; I really enjoyed the obstetric and gynaecology, I quite like working with women. When breast screening came about it was just … I’ll do that bit as well… and then I had to make a choice … I was told there wasn’t enough time in the week to do both, so I then went into breast. [Site 8 G30 CP]*

This radiographer’s specialisation in breast imaging had not been influenced by ‘monetary’ reward as she was already an advanced practitioner by virtue of her ultrasound training and experience. This data extract alluded to a possible gender affinity between mammography radiographers (all female) and breast cancer patients of which more than 99% are women (Cancer Research UK, 2014); by contrast between 60 – 65% of radiologists are male (RCR, 2012).

Across all the sites studied, it was more common for radiographers to specialise in breast imaging, to the exclusion of other imaging areas of practice than it was for radiologists to restrict their practice to the breast domain. One radiographer had highlighted an unintended consequence of specialisation:

> *I don’t know how bored you would get just doing one thing all the time but... there is a bit of a trade off. [Site 4 G11 AdvP]*

The radiologist from Site 6, a large university teaching hospital that provided screening and symptomatic services, alluded to this conflict between specialisation and occupational stimulation when she explained why she thought junior radiologists in training might avoid restricting their practice to breast:

> *Our registrars probably thought that it's breast, breast, breast; perhaps it's boring for some people, they want to keep their skills in doing CTs and interventional work or ultrasound scans of other body parts. They thought that if they started doing breast as consultants in our hospital they would be stuck with only breast, so they go to a hospital where they do a lot more other things, we lost them to a DGH. [Site 6 L19 radiologist]*

Data from the CP radiographer at Site 2 confirmed that it was difficult to recruit radiologists to full time breast work and that it was more usual for them to have a combined role at smaller DGHs:

Breast radiologists are like hen's teeth - purely breast; you might get a gynaecology radiologist with an interest in breast or you might get a CT radiologist with an interest in breast but breast, solely breast radiologists are few and far between. [Site 2; G08 CP]

Another radiologist participant speculated further reasons why radiologists might not consider breast imaging to be a particularly attractive speciality:

I think people think it's boring… a belief that breast radiologists get sued more than anyone else… that it's stressful…. reluctance to take on the patient contact involved… sit down and talk to the patient – some people choose radiology because they are not particularly good at that sort of thing. [Site 3; L10 radiologist]

In contrast to the last issue, the following radiographer participant explained how her choice to specialise in breast imaging had been driven by a desire for greater involvement in patient care:

It is still the area really for you to be properly involved in patient care and … when I first moved into doing breast work, people said to me 'oh you won't like it, it's too narrow, it won't be very interesting, you will hate it'…I knew straight away, I never, ever wanted to do (on call and casualty) again - that this was my calling, if you like... I think that from a radiographer's point of view, if you want to be really involved in the patient care... [Site 6 G18 CP]

Data from the radiologist at Site 6 eloquently illustrated how the propensity for radiologists to retain a broad clinical workload was an ideal opportunity for radiographers with an interest in breast imaging to develop their role:

It's not very easy to get a breast radiologist, so if you can't have breast radiologists then maybe your radiographer is a breast radiologist? [Site 6; L19 radiologist]

At Site 4, a DGH, radiographer access to symptomatic MIIR was increased because there was only one radiologist with an interest in breast imaging and he only covered this one day a week. The radiologist explained how the other symptomatic clinics were staffed entirely by the AdvP and CP radiographers operating in extended roles:

I am only here one day a week; (the four other days) will be covered by reporting mammographers, the consultant radiographer and ultrasound radiographers. [Site 4; L20 radiologist]

This data supported the programme theory that substituting radiographers who had extended their professional boundaries to encroach on radiologists' professional territory enabled the maintenance of service provision where there was a local shortage, or indeed absence of radiologists.

The radiologist at Site 4 had confirmed that radiographers were filling in when there were no radiologists available to support the symptomatic breast clinics. In addition to filling the radiologist workforce gap in clinics, the study data evidenced further that radiographers could take the place of radiologists and contribute to clinical decision making in MDT meetings. This occurred for logistic reasons because radiologists with a part-time commitment to the breast domain and a varied role that encompassed non-breast imaging did not have the flexibility to alter their work rosters:

> *We had a radiologist who couldn't attend the MDT because of his commitment in the main x-ray department. So the consultant practitioner radiographer would do the MDT with the help of one of the advanced practitioner radiographers. [Site 4; G12 AdvP]*

Radiographer involvement in clinical decision making during MDT meetings is considered in more detail in section 5.3.5.4.

Attending the MDT meeting also appeared to contribute to radiographer job satisfaction and acceptance of radiographers as 'team members'. The following data extract illustrated how being a respected and recognised member of the clinical breast care team was triggered by full-time breast imaging practice:

> *I was general as well as mammography then but now I really do feel part of the team. I feel on an equal footing rather than a little minion…equal with everybody. I feel they all treat you as an equal in the multidisciplinary team… because they know you do the image interpretation and intervention. They take on board what you say and don't just pooh-pooh you. [Site 9 G22 AdvP]*

As described in the commenting case study (see section 5.3.2) attending the MDT was an important source of feedback which helped radiographers calibrate their performance and had the potential to improve their subsequent MIIR practice. The IPT had hypothesised that expeditious reasoning in expert practitioners occurred because their pattern recognition was based on a large comprehensive and well-organised memory store of previously encountered exemplars and characteristic theoretical prototypes. The following testimony from an experienced consultant practitioner provided an example of how this might occur because she saw, not just her own cases, but those of her colleagues by attended the MDT meetings:

> *I think it's interesting to see cases that you have not been involved in… (ones that) turned out to be a cancer... my God… it makes you… it's a bit like having a training session because you think well actually I've seen something like that before… this actually was a cancer and perhaps I shouldn't ignore it…. you are always learning… breast cancer is so diverse.. there are so many different types and appearances… you are always constantly surprised... the obvious barn*

> *door ones are the easy ones... .it's the little subtle ones.. and you think 'mmm I've seen something like that before'. [Site 2 G08 CP]*

This evidence illustrated how getting feedback by attending the MDT meetings helped to improve diagnostic reasoning and could improve diagnostic accuracy. Both of the Site 4 AdvP radiographers explained how part-time working in the breast unit operated as a barrier to them attending MDT meetings and getting this feedback:

> *Because I don't work on a Tuesday morning in the breast unit it's a case of … will the x-ray department allow me to go into the MDT to actually see cases I have reported the previous week…any cancers. [Site 4; G12 AdvP]*

> *That's what the (follow up) book was intended for us to be able to do… fill it in with the reports and information from the MDTs… but I haven't been able to do it as much as I would like…. it's been difficult with working in two different departments… [Site 4 G11 AdvP]*

The data suggested that radiographers might be developing greater expertise in MIIR than radiologists and that this was because they restricted their practice, and worked full time, in a single clinical domain. This was in line with the 'volume' and 'practice' effects described by Ericsson and Charness (1994) – they spent more time in breast imaging and accumulated more experience. The following quotation from a radiographer participant at Site 2 illustrated this. She explained how one of their radiologists struggled to meet the minimum caseload recommended by BASO (2005) in contrast to the radiographers who exceeded the minimum recommendation two-fold:

> *In symptomatic bandied about is something like 500 (cases) but that's still 10 per week... and if (radiologists) are only doing one clinic a week that may be all they get... so those numbers might be hard to get. One of our other radiologists that's about all they get… I think there are concerns that they're not doing enough. If we do say 20 a week... that's 1000 a year… each. [Site 2 G08 CP]*

Evidence that increased time, and thus volume and practice, led to the development of 'expertise' in radiographers was provided by both radiographer and radiologist participants. This radiographer quotation showed how one characteristic of their 'expertise' was manifest in the preferential allocation of cases that others found difficult to resolve:

> *Because we spend all of our time here, you tend to find that all the complicated cases come to our lists. [Site 6; G18 CP]*

The radiologist at this site concurred that the radiographers' expertise exceeded that of the junior radiologists, and also that of the junior surgical members of the breast MDT:

> *Their knowledge is of course far more than many of the surgical registrars or radiology registrars… they have lots of experience in screen reading and symptomatic and dealing with patients. [Site 6; L19 radiologist]*

A CP radiographer at Site 3 explained how full-time breast radiographers (and their full-time clinical lead radiologist) preferentially did more of the symptomatic work in their dual screening / symptomatic service. She explained that this was because part-time radiologists had to prioritise screen reading to meet the strictly monitored NHSBSP caseload targets:

> *We've got one full time radiologist, the rest are part-time …they generally prioritise screen reading to keep their numbers up - they have got to have 5000 screening. Some of them, depending on the hours that they work, struggle. So inevitably it usually ends up being one of us (radiographers) that does the symptomatic reporting or the full-time radiologist. [Site 3; G03 CP]*

A further reason why radiographers accumulated more MIIR experience, even than full-time radiologists related to the different way in which the working week of the respective professions was structured. The AdvP radiographer at Site 7 explained in the following data extract how as a full-time breast radiographer, she undertook a higher proportion of the clinical workload, even compared to a full-time breast radiologist because more of a radiographer's working week was allocated to clinical sessions:

> *We have myself and the senior radiologist… we're both the same – virtually full-time in the department. It's just that our hours are slightly different… he is clinically 2.5 sessions and I'm 4.5 sessions clinically. The other radiologists are half breast and half general and they are all 2 sessions a week clinically. So I do the most clinical sessions of all of us. [Site 7; G12 AdvP].*

A radiologist at a further site explained how radiographers that were '*indigenous to the unit'* could help increase the capacity of the department by providing extra clinics:

> *They can turn their very expert hands to things like reporting in a one-stop clinic… so they are invaluable in that they are much more flexible… if I am in the main department doing an ultrasound… barium … CT list… I can't come and do a one-stop clinic… whereas they are much more flexible so they can be used for additional clinics, if the need arises. [Site 9; L21 radiologist]*

Again, illustrating how this phenomenon seemed to occur across most of the sites studied, a radiographer from yet another site explained how radiographers could help departments meet waiting time targets in the absence of adequate radiologist resource:

> *We can keep to targets because the radiographer's here all the time... if the radiologist's off and because the radiologists don't work in the breast unit all the time, so they are not always available for symptomatic reporting… we're always here so we can step in and do it. [Site 9 G22 AdvP]*

Corroborating this evidence the radiologist at Site 9 identified a further organisational outcome, an 'intended consequence' of substituting a radiographer who is specialised and working full-time, in breast imaging for a radiologist:

> *A consultant radiographer is on the shop floor much more so than a consultant radiologist…we all do other things in the main department so we're relatively inflexible whereas a consultant radiographer is very flexible …they can deal with the breast imaging side of things to the same standard if not better. So from a point of view of value for money I think we get much better value for money out of a consultant radiographer than we would a consultant radiologist in the breast imaging unit. [Site 9, L21, radiologist]*

This interview extract highlighted how dedicated breast radiographers were more organisationally flexible and gave better value for money in comparison to radiologists who worked across multiple clinical specialities.

In summary the data presented above supported the initial programme theories that:

- increased MIIR volume and practice seemed to improve skill and confidence;
- dedicated and full time breast imaging practice enabled radiographers potentially to develop greater expertise (diagnostic accuracy) than (some / part-time) radiologists because they:
    - exceeded the RCR (2003) minimum number of symptomatic cases;
    - undertook both screen reading and symptomatic MIIR where they worked in a combined service;
    - attended MDT meetings to get feedback to calibrate their performance.

In addition the study data suggested that

- MIIR volume and practice might be limited at smaller sites (DGH) and / or those which only provided a symptomatic service and this might restrict the number of practitioners who could be involved;
- part time practitioners might need to super specialise, for example give up image acquisition (radiographers) or restrict practice to screen reading (radiologists) to attain / retain competence in symptomatic MIIR.

The data revealed that:

- radiographers involved in symptomatic MIIR were more likely to have dedicated their practice and be working full-time in the clinical domain of breast imaging, than radiologists were;
- radiographers might derive job satisfaction and be motivated to specialise in breast imaging because of a gender affinity with women, greater involvement in patient care, enhanced pay /grading prospects, desire for mastery and better integration into the MDT;
- radiologists might be discouraged from specialising in breast imaging by organisation size (DGH – need /desire to maintain balanced portfolio), perceptions of boredom and / or stress for example litigation risk, and increased patient contact;
- reduced radiologist interest in breast imaging provided opportunities for radiographers to extend their professional boundaries in this domain.

Full-time clinical specialist radiographers were a flexible organisational resource which seemed to afford departments the potential to:

- respond to fluctuations in demand and (radiologist) capacity;
- meet cancer waiting list targets;
- reduce the cost of the symptomatic MIIR service because substitute radiographers appeared to be able to do the same work as a (higher paid) radiologist.

The next section of the thesis presents data analysis which suggested that full time working in breast imaging allowed radiographers to develop expertise across the entire diagnostic patient journey. This re-defined their scope of practice in terms of a clinical, as opposed to a technical, professional boundary and gave radiographers a similar holistic overview of the patient's entire diagnostic journey to that of a radiologist.

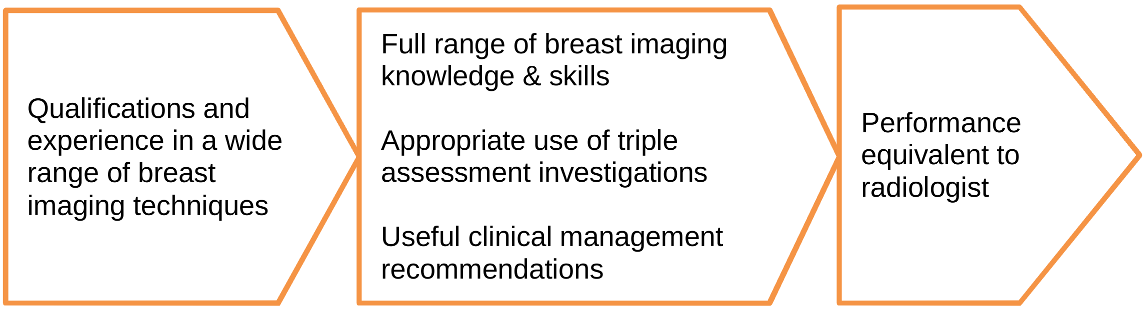
5.3.5.3 Multiskilling and provision of holistic care

The Stage 2 data appeared to confirm that radiographers who dedicate their practice full-time to breast imaging were able to train, gain experience and thus eventually develop expertise, in multiple breast imaging techniques (technical disciplines). This was illustrated in the following radiographer interview quotation:

> *It's only recently now that I am starting to work here (in the breast imaging department) longer... I am hoping to do the biopsy course… I haven't wanted to do ultrasound because of my other commitments (in general x-ray). [Site 4; G11 AdvP]*

In the initial programme theory (IPT) it was hypothesised that ‘multiskilling’ had cognitive (diagnostic reasoning) and organisational (resource use) consequences (intermediate outcomes) and that the practice and performance of a multiskilled radiographer aligned more closely to that of a radiologist in the symptomatic service (distal outcome), see Figure 5.11.

Figure 5.11 IPT - multiskilled clinical specialist radiographers



The IPT suggested that the intermediate outcomes resulted from transfer of knowledge and skill across (technical) disciplines, integration of clinical and imaging information and synthesis of all this into a ‘patient-centred’ overall diagnostic impression. It was hypothesised in turn that this contributed to improved diagnostic accuracy and insightful and clinically useful conclusions and recommendations in examination reports.

The radiographer participants in the study fell into two groups. In this thesis they were differentiated as uni-skilled - those who had ‘advanced’ practice skill, that is skill beyond mammography image acquisition, in mammography image interpretation and reporting OR clinical examination of the breast OR breast ultrasound OR image-guided tissue sampling (biopsy), and multi-skilled - those who, like radiologists were knowledgeable and skilled in all techniques.

Within the study sample all of the ‘consultant practitioner’ (CP) radiographers worked full time in breast imaging and with the exception of the trainee CP (participant G31) all had at least 10 years’ experience of MIIR. Several of the ‘advanced practitioner’ (AdvP) participants worked part-time in breast imaging and / or had less than 5 years MIIR experience. The CP participants were all multiskilled but the AdvP participants did not always have the full range of competencies. Multiskilling thus appeared to be an indicator of higher social prestige within the workforce (Nancarrow and Borthwick, 2005) because it was associated with seniority, as illustrated in the first quotation below, and led to career progression, as illustrated in the second quotation:

> *We have people who are at the mammography (image acquisition and commenting) only part of their training so not in a position to do ultrasound; so they will do mammography and then they will hand over*

to a more senior radiographer who will then do ultrasound. [Site 1; L13 radiologist]

If everyone got to do everything then it would reduce the number of advanced practitioners… they would all want to be consultants. [Site 8; G31, trainee CP]

The first data extract supported the programme theory that achieving ‘specialisation' across a clinical domain was a consequence of time spent in the domain; it explained how some radiographers were not multiskilled because they were at an early stage of career development in breast imaging.

The radiologist at Site 1 provided a supporting example of the intended ‘cognitive’ consequences of multiskilling. She illustrated how knowledge from one discipline could inform another when she explained why she thought it was important to have knowledge and skill in mammography, which also involved commenting on image appearances at her site (see earlier section 5.3.2), before doing ultrasound:

Once they are confident and accomplished at mammography they can then do ultrasound. That seems to be the right way round because what you have got to do is you have got to understand the mammogram, where the lesions are before you start doing the ultrasound. [Site 1; L13 radiologist]

One of the multiskilled AdvP radiographer participants at this site also provided supporting evidence for this programme theory. She implied that she transferred her skill and knowledge between mammography, ultrasound and tissue sampling when she expressed amazement that colleagues trained only in ultrasound (sonographers) and therefore not multiskilled, could undertake tissue sampling accurately:

I have come across sonographers who have been doing biopsies that haven’t done mammography and I don’t understand how they know the lesion that they are sampling is the same lesion on the mammogram… they go side-by-side, so how can they tell … if you have never done a mammogram in your life and don’t know what your mammogram should look like and where things are, how can you work out that you are sampling, or you’re scanning the right bit? [Site 1; G32 AdvP]

A colleague gave a corroborating example of knowledge synthesis which demonstrated how current formal training in MIIR helped her perform ultrasound more accurately:

It's useful to measure the lesion on the mammogram and think ‘right I am looking for something that’s roughly 5mm, 10mm’, because you might scan the breast and find something but it might not necessarily be what you’ve seen on the mammogram…. they both come hand in hand … you are thinking ‘ I have found something at 9 ‘clock but when I looked on the mammogram it looked more towards 11 o’clock so I don’t think what I’ve seen (on ultrasound) is what I was worried about *on the mammogram'…. so you will deal with the 9 o'clock lesion, but then you would carry on looking … you know what you expect to find a bit further round the breast. [Site 1; G36 MIIR trainee practitioner]*

This last example illustrated how diagnostic accuracy might be compromised, how error might occur due to premature closure 'satisfaction of search', where a sonographer did not have MIIR competence and did not realise that the first lesion she found might be an additional, mammography occult, abnormality. This radiographer's evidence also contained a further illustration of knowledge transferability, this time how her tissue sampling experience was informing her current MIIR learning:

I've had the opportunity to look at images with the radiologist whilst I was doing the image guided biopsies… so I do have that little bit of background… it was helpful because the radiologist would call you and you would discuss what they see on the images… [Site 1; G36 MIIR trainee practitioner]

In further support of the programme theory the following example from an experienced radiographer participant illustrated how knowledge of both MIIR and ultrasound allowed her to synthesise the separate examination findings into an overall 'level of suspicion of cancer' conclusion encompassing the entire imaging component of triple assessment:

Both things give you a different … if you've done the mammogram you might think there is nothing there, and when you have done the ultrasound you find there is…. then you give an overall R1,2,3,4,5 at the end… you combine the two to say what you think you've seen as a combination of the two. [Site 1, G33 AdvP]

In the situation described by this participant, the ability to combine knowledge across imaging examinations to give a single concordant result avoided the clinician receiving two separate conflicting reports about the different imaging examination results.

The radiologist at Site 1 highlighted how patients might enjoy a better clinic experience because multiskilled radiographers could perform all necessary imaging investigations for an individual:

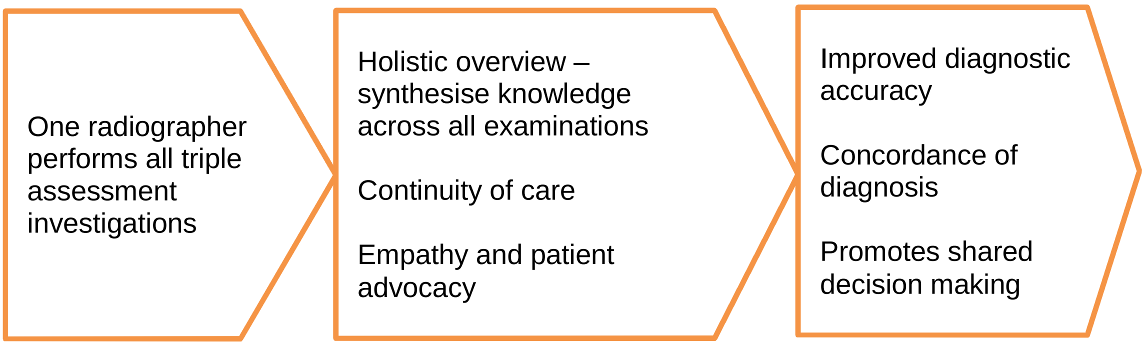
I do think the ideal thing for patients is that they have one person that does their mammogram and their ultrasound, so they are guided through by one person; that is our ideal. [Site 1; L13 radiologist]

One of the experienced radiographers at this site contrasted this with a graphic example of the consequences of multiple uni-skilled practitioners performing the different examinations:

It perhaps makes a difference to the patient because you have not followed her right through, she's had to have two people see her naked and do her examinations. [Site 1; G33 AdvP]

This and other potential consequences of what was defined in this thesis as a 'holistic' model of care, that is seamless care provided to an individual patient by one radiographer, had been outlined in IPT, see Figure 5.12.

Figure 5.12 IPT - Holistic model of care



The next two quotations from the team lead radiographer at Site 1 illustrated how the 'philosophy' of holistic care operated at meso (departmental) and micro (individual) levels:

> *We are not just a mammography department, we are a breast imaging department… you are not just producing images… you've got a symptomatic person who needs care there and then and afterwards. (They) are not a well woman… the philosophy is you care for that lady. If you see something on (the mammogram) you think 'I need to go further'… that's the philosophy – it's actually caring for the patient. [Site 1 G32 AdvP]*

This extract seemed to imply that the 'holistic' care model was patient focussed, triggered empathy in practitioners and had the potential to be perceived as higher quality of care by patients.

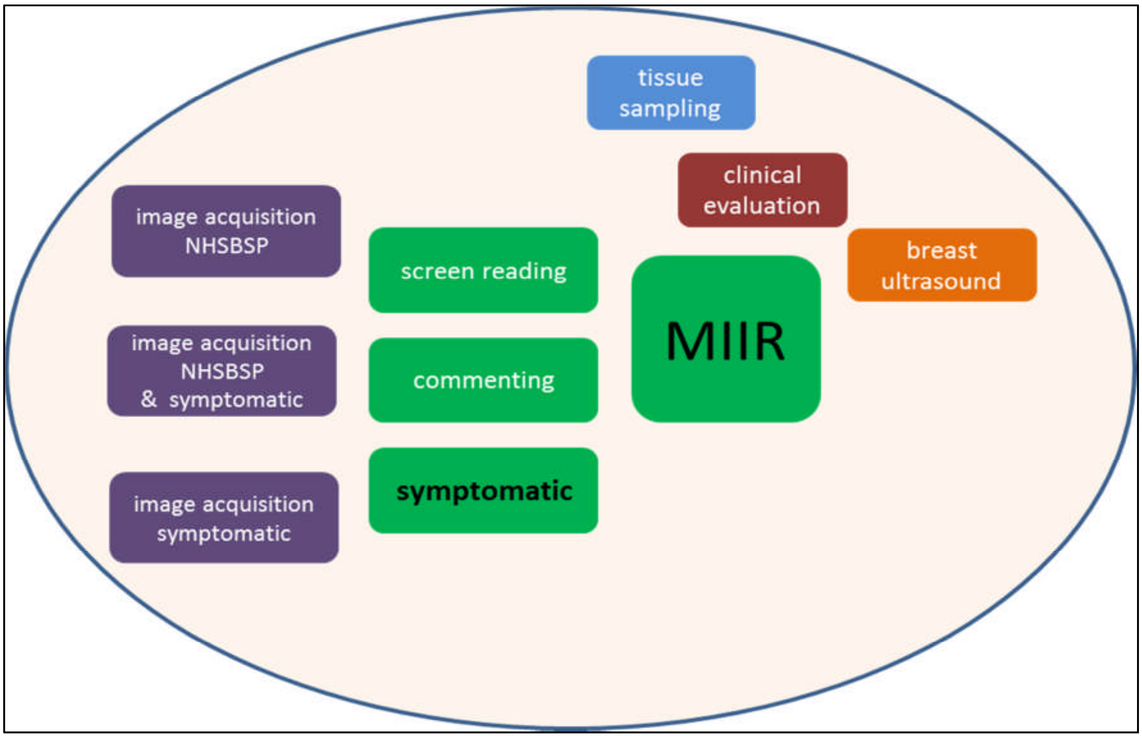
In another part of the interview this participant clearly reiterated:

> *'I am a breast imager…I do it from a breast imaging point of view because that's what I am' [Site 2 G32 AdvP].*

Her differentiation of mammography and breast imaging, and the use of a professional label other than 'radiographer' was an example of how the 'specialist' status of the multiskilled radiographer's professional scope of practice might be legitimised through use of a specific title (Nancarrow and Borthwick, 2005).

Figure 5.13 shows the various diagnostic investigations performed across the range of radiographers involved in symptomatic MIIR who participated in this study. This range of technical disciplines covered all the imaging tests and other triple assessment procedures (tissue sampling and clinical examination) that a patient might undergo on their diagnostic journey through the symptomatic breast clinic.

Figure 5.13 Models of care



At Site 1 the radiographers who were multiskilled operated the holistic model of care described above - a single radiographer performed all the tests, and interpreted all test results (except tissue sampling – cytology / histology slide interpretation) enclosed in the circle. Radiographers who were not multiskilled had to work in teams to deliver the full range of diagnostic examinations. In this second model of care, defined in this thesis as ‘blended’ care, the circle in Figure 5.13 encompassed several individual radiographers who each carried out different imaging tests.

In the blended model of care patients met multiple radiographers during their transit through the diagnostic service and the radiographers had to work collectively to co-ordinate patient care and transfer diagnostic information along the chain of diagnosis. This was illustrated by one of the Site 4 radiographer participants:

> *I will go and speak to my ultrasound colleagues often just to highlight the area… some of my colleagues don’t do mammography so they don’t know how to read the mammograms. I don’t do ultrasound so I would rather go with my mammogram report and if it's not the clinical area which is marked on the patient, I will go and discuss that and I will show the images to my colleague. And they will give me feedback on what they have seen on ultrasound which helps me understand whether what I think is on that image is actually what the ultrasound has actually shown. And because we have a close relationship if they can’t see anything…if I don’t suggest in my report it may need to have a stereotactic biopsy then my ultrasound colleagues will suggest that on my behalf. [Site 4 G12 AdvP]*

The CP radiographer at this site explained how even though she was multiskilled and might synthesise knowledge across disciplines where some of her colleagues could not, she considered that the blended model of care allowed practitioners to be a ‘master’ in one discipline at a time:

> *You are making sure that your film reader is concentrating on reading films and your ultrasonographer is concentrating on doing ultrasound… that’s the best way round of doing it, I think. [Site 4 G14 CP]*

One other site (Site 3), where all the radiographers involved in symptomatic MIIR were multiskilled, also operated the blended model of care. One of the AdvP participants explained how despite operational policy she sometimes preferred to do both MIIR and ultrasound examinations (holistic model) because it helped her interpret and report a mammogram more accurately:

> *I quite like it... sometimes I might look at a mammogram and I am not confident about whether something is really there… like in a dense breast, are there cysts or aren’t there? Is that just glandular, is that asymmetry just a bit of glandular tissue or is it a little bit more?...it's actually good to look at the mammogram and then do the ultrasound scan, and then put the information from both together and write your report. [Site 3 G05 AdvP]*

Her more experienced CP colleague pointed out that this could actually introduce errors into the reasoning process:

> *That isn’t our practice because you can have lesions that appear on mammograms that are not on ultrasound. So personally I wouldn’t encourage that. I think make your mind up on your mammogram and just write it. If you don’t know what it is, just describe what you’re seeing. [Site 3 G03 CP]*

The above evidence illustrated that participants made contradictory arguments about the holistic model of care. Although it appeared to have the potential to improve diagnostic accuracy because practitioners synthesised information across technical disciplines, it also appeared to have the potential to introduce errors due to ‘ordering’ effects (Bergus et al., 1995).

One consequence of the ‘blended’ model of care highlighted by participants was the serendipitous introduction of ‘double reporting’ into the diagnostic processes, a process which in itself offered the potential to improve diagnostic accuracy. Double reporting occurred because multiskilled radiographers performing ultrasound examinations always reviewed mammographic images, performed and reported on by colleagues, prior to performing ultrasound examinations. This was illustrated in the following quotations from the radiologist and a radiographer at Site 1:

The (radiographer performing ultrasound) will look at the mammogram so they'll (tell the radiographer) that has done the mammogram whether they agree or disagree with their interpretation; they will certainly look at the mammogram before they do the ultrasound. [Site 1; L13 radiologist]

The commenting form goes with the request card to the sonographers and the sonographers will look at it. Personally I will always look and see what they have written and then I look at the images. Now if I don't agree with what they have written I will speak to them. I will add on things that they might have missed. [Site 1; G34 AdvP]

This was a common finding across all sites and all practitioners. The following exemplar quotation encapsulated the 'team working' nature of blended care:

Although we are not officially double reporting we do look. The person in ultrasound is looking at the mammogram and the report and… they can and do come out if they feel they have seen something else or want to discuss something... I think that's how we work as a team, between the people that are doing the clinic... it's not like we are just getting on with it…. we look and have the opportunity to comment. [Site 3 G04 AdvP]

As illustrated in these data extracts blended care delivered by multiskilled practitioners provided opportunistic peer review and thus feedback on MIIR performance, and had the potential to improve diagnostic accuracy because multiskilled practitioners applied their knowledge across the whole patient pathway regardless of the specific diagnostic task they were undertaking. It appeared that multiskilled radiographers operating the blended model of care might perhaps be delivering a 'virtual' model of holistic care.

One radiologist pointed out how multiskilled radiographers made the breast imaging workforce more flexible at an operational level and thus allowed it to better respond to fluctuations in demand for different types of examination during clinics:

If you've got more people that can multitask it makes keeping a lid on the workload pressures a lot easier because you've got more people who can work flexibly. [Site 2; L07 radiologist]

The following example, from the multiskilled CP radiographer at Site 4 explained how she might change from her normal blended model of care, to a holistic model, on a day-to-day moment-by-moment basis, in response to local workload 'bottlenecks':

Sometimes if I am doing ultrasound and I want to get the patients through… invariably it is a separate report from mammography and ultrasound but if I am doing an ultrasound list and the film reading is getting behind, I will come and take some and do it as I am doing the ultrasound to speed the clinic through. [Site 4 G14 CP]

This consequence appeared to result from multiskilling and was independent of the operational model of care at a particular site.

In summary, the data collected during Stage 2 of the study appeared to support the programme theories that multiskilled radiographers:

- were experienced senior clinical specialist practitioners;
- synthesised knowledge across technical disciplines;
- had a patient-focussed attitude to the care they delivered.

The study data revealed in addition that radiographers involved in symptomatic MIR operated within two different models of care:

- in a 'holistic' care model a single multiskilled radiographer performed multiple examinations for an individual patient;
- in a 'blended' care model multi- and uni-skilled radiographers worked as a team to transfer information and co-ordinate patient care along the chain of diagnosis;
- in both models of care multiskilled radiographers could offer logistic flexibility to respond to fluctuations in demand for different tests in the diagnostic pathway;
- multiskilling should improve diagnostic accuracy in both models of care – through double reporting (blended model) or knowledge synthesis (holistic model);
- in the holistic model of care a single multiskilled radiographer provided direct continuity of care for patients; in the blended model of care multiskilled practitioners provided 'virtual' continuity of care.

5.3.5.4 Role substitution or innovation

In addition to MIIR expertise, the study data suggested that multiskilling was an important trigger for substitution of radiographers in the role of a radiologist in the symptomatic service, over and above their substitution in the MIIR task.

It was hypothesised in the IPT that the practice and performance of a multiskilled clinical specialist radiographer might be indistinguishable from that of a radiologist. The following data extracts from the interviews of radiologists participating in Stage 2 of the study confirmed this hypothesis:

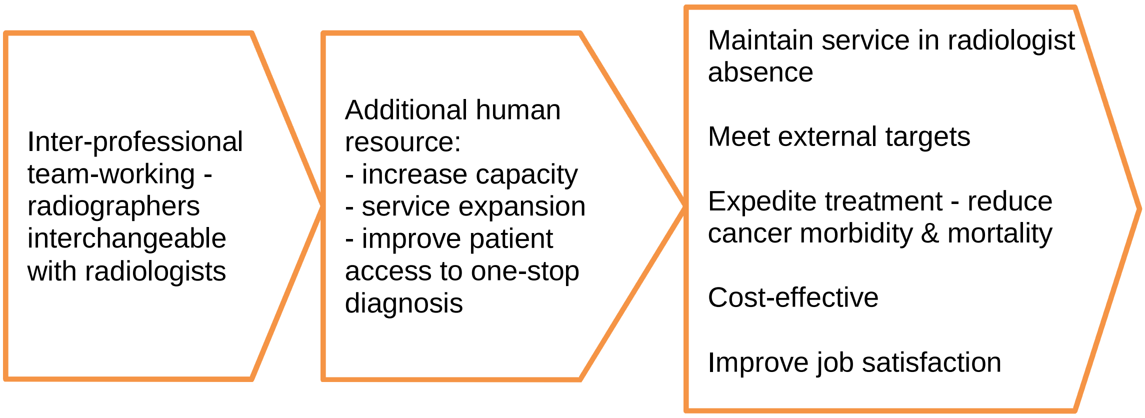
> *They do exactly the same as I do. [Site 4; L20 radiologist]*
>
> *…the person became a 'mini-me' and did everything exactly like …. if I read my report and that person's report sometimes I can't tell the difference because it's just exactly like I would have said. [Site 6; L19 radiologist]*

She does exactly what I do… exactly analogous to the way that I'd do that… she's treated, in the same way. [Site 7; L01 radiologist]

Our consultant radiographer works completely independently … she makes her own patient management decisions, she reports completely independently… just exactly the same as a consultant radiologist really. [Site 9; L21 radiologist]

These data supported the theory that the multiskilled clinical specialist radiographers in this study not only 'task' substituted for radiologists by undertaking MIIR but also 'role' substituted across the entire imaging scope of practice in the symptomatic clinics. These data implied that the radiographer and radiologist professional boundaries might be concordant. The IPT had suggested that radiographers might work interchangeably with radiologists as a seamless inter-professional team and that this would have wide ranging consequences for services, patients and practitioners – see Figure 5.14.

Figure 5.14 IPT - Inter-professional team working



The following quotation from the Site 9 radiologist is a representative and confirmatory example of how consultant radiographers and radiologists worked in seamless in inter-professional teams:

The consultant radiographer will stand in for a radiologist if they are not available, on holiday for example or on sick leave and vice versa, we'll stand in for her clinics as well if she is not here. So the consultant radiographer is used within this unit in exactly the same way as a consultant radiologist would be in the world of symptomatic breast imaging and mammograms. [Site 9 L21 radiologist]

This testimony suggested that substitution between the 'consultant' medical and non-medical professionals in the symptomatic clinics was reciprocal and supported the theory that availability of a 'substitution' radiographer resource allowed continuity of service provision during periods of planned and unplanned practitioner absence.

A further hypothesised consequence of substituting radiographers into the MIIR task or radiologist role was increased service capacity. It was hypothesised that this might allow services to schedule additional clinics to enable them to meet external targets or allow services to expand their remit to encompass innovative diagnostic or minimally invasive therapeutic techniques. It was postulated that increased clinic and / or service capacity would occur because radiologists were released from MIIR to undertake additional or alternative work.

The Stage 2 data contained little evidence that involving radiographers in symptomatic MIIR was releasing radiologists to extend the scope of the breast imaging service. Rather it appeared that radiographers were simply plugging holes that had once been filled, or would traditionally have been filled, by radiologists. In the following data extract one CP participant explained how lack of radiologists would have rendered her service unsustainable had radiographers not developed their roles:

> *If this Trust hadn't been supportive of advanced practice the symptomatic service would have collapsed because there was such a long period of time with one sole radiologist. And had radiographers not stepped up to advanced practice and taken on the role I don't know how they would have sustained a service basically. [Site 6 G18 CP]*

In contrast to the IPT hypothesis that vertical substitution would release radiologists to engage in service remit expansion, the data suggested that radiologists were not 'cherry picking' the new interesting 'more desirable' work and 'ditching the dirty work', or delegating 'less pleasant' work to radiographers of 'lesser standing' (Hughes, 1958 cited by Nancarrow and Borthwick, 2005). This was illustrated at Site 8 in the clinical lead radiologist's testimony when asked to comment on this idea:

> *We have recently implemented our vacuum assisted biopsy service and everybody including our Advanced Practitioners are doing that... in terms of vacuum assisted excisions that's something I have been very, very conscious that I do promote everybody to do it… because we've literally only just started doing those, so I making sure everybody's done at least one [Site 8 L25 radiologist]*

In addition she went onto explain how the clinical specialist radiographers were just as, if not more likely to be involved in developing and implementing new techniques:

> *Our equipment is capable of undertaking tomosynthesis, our licence is on and ready to go. …one of our consultant radiographers is leading the research project that we want to do for tomosynthesis so she is our lead for that. [Site 8 L25 radiologist]*

The substitution theory suggested that one of the intended consequences of replacing radiologists with radiographers would be to reduce service cost. It was hypothesised that this would occur because a higher grade, higher paid practitioner (doctor) was replaced with a practitioner who cost less to train and employ (radiographer). Although none of the participants offered any quantitative evidence to support this theory, there was a general belief among the participants that this theory was valid. The following data extracts were typical participant opinions:

> *… we are not radiologists and we cost a lot less.[Site 2; G08, AdvP]*

> *… they are paying us a fraction of what the radiologists are being paid. [Site 8; G30 CP]*

> *…they are like a complete package… but at a cheaper price of course [Site 6; L19 radiologist]*

A further radiologist expressed the view that radiographers were good ‘value for money’ not only because they cost less to train and employ than radiologists but also because they did more clinical work than radiologists:

> *I think we get much better value for money out of a consultant radiographer that we would a consultant radiologist in the breast imaging unit. [Site 9; L21 radiologist]*

In contrast, but again concordant with the IPT, one of several experienced multiskilled radiographers who were not allowed to function in substitution roles, because there were adequate numbers of radiologists to cover the service at their site (Site 1) explained how she considered this a ‘wasted’ resource:

> *We’ve been invested in.. we’ve invested ourselves into learning how to do this… the Trust invested time and money in getting us to this standard so use us more it makes sense from all points of view [Site 1, G32 AdvP team leader]*

Although the study evidence overwhelmingly supported the hypothesis that substituting a multiskilled radiographer in a radiologist role was cost-effective, the data also confirmed that IPT hypothesis that there were limitations to role substitution in the symptomatic service. The following data extract illustrated the limited role of even experienced radiographers, compared to radiologists in MDT case discussions and clinical decision making:

> *If you are actually there in the MDT I think I am that long in the tooth that I am not frightened of speaking up if I have done something. But there is no official forum or space for the radiographer to comment…it's done at clinician level, at radiologist level. [Site 1 G32 team lead AdvP].*

The Site 2 CP radiographer’s evidence was concordant with published data reinforcing claims that MDT’s are dominated by medial and surgical contributions:

> *The surgeons tend to chair it, there tends to be 4 or 5 of them, with the oncologist - the oncologists tend to lead the therapeutic bit – when they talk about radiotherapy and chemotherapy. So usually the*

> *surgeon, whoever chairs it… has got the patient's notes and will present the case and then radiology say what they have found, and then pathology go on. It works like that, it's pretty set in stone how it works. [Site 2 G08 CP]*

Continuing the radiographer participants illustrated how their professional subordination manifested in practice:

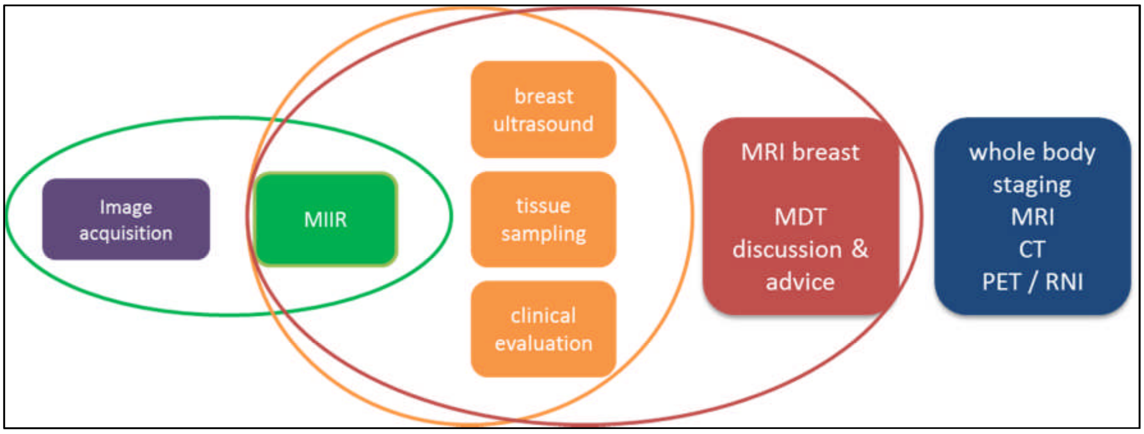
> *I tend to be there with images up and CRIS (computerised radiology information system) up so that if they say 'can we book this patient for surgery' we've got the diary open and we write it in the diary. If they want to recall a patient we arrange that. If they want to look at an old report, we fetch it up… so it's an admin role really. [Site 2 G08 CP]*

> *It's the radiologist's handmaiden role… the radiologist will say 'we'll recall that patient' but they haven't got a clue when or where they are going to recall the patient… so we are the ones that sort things like that out. [Site 2 G09 AdvP]*

The study data thus evidenced that 'radiology' contribution to the MDT tended to mean 'radiologist' contribution. All the departments from which participants were recruited to the study had a consultant radiologist who was 'in charge', a clinical director who had overall responsibility for the breast imaging service at organisational level and who invariably 'led' the imaging contribution to MDT case discussions. Although it was known that one site (Site 5) did not have a substantive breast radiologist and the consultant radiographer at this site operated as imaging 'lead' and was also the deputy leader of the breast MDT, no data was collected from this site because it was undergoing major organisational restructuring (merging with an adjacent service) during the study and no participants could be recruited.

In concordance with the IPT hypothesis, radiographer clinical and technical expertise was limited to routine 'breast' examinations and their ability to substitute entirely for radiologists was restricted because they were unable to undertake, interpret and report on staging whole body MRI and / or CT and / or RNI examinations. Figure 4.6, which illustrated the radiologist's retained exclusive scope of practice (blue square) is reproduced here as Figure 5.15.

Figure 5.15 Radiographer and radiologist scopes of practice



In line with the IPT (red square) the scope of practice of two of the experienced consultant radiographers (Site 3, G03 and Site 4, G14) included breast MRI. Although it did not happen often, only when radiologists were on annual or sick leave, two consultant radiographer participants (Site 2, G08 and Site 3, G03) also occasionally led the diagnostic component of the MDT meeting. They explained how this worked in the following interview extracts:

> *If there isn't a radiologist that goes, I mean there usually is, but on the very rare occasions that there hasn't been a radiologist I will lead the radiology bit and present the cases…. present the radiology part of the case. [Site 2 G08 CP]*

> *I personally can do the diagnostic MDT, but obviously we need a radiologist to do the second half. That's just part of my role as consultant practitioner – to be able to conduct the MDT and make a decision… either me or the radiologist… for further investigations, repeat biopsies if the results of biopsies don't match how we've interpreted the images... decide on whether to do follow up or whether to do a vacuum assisted procedure, or whether they will need an excision, things like that. [Site 3 G03 CP]*

In addition to these differences in the respective roles and responsibilities predicted in the IPT, both radiologist and radiographer participants were keen to point out further differences between radiographer and radiologist practice. The following quotations illustrated how consultant radiographers too had their own 'exclusive' domains of professional practice:

> *Quite right, she's quite adamant that she doesn't want to be a radiologist on the cheap or to get conned into doing exactly the same role because she also has a large admin, teaching, audit and other part to her job… [Site 2 L07 radiologist]*

> *We are expected to do all the picking up and all the covering.. well we are going to stand our ground on this… we don't see why we should*

> *be giving up our 'other' things…. having fought so hard to do this consultant role which as you know has got the four core domains... we've worked really hard to establish that, to get involved in the research, to get involved in the teaching and things, and we won't give it up lightly.. . [Site 6 G18 CP]*

These examples suggested that radiographers did not want to substitute as 'mini radiologists because they were keen to preserve the four nationally agreed domains of professional practice for non-medical consultant practitioners (DH, 2000a) in their role.

In summary, the data presented in the above section supported the hypothesis that radiographers were pioneering a new innovative role, a hybrid role which bridged the professional boundaries between radiographer and radiologist. The data suggested that such radiographers:

- were flexible and capable of responding to fluctuating demand for different examinations which had the potential to expedite patient transit through clinics;
- could substitute in the radiologist's role in clinic and therefore help maintain capacity during absence and / or increase capacity to address waiting lists / service expansion;
- might be more cost-effective than radiologists because they are paid less and seem to do the same type and amount of work.

The hypothesis that consultant breast radiographers were 'more than a radiographer, but not quite a radiologist' and further exploration of the nature of the differences between radiographer and radiologist practice, at micro (individual) and meso (profession) level formed a focus for Stage 3 of the study.

5.3.6 Preliminary discussion of Stage 2 study findings

In Stage 2 of the study 30 radiographers and 8 clinical lead radiologists working in NHS breast imaging services described their own individual, and their local department's history and current practice of involving radiographers in symptomatic MIIR. Their data included evidence about:

- the real-life roles, responsibilities and working practices of radiographers and radiologists involved in symptomatic MIIR;
- the inter-professional working relationships between radiographers and radiologists in symptomatic breast services;
- the involvement of radiographers and radiologists as members of multidisciplinary breast care teams.

This section of Chapter 5 summarises how the cross-sectional overview data collected and analysed during Stage 2 confirmed and / or refined the initial programme theory (IPT). It also identifies the emerging theories that were tested and explored in more depth in Stage 3 of the study.

5.3.6.1 Programme theories about roles and responsibilities.

The ways in which the characteristics of the participant radiographers and their involvement in symptomatic MIIR could be explained in terms of the professional boundary frameworks described by Nancarrow and Borthwick (2005) and Sibbald et al. (2004) are summarised in Table 5.7.

Role enhancement, adding MIIR to every radiographer's traditional image acquisition role, was unusual and only encountered at one site (Site 1). Contrary to the IPT this intervention was not restricted to radiographers without formal MIIR training, it was not used to provide surgeon's with an interim report in the absence of radiologist resource, nor were radiographer opinions reviewed 'cold' once the patient had left the department.

At Site 1 all radiographers were encouraged by radiologists to offer a preliminary clinical evaluation (PCE) of the images they acquired. New practitioners and those without formal training were able to participate because they collaborated with more experienced radiographer colleagues, some of whom were formally trained in MIIR, who provided advice and assistance with image evaluation and report writing.

This study identified that radiographer involvement in PCE might streamline the patient journey through the clinic because radiographers were allowed to initiate additional mammography views and ultrasound examinations on the basis of their image interpretation rather than waiting to act at the request of a radiologist. Patient safety (procedure related morbidity) seemed to be maintained because radiographers were not allowed to initiate minimally invasive tissue sampling (biopsy) investigations without radiologist authorisation and radiologists double read all cases in the clinic (hot double reporting) and were responsible for the definitive interpretation and report (hierarchical double reading). Participants claimed that involving radiographers in PCE had the potential to improve diagnostic accuracy because it could alert radiologists to subtle abnormalities that they might have overlooked but no quantitative data was available to support this assertion.

Compulsory involvement in PCE was stressful for newly recruited radiographers and those without training or previous experience, but overall it enhanced radiographer job satisfaction. This model of PCE was not associated with an additional direct cost (radiographers did not get any additional reward) but hidden costs (increased patient transit time / unnecessary use of additional investigations) were not assessed in this study.

Table 5.7 Mapping of real-life professional boundaries of participants to existing theoretical frameworks

Site identifier Radiographer characteristics	**Radiographer involvement**	**Mapping to professional boundary frameworks of Nancarrow and Borthwick (2005) and Sibbald et al. (2004)**
Site 1 - All radiographers irrespective of MIIR training	Hot commenting Hierarchical double read / reporting with radiologists	Role enhancement – adding to / increasing depth of existing role Role diversification –- novel approach to practice not previously owned by the professional group.
Site 2 – Multiskilled CP radiographer and AdvPs with MIIR qualification	Cold second read Equivalent double read / reporting with radiologists	Specialisation – practice limited to breast imaging Vertical task substitution for second radiologist –allocation of duty and responsibility to worker with less / more narrow (overall) training.
Site 3 - Multiskilled CP and AdvPs radiographers	Hot, single autonomous read / reporting	Specialisation – practice limited to breast imaging (not Site 4 AdvPs) Vertical task substitution for single radiologist – allocation of duty and responsibility to worker with less / more narrow (overall) training. Role innovation – role advancement – radical new approach to skill and competence - creation of a new role, type of work, type of worker
Site 4 - Multiskilled CP radiographer and AdvPs with MIIR qualification		
Site 7 - Multiskilled AdvP radiographer		
Site 8 & Site 9 - Multiskilled CP radiographers		
Site 8 & Site 9 AdvPs with MIIR qualification	Hot, hierarchical radiographer / radiographer or radiographer / radiologist double read / reporting	Specialisation – practice limited to breast imaging Role delegation – junior practitioner undertakes some of the duties of a more senior practitioner; performance moved but not responsibility.
Site 6 – AdvPs with MIIR qualification Multiskilled CP radiographer	Filtering Cold, autonomous single read / reporting (P1, P2 cases) Hot, autonomous single read / reporting (P3 – 5 cases)	Specialisation – practice limited to breast imaging Role diversification – an intra-disciplinary change – extend scope to encompass practice not previously owned by the professional group. Role delegation – allocation of duties but not responsibility to junior practitioner who may, but need not be from the same profession.

Role diversification, using NHSBSP trained and experienced screen readers to filter normal and uncomplicated benign cases to reduce radiologist workload, was not encountered at any of the participating sites. In the symptomatic service it only appeared logistically feasible to have radiographers interpreting and reporting all or none of the cases. Historically, radiographers moving into symptomatic work from a screen reading background needed a period of supervision, or preceptorship to enable them to become competent in recognising a greater range of pathology and to develop competence and confidence in report writing. Most current training schemes covered dual screening and symptomatic practice. Although prior NHSBSP experience was not essential for involvement in symptomatic MIIR (Sites 1, 2 and 4) radiographers with screen reading experience were reported to have better specificity for normal variant and benign pathology. Involvement of NHSBSP screen reading radiographers in symptomatic MIIR appeared to be contingent on multiskilling (Sites 6, 8, 9) – see below (specialisation).

Delegated roles where radiographers performed the MIIR task but radiologists retained responsibility were not encountered at operational (micro) level in this study other than during training and preceptorship. The clinical lead radiologists were confident in the radiographers' abilities and said they felt no need to supervise them directly. However, it could still be argued that by retaining organisational (strategic / meso) responsibility for the service, clinical lead radiologists retained some responsibility for the symptomatic MIIR practice of radiographers. Professional accountability, and in particular accountability for error, was explored further in Stage 3 of the study.

Substitution best described the role change experienced by almost half (14/30) of the radiographers participating in this study (Sites 2, 3, 4, 6 - 9). These radiographers were acknowledged to have had better task-specific training and have more experience in MIIR than some of their radiologist colleagues.

At Site 2, where radiographers and radiologists shared diagnostic responsibility by equivalent double reading all cases and resolving discrepancies by consensus, the professions' roles were reversed to what had been predicted. In real life, radiographers substituted for a second radiologist 'cold' double reading all symptomatic cases that had previously been 'hot' read and reported by a radiologist. In a similar way to how radiologists used radiographer PCE at Site 1, the radiographers at Site 2 had responsibility for detecting subtle and incidental abnormalities that radiologists might have overlooked. This role incurred additional resource, had no potential to address medical workforce shortage and again, no quantitative data was available about its consequences for service cost or clinical impact.

At all other sites where radiographers functioned in substitution roles (Sites 3, 4, 6-9), at micro (individual) level responsibility for MIIR appeared to have been transferred into the non-medical professional boundary because radiographers operated as autonomous single readers independent of radiologist supervision. As above – it was not clear to what extent the clinical lead radiologist for the service (meso level) was accountable for radiographer performance.

Substitution triggered enhanced professional status and potentially motivational financial reward for radiographers - the majority (9/14) were consultant practitioners. Substitution augmented the MIIR workforce; it could free up limited radiologist resource to work in other areas of the imaging service, increase service capacity and provide flexibility to cover radiologist absence. The availability of MIIR trained and experienced radiographers did not seem to displace adequate radiologist resource for service expansion (Sites 1 and 2). Where there was adequate radiologist resource services involved radiographers in double reporting. The hypothesis that this might occur, without evidence or evaluation of any added value, cost implication or clinical benefit for example, where radiologists are reluctant to concede professional territory, requires further study.

Specialisation, dedication of practice to a single clinical domain and the acquisition of expertise in multiple diagnostic breast techniques, was a key enabling resource for the substitution of radiographers for radiologists in the symptomatic service. Dedication of practice enabled radiographers to develop MIIR expertise and multiskilling gave them a holistic overview of the patient's diagnostic journey which enabled them to situate their technical skill in a clinical context. Where services had adequate radiologist resource (Sites 1 and 2) specialist (dedicated, multiskilled) radiographers did not substitute and tended (80%) to be advanced practitioners.

Radiographer professional boundaries did not appear to have expanded to encompass substitution in, and legitimate independent membership of, the breast care MDT. This supported the initial programme theory that radiographers had evolved a new 'innovative' role rather than assimilated entirely into the radiologist role. Specialisation seemed to equip radiographers with similar task specific (MIIR) resources as radiologists but it was not clear if the decision making practices of radiographers in their new innovative role aligned to or differed from those of radiologists; it was not clear how confidence, and / or anxiety in a new role influenced radiographer decision making. These aspects of programme theory were explored further in Stage 3 of the study.

As anticipated formal double reporting was not often encountered and where implemented required additional human resource and could increase time to diagnosis. In addition to formal systems such as PCE (commenting) and 'cold' equivalent second reading, the study identified three other 'informal' ways in which radiographers and radiologists could share decision making responsibility with the potential to incur no additional direct costs nor add significant time to the diagnostic journey:

- multiskilled practitioners reviewed mammograms prior to performing ultrasound examinations (Sites 1, 3, 4, 9);
- uni-skilled advanced practitioners first read and provisionally reported mammograms (Site 8);
- practitioners sought additional opinions from colleagues (all sites).

Informal double reading, peer-to-peer collaboration and 'collective' decision making were new phenomena. It was hypothesised that in addition to improving diagnostic accuracy these might be resources which enabled radiographers to undertake symptomatic MIIR because they triggered confidence. This was explored in Stage 3 of the study.

5.3.6.2 Programme theories about MIIR skill acquisition

In line with the initial programme theories the Stage 2 data confirmed that radiographer development of MIIR competence was heavily dependent on pattern recognition and heuristic reasoning.

Experiential learning, in the absence of routine balanced feedback, did not equip radiographers with enough knowledge and skill to participate in symptomatic MIIR. Even in a 'commenting' role radiographers felt unable to participate without some task specific instruction or the availability of trained and more experienced colleagues to consult for advice and assistance. As predicted, formal academic and practical training (instruction) were essential resources which triggered involvement in symptomatic MIIR for all other radiographers in the study

In line with the initial programme theory skills and knowledge acquired during NHSBSP screen reading were confirmed as transferable to the symptomatic setting, In particular screen reading experience seemed to help improve specificity although it was not operationally feasible to involve such radiographers in a 'filtering' role in the 'one-stop' setting. As predicted, involvement in MIIR the full range of symptomatic cases required additional knowledge and skill in differential diagnosis and report writing. Participation in screen reading was desirable for radiographers involved in symptomatic MIIR and occurred at all sites which provided a combined service, but was not a pre-requisite for participation at sites which only provided a symptomatic service. In addition to its intended cognitive consequences, participation in the NHSBSP was also identified as a valuable quality assurance and training resource.

Continued practice (repetition) and feedback (situated learning) were confirmed as resources which triggered the development of expertise – the ability to interpret and report the full range of symptomatic cases including those that were technically difficult, unusual or clinically complex. Confirming the study hypothesis, radiographers in substitution roles lacking radiologist supervision calibrated their performance against independent patient outcomes by following up cases. This enhanced both their competence and confidence and was claimed to enable them to exceed the performance standards of (tutoring) radiologists. As predicted, radiographers with expertise in MIIR were a valuable and flexible resource and they were involved in interpretation and reporting across the full range of mammographic workload (additional evidence not presented in this thesis). Opportunities for feedback for radiographers who did not operate in substitution roles appeared not to be an organisation priority.

Although some formally trained and experienced radiographers had developed 'expertise' and they claimed that their diagnostic accuracy was equivalent or exceeded that of radiologists, none of the study data explained how decision speed or confidence were developed. Perhaps because of the unstructured minimally invasive interview technique used to gather data in Stage 2 little data was collected about the 'affective' and situated influences on radiographer MIIR skill development or performance.

The decision making processes of 'expert' radiographers were explored further in Stage 3 of the study with particular reference to the 'thinking fast and thinking slow' dual processing theory of Kahneman (2011). Using a semi-structured interview technique in Stage 3 additional evidence was sought about the development of confidence and the paradoxical influences of 'autonomy' and 'team working' on the reasoning and decision making processes of radiographers involved in symptomatic MIIR in substitution roles.

5.3.6.3 Programme theories about the symptomatic environment

As predicted in the initial programme theory the need for immediate differential diagnosis and report writing was limited where radiographers shared responsibility with radiologists in formal double reporting systems. At Site 1 radiologists dictated the definitive examination report during the clinic, the radiographers written opinion on a ‘yellow comments sheet’ being an interim and temporary record. To expedite patient transit through the clinic radiographers at this site were allowed to initiate additional imaging examinations; the practitioners who did this used the comments sheet to explain to the radiologist what they had done and why.

At Site 2 and seemingly after a delay of up to 4 weeks, MIIR trained and experienced radiographers second considered the differential diagnosis made by a radiologist in the one-stop clinic. Their reporting was restricted to adding an addendum that they agreed or disagreed with the radiologists report; when they disagreed cases were discussed with the radiologist before indicating on the report if and why patients were recalled.

As predicted, radiographers in substitution roles produced free-text definitive reports. It was implied that these might be indistinguishable from those of radiologists but this aspect of programme theory was explored further in Stage 3 of the study.

In line with the programme theories MIIR was embedded in the ‘triple assessment’ process in the symptomatic setting. The study identified two alternate models of care, defined as holistic and blended, within which radiographers undertook MIIR. Both of these models had been implicit in the initial programme theories but the study data helped to explicate how and why they worked for different practitioners and / or at different sites, or at different times.

As predicted, continuity of care could be achieved by either a single practitioner (holistic) or through communication between a team of practitioners (blended model). In addition the study revealed that multiskilled practitioners involved in blended care had a virtual holistic overview of the entire diagnostic pathway which enabled them to synthesise a wide range of technical / discipline knowledge irrespective of the model of care delivered. It was not clear how this affected diagnostic accuracy in comparison to the double reporting possible in the blended model, nor was it clear if the different models resulted in different preferences for additional tests, further mammographic images and ultrasound examinations for example. These aspects of practice were explored further in Stage 3 of the study.

The models of care tended to be determined and fixed at organisation (meso) level – rationale included staff skills mix, the blended model could involve novice and uni-skilled and part-time practitioners for example, and impact on patient experience, the direct continuity of the holistic model was perceived to be more acceptable to patients. The study revealed that multiskilled practitioners could move flexibly and informally between the models in response to fluctuations in practitioner capacity and patient demand.

The Stage 2 data provided some evidence to support the programme theory that experienced multiskilled clinical specialist practitioner radiographers were accepted as radiologist substitutes. The evidence that this might happen in the one-stop clinic environment was more compelling than evidence that it happened in MDT meeting case discussions. Programme theories related to radiographer status in the MDT, contribution to collaborative MDT clinical decision making, how radiographers develop an identity within the MDT and how the social learning environment of the MDT affects MIIR competence and confidence were explored further in Stage 3 of the study using direct observation of MDT meetings.

5.4 Chapter 5 summary

This chapter of the thesis critically analysed the data collected during Stage 2 of the research. Throughout the results section the data was used to test and refine the initial programme theories presented in the preceding chapter.

The following chapter presents Stage 3 of the study, where revised and new programme theories arising from the Stage 2 data analysis were re-presented to a sample of original radiographer participants. In addition to collecting interview data, Stage 3 of the study involved observation of the real life working practices of expert clinical practitioner radiographers both in clinics and in MDT meetings. Chapter 6 explains how this combination of interview and observation data was used to test and refine evolving programme theory about the development of expertise and legitimate MDT membership – two resources which appeared to be critical for successful substitution of radiographers for radiologists in symptomatic MIIR.

Chapter 6 Refining programme theory about substitution

6.1 Introduction

This chapter presents the methods and findings of Stage 3 of the study. The aim of Stage 3 was to test and refine three programme theories developed during Stage 2. These programme theories seemed to explain how local circumstances and individual practitioner characteristics triggered the development of expertise, team working and role innovation for radiographers involved in MIIR, and how these resources enabled them to substitute for radiologists in the symptomatic breast service. In Stage 3 of the study the three programme theories were subjected to observational scrutiny in an iterative cycle of further data collection and analysis in line with the study's RE methodology (Pawson, 2013).

The next section of this chapter (section 6.2) describes and justifies the sampling, data collection and data analysis methods employed in Stage 3, following this the results are presented (section 6.3).

The initial section of the results (section 6.3.1) provides the reader with an overview of the characteristics of the case study sites and individual radiographer participants. The depth of this information is again constrained by ethical obligations to balance participant anonymity with meaningful insight for the reader. Following this section 6.3.2 presents critical analysis of data exploring the development and characteristics of expertise; section 6.3.3 presents a critical argument that radiographers involved in symptomatic MIIR function within a social learning environment, a 'community of practice'; section 6.3.4 critically evaluates the hypothesis that differences in the reasoning and decision making behaviours of radiographers and radiologists prevented direct substitution and triggered role innovation

6.2 Methods

Stage 3 employed a multi-method design to allow interweaving of the interpretation of two different types of data into the analysis (McNaughton Nicholls et al., 2014). Non-participant observation was used to capture data about real-life MIIR cases which might help to explain the practices described by participants in Stage 2. Observation of practice yielded additional insight because it illuminated complex decision-making behaviours that participants might find difficult to articulate verbally (McNaughton Nicholls et al., 2014). It also allowed capture of data about the social and environmental influences present in the real-life clinical setting. Post-observation interviews clarified observations, teased out tacit knowledge that underpinned observed behaviour and explored how practice and radiographer decision making behaviour could be explained by the programme theories being tested.

6.2.1 Sampling of participants and events

In Stage 3 a relatively homogeneous sample of radiographers was used to test the programme theories across the two different models of care (holistic and blended) identified in Stage 2, capture diversity of radiographer voice (Holloway and Wheeler, 2002) and make cross case (site and radiographer grade) comparisons (Yin, 2009).

Participants for Stage 3 were recruited from the population of Stage 2 radiographers expressing interest in continued research participation following circulation of a summary of the Phase 1 findings.

Sampling was purposive because sites were selected where radiographers interpreted and reported mammograms in 'substitution' roles without direct involvement from a radiologist. Sampling was also theoretical because two sites were chosen to develop and test theories under two conditions (Emmel, 2013). At Site 8 radiographers worked in a 'holistic' role where one radiographer undertook MIIR, ultrasound and tissue sampling for an individual patient in a clinic. At Site 3 the radiographers worked as a team with different radiographers undertaking the separate components of individual patients' diagnostic imaging examinations (blended care). Within these conditions, site choice also maximised the number of potential participants increasing the ability to test theories which explained how differences between individual and type of radiographer (CP and AdvP grades) triggered different decision making practices and produced different outcomes. Including total populations of radiographers involved in symptomatic MIIR at each site incorporated maximum diversity of training and experience into the sample.

Statistical sampling of observations was not appropriate as it was not feasible to predict in advance all the situated and patient case factors which might influence the decision making practices of the participants. The observation event sampling strategy balanced methodological principle and logistic pragmatism (funding and time available). The mammography based diagnostic decision making behaviour of nine radiographers was observed, over a 2 week (10 day equivalent) period at each site. A sample of one full clinic (maximum 20 mammography cases per session) per radiographer and one MDT meeting per week at each site (approx. 20 diagnostic cases discussed per meeting) captured a range of different clinical patient profiles and minimised the risk of omitting a significant atypical subgroup (DePaulo, 2000). This yielded a spectrum of observations that illustrated how different practitioners working under different conditions responded to a range of different decision making demands posed by different clinical questions.

6.2.2 Observation and interview data collection

Data collection using non-participant observations and post-observation interviews took place at the participants' normal places of work (NHS hospital sites). Details of ethical and governance compliance were provided in thesis Section 3.6.

6.2.2.1 Non-participant observation

Observations were used to collect data about diagnostic mammography decision making events in real- time as they occurred. Participants' decision making behaviours and practices were observed by shadowing them as they carried out their normal professional duties, which included mammography image interpretation and reporting in symptomatic (one-stop / rapid access) breast clinics and as they attended MDT meetings where they contributed professional opinion to clinical decisions about patient management and treatment.

The researcher adopted the role of 'observer as participant' (McNaughton Nicholls et al., 2014) being present in the clinical environment but detached from clinical care. In accordance with ethical permission the researcher did not interact directly with patients. The participants, their colleagues and patients were informed about the researcher's presence and purpose; as such any additional observations which occurred during the site visits but outside of specific clinic and MDT meeting data collection events, such as during tea and lunch breaks, were recorded at the researcher's discretion where considered directly relevant to the study. Although participants and patients had the opportunity to exclude the researcher from specific events if desired this did not happen during the study. On two occasions the researcher exercised professional discretion and withdrew from clinical examination rooms when patients were particularly distressed.

Observation data were recorded manually as hard copy (paper) field-notes. Audio recording of naturally occurring dialogue during the clinics and MDT meetings would have allowed return to the data in original form as often as needed rather than reducing the data to whatever was noted at the time (Silverman, 2013). This approach was not used because the events of interest (interpretation of mammograms, contributions to MDT discussion) occurred sporadically and there would have been multiple long data-poor periods in such recordings. In addition, observation data had to capture the non-verbal activities of participants whilst interpreting mammographic images, for example reading notes from image acquisition radiographers on examination request slips or looking at images or reports from a patient's previous attendance. The observation data also had to capture spatial information about the decision making environment – the layout and location of the interpretation and reporting rooms and the distribution of professional colleagues in clinic and in MDT meetings.

A formal verbal protocol ('think aloud') technique was not appropriate for capturing the (verbalised) thoughts and reasoning processes of participants during actual decision making events as they occurred because this data-driven approach was not in keeping with the study's theory driven methodology (Thompson, 2011). However, participants were asked to 'think aloud' when actually interpreting mammograms as this gave the researcher some indication of the concepts and strategies they used in the diagnostic reasoning process that were otherwise invisible (Prime and Le Masurier, 2000). A combination of concurrent 'think aloud' and observation allowed the novice qualitative researcher to explore the decision making processes of the participants retrospectively in the post-observation interviews to improve the accuracy and reliability of this data (Lundgrén-Laine and Salanterä, 2010).

Before embarking on the fieldwork a structured observation guide was designed using broad topic headings based on the three programme theories being explored. The observation guide was intended to capture key aspects of events and interactions and give structure and consistency to data collection between sites and participants; it contained space for the researcher to add notes, diagrams and other comments (McNaughton Nicholls et al., 2014). The guide had been considered a useful starting point for capturing contemporaneous data in view of the researcher's lack of experience conducting field observations. In reality it proved too difficult to use during actual observations because events happened too quickly. The pace of the participants' decision making was too fast to work out which section of the guide to record their activity in. An alternative approach, simply recording sequential events seen and heard freehand in a note book, alongside associated reflexive comments, was used instead.

The observation guide might have been more useful as a contemporaneous data recording tool if observations had been video or audio recorded rather than directly observed; this would have allowed the recordings to be stopped and started to allow time to make notes.

The reliability of the field-note data was enhanced using a combination of three strategies: a strict convention of recording what was seen as well as what was heard, expanding field-notes beyond immediate observations and adhering to a consistent theoretical orientation (Silverman, 2013).

Aitken and Mardegan (2000) compared the controlled conditions under which decision making is studied in laboratory experiments to the naturally occurring (clinical) environment. They highlighted the importance of capturing (non-verbal) data about field-based factors that have the potential to influence the phenomenon being studied. It was crucial to capture such contextual factors in this study because they helped to explain how and why particular decision making practices were triggered in specific participants with specific cases.

Field-notes included the following data:

- *patient cases* which described the diagnostic journeys of individual patients in terms of their clinical history and imaging examinations; these were important for exploring the influence of case complexity and practitioner experience on interpretation and reporting competence and confidence (expertise theory);
- *image interpretation events* which described how radiographers viewed, talked about and manipulated mammography images in order to reach a diagnosis; these helped to explain how cognitive and behavioural reasoning processes were influenced by ‘task work’ and ‘team work’ knowledge (expertise and team work theories);
- *image report transcripts* which summarised the terminology used to record image interpretation outcomes in patient records; these informed exploration of the relationship between confidence and autonomous practice (role innovation and team work theories);
- *boundary events* which included physical, as well as verbal, transfer of mammography images, and other pertinent information between successive radiographers in a patient’s ‘chain of diagnosis’; these were used to compare the influence of multiskilled specialisation on holistic and blended practice schemes of working (expertise and team work theories);
- *interactions* which detailed when and why participants talked to colleagues; these were primarily of interest in respect of the teamwork theory but also contributed to refining theories about expertise and role innovation;
- *diagrams* to indicate the spatial layout of the interpreting and reporting environment, MDT meeting room and location of professional groups in these spaces; this was important for testing the teamwork theory;
- *annotations* indicating which and how events juxtaposed the theories being tested.

The observation guide was used after the observation event as a contact summary sheet (after Miles & Huberman 1984, cited by Silverman, 2013) to record background information about who had been involved (participants and interacting colleagues), what decision making events were observed (numbers and types of symptomatic cases) and to record the characteristics of the participants and the physical environment.

The observation guide was useful as a preliminary coding tool for initiating data analysis. Illustrative raw data from fieldwork notebook entries were copied into the theory-based cells of the observation guide to identify the main themes / issues covered in each session and to plan for the type of data that needed to be captured in successive observation events. By doing this it was possible to identify which research hypotheses and theories each session helped to refine and where to place most energy next time (Miles & Huberman, 1984 cited by Silverman, 2013).

6.2.2.2 Post-observation interviews

The purpose of the Stage 3 interviews was to invite participants to discuss how the researcher's programme theories related to the practices that had been observed and strengthen the theoretical links between researcher ideas and participant evidence.

A blend of structured and unstructured interview approaches was used by employing the theory-driven 'teacher-learner' technique suggested by Pawson (1996). This technique acknowledges the division of expertise in theory formation because it brings together the complementary insights of the researcher and the participants (Nanninga and Glebbeek, 2011). It is rare to find accounts of implementing the full recursive teacher-learner cycle in published RE studies. This study illustrated its use in a complex practical intervention and thus adds to earlier published examples conducted in relatively limited practical contextual settings (Nanninga and Glebbeek, 2011).

The theory-driven interview located the researcher's theories in the interview subject matter and charged the informants (interview participants) with confirming, falsifying, modifying and refining the programme theories. In the 'teacher-learner' style interview the researcher adopted a more active role that had been used in the unstructured Stage 2 interviews and in comparison to a traditional semi-structured interview. The 'teacher-learner' style of questioning allowed the researcher to teach the informants about the overall conceptual structure of the investigation and describe the nature of the information sought (Pawson, 1996).

In the interviews, the ideas and assumptions contained in the programme theories were offered to the radiographer participants and they were invited to agree or disagree with the theories, locate themselves within or modify the conceptualisations of decision making behaviour and action as individuals and as team members. This was achieved using a structured interview topic guide based on three programme theories developed out of Stage 2 data analysis.

The three theories were presented to the participants as a series of ‘sub-theories’ expressed as short narrative questions (See Appendix). The questions were framed in an explanatory and narrative style to help the participants understand the theoretical conceptualisation of the CMO configurations and channel their responses towards how the theories applied to their individual situations and practices. In the question stems the ideas and assumptions of the theory were expressed in professional and lay language to help make the concepts clear to the participants to allow them to apply them to their own thinking and give useful answers (Pawson, 1996). Informants were encouraged to ‘talk about their world in the researcher’s language’ (Pawson, 1996). As the researcher-participant dyads engaged in shared dialogue they built the ‘mutual knowledge’ of the study (Pawson, 1996).

The post-observation interviews were conducted individually with each participating radiographer as soon as was practicable (where possible on the same day) after the practice observations had taken place to reduce recall bias, that is flawed recollection of historical events (Bowling, 2002). Illustrative observed cases that appeared to confirm or falsify the programme theories being tested were used as prompts to encourage participants to explore and elaborate on theoretical ideas. By prompting the participants to reflect and comment on events that had occurred during observations they were encouraged to offer their own explanations for decision making behaviours and practices in the context of, and as corrections to, researcher theories (Pawson, 1996).

Interviews were digitally audio-recorded as before but to allow the researcher to focus on data analysis and thesis preparation, the arduous and time consuming task of verbatim transcription (Atkinson, 1995) was performed by a clerical employee of the university under a confidentiality agreement. The researcher proof read the transcripts whilst listening to the original audio recordings to ensure all professional and technical terms were faithfully represented.

6.2.3 Data analysis – juxtaposing, reconciling and adjudicating evidence

The researcher was familiar with the data, having carried out all the observations and interviews personally, and had begun analysis by making contemporaneous analytical field-notes at the end of every day during data collection. Systematic data processing commenced on completion of field work and transcription.

First order analysis of the Stage 3 interview data was thematic. The data were open coded in NVivo® using a coding framework based on the interview topic guide - the coding categories matched to the sub-themes of the three programme theories being tested (Table 6.1). This method was used to summarise the data in each theme and explore, compare, contrast and identify atypical data across the participants and sites.

Table 6.1 Stage 3 data open coding categories

Programme theory	Coding categories
1. Expertise	1.1 Expertise takes time 1.2 Expert - intuitive and analytical - reasoning 1.3 Speed and accuracy
2. Community of practice	2.1 Teams and goals 2.2 Sharing and learning 2.3 Errors and accountability
3. Role innovation	3.1 radiographer / radiologists differences 3.2 radiographer accuracy 3.3 cost effective

Second order analysis (axial coding) of the data was undertaken using categorising and connecting strategies to explore similarity and contiguity (Maxwell, 2012). In this ‘realist evaluation’ study axial coding reduced the data to the programme theory hypotheses expressed as ‘CMO’ configurations. Where they elaborated the theoretical ideas being tested and appeared to strengthen the theoretical links between ideas and evidence, illustrative excerpts (selective coding) were extracted from the observation data and combined with the interview data.

Cross-participant (CP and AdvP) and cross-case (site) comparisons added depth and richness to the evaluation as they identified resemblances and commonalities that appeared independent (non-causal), and differentiation of these from (causal) relationships that appeared to be connected or associated (Maxwell, 2012). These informed refinement of the CMO configurations which underpinned the theoretical propositions (research hypotheses / programme theories) being tested (Pawson and Tilley, 1997).

The Stage 3 data were not considered in isolation from those collected in Stage 2 or from the evidence in the literature used to develop the initial programme theories in Stage 1. Throughout the study as data accumulated, programme theories were refined until they built a cogent and complete explanation of how radiographers became involved in symptomatic mammography image interpretation and reporting, why they operated as they did and what effects this had.

The final programme theories were expressed as context, mechanism, outcome configurations to explain 'what works, for whom, in what circumstances, and why?' in accordance with RE methodology (Pawson and Tilley, 1997). These programme theories identified radiographer's decision making processes (resources and reasoning), facilitators that supported effective decision making and factors which constrained or prevented it (contexts), and the resultant (outcome) effects.

6.3 Results

The Stage 3 results are presented below in four sections:

- case study site and participant characteristics (section 6.3.1)
- development and characteristics of expertise (section 6.3.2);
- social learning in a community of practice (section 6.3.3);
- role innovation (6.3.4).

Similar conventions for identifying participants and presenting interview data as described in Chapter 5 (see section 5.2.3.4) were again used in this chapter. Observation field-note data are identified using the convention [FN date of observation; case study site; anonymous patient case identifier], for example [FN 9.10.14; Site 3, #4] relates to a field-note made on 9th October 2014, at Site 3, about the 4th patient in the clinic or MDT meeting.

6.3.1 Participant and case study characteristics

<u>Participants</u>

All the radiographers who participated in Stage 2 of the study at Site 3 (n=3) and Site 8 (n=7) volunteered and participated in Stage 3. An additional (advanced practitioner) radiographer (G39) who had qualified in MIIR in the interim period was recruited at Site 3. The professional characteristics of these participants are summarised in Table 6.2.

A total of 16 individual interviews were conducted between October 2014 and November 2014. The average duration of the interviews was 89 minutes (range 45 - 130 minutes) giving a total of 1426 minutes (23.8 hours) of interview data for analysis.

Case study sites

Site 3 was part of a large NHS Trust that served a rural population of approx. 660,000. It provided combined screening and symptomatic services from a single site. Site 8 was an acute and community Trust serving a population of approx. 500,000 in a large inner city conurbation. It provided combined screening and symptomatic breast services for its own Trust (Site 8a) and similar services for a neighbouring general and community hospital Trust serving a further population of approx. 260,000 (Site 8b).

Each site delivered three rapid access symptomatic clinics per week and held a weekly symptomatic MDT meeting. The number of cancers detected in the symptomatic service at each site was approximately 300 (Site 3), 500 (Site 8a); 300 (Site 8b).

The study specific characteristics of the two sites, that is the models of care and the roles and responsibilities of the radiographers (participants) and radiologists in symptomatic MIIR are summarised in Table 6.3 .

In total 10 rapid access clinics (4 at Site 3, 4 at Site 8a and 2 at Site 8b) and 5 MDT meetings each of approximately 2 – 3 hours duration (2 at Site 3, 2 at Site 8a and 1 at Site 8b) were observed. This yielded field-note data covering a sample of 91 patients attending one-stop clinics and 104 patient cases presented at MDT meetings.

Table 6.2 Stage 3 participant characteristics

Study identifier	**Site**	**Professional characteristics**
G03 Experienced consultant radiographer	3	Multiskilled in breast imaging including some experiential learning in MRI image interpretation; involved in both screening and symptomatic MIIR; works full time; deputises for clinical lead radiologist in MDT meetings when absent.
G04 Experienced advanced practitioner	3	General ultrasound background; no mammography image acquisition or tissue sampling training or experience; involved in both screening and symptomatic MIIR, breast ultrasound and tissue sampling and clinical evaluation of the breast; works full time hours ‘term time’ only; attends diagnostic MDT meetings.
G05 Experienced advanced practitioner	3	Multiskilled in breast imaging; currently training in ultrasound tissue sampling; involved in both screening and symptomatic MIIR; works full time; attends diagnostic MDT meetings
G39 Experienced senior radiographer	3	Extensive experience of performing and teaching mammography image acquisition; ex-service manager; newly qualified in MIIIR; involved in screen reading; yet to start symptomatic MIIR. Works part time; does not regularly attend MDT meetings
G06 Advanced practitioner	8	Not multiskilled - mammography image acquisition and MIIR training and experience. Involved in screen reading; occasionally first reports symptomatic cases when consultant busy. Recently selected for breast ultrasound training.
G26 Experienced advanced practitioner	8	Mammography image acquisition, MIIR and mammography guided tissue sampling (stereo) competence. Involved in screen reading; occasionally first reports symptomatic cases when consultant busy.
G27 Experienced consultant radiographer	8	Multiskilled in breast imaging. Involved in both screening and symptomatic MIIR; works full time. Attends MDT.
G28 Experienced advanced practitioner	8	Mammography image acquisition and MIIR competence. Involved in screen reading; occasionally first reports symptomatic cases when consultant busy.
G29 Experienced consultant radiographer	8	Multiskilled in breast imaging. Involved in both screening and symptomatic MIIR; works full time. Attends MDT.
G30 Experienced consultant radiographer	8	Obstetric and gynaecology sonographer background; multiskilled in breast imaging. Involved in both screening and symptomatic MIIR; works full time. Attends MDT.
G31 Trainee consultant radiographer	8	Experienced and multiskilled in breast imaging; undertaking final (research) component of MSc. Involved in both screening and symptomatic MIIR; works full time. Attends MDT.

Table 6.3 Stage 3 case study site characteristics

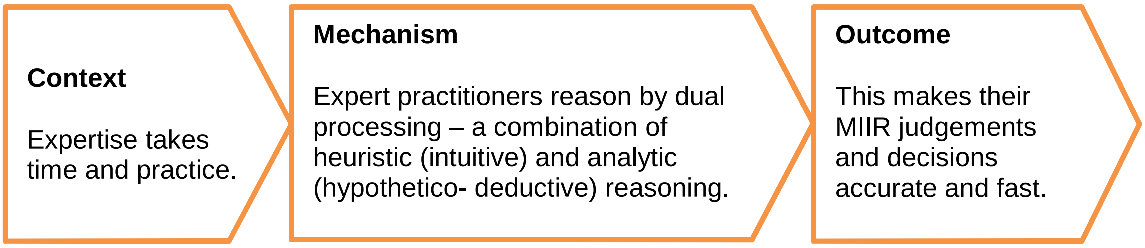
Site	Roles and responsibilities – imaging in one-stop clinic	Roles and responsibilities – MDT clinical decision making
Site 3 Blended model of care	Radiologists, advanced practitioners and a consultant radiographer work interchangeably. Working ‘in series’ as a team each one undertakes either MIIR or ultrasound and tissue sampling for all patients in any one clinic. Roles are rotated clinic by clinic. Mammogram images acquired by assistant radiographic practitioners and practitioner grade radiographers.	Clinical lead radiologist (CLR) presents the imaging cases; consultant radiographer assists with case information and discussion. Consultant radiographer deputises when CLR absent. Advanced practitioners attend first (diagnostic) part of MDT meetings but usually have alternative workload during second (therapeutic) part of MDT meeting. Participation ad hoc.
Site 8a Holistic model of care	Radiologists and consultant radiographers work in parallel. Each one undertakes MIIR and ultrasound and tissue sampling for an individual patient in clinic. Mammogram images acquired by assistant radiographic practitioners and practitioner grade radiographers. Advanced practitioners not involved in symptomatic MIIR.	Cases presented by surgeons. Clinical lead radiologist (CLR) reviews imaging; comments ad hoc. Consultant and advanced practitioner radiographer attend first (diagnostic) part of MDT meetings. Occasional participation - ad hoc.
Site 8b Holistic model of care	Single radiologist or consultant radiographer usually undertakes MIIR and ultrasound and tissue sampling for each patient in clinic. Mammogram images acquired by assistant radiographic practitioners and practitioner grade radiographers. Advanced practitioners undertake provisional MIIR if clinic is busy; consultant checks and verifies / amends this.	CLR presents the imaging cases; consultant radiographer assists with case information. Alternative radiologist deputises when CLR absent. Advanced practitioners attend first (diagnostic) part of MDT meetings. Participation rare.

6.3.2 Development and characteristics of expertise

The first programme theory tested in Stage 3 of the study hypothesised that ‘expertise’ was a resource which enabled radiographers to become involved in symptomatic MIIR because it changed their reasoning and decision making behaviour. In contrast to the slow and deliberate reasoning of novices, the theory hypothesised that experts developed the ability to reason with greater accuracy and speed. This programme theory was based on the substantive theories of 'deliberate practice' (Ericsson, 2004a), 'fast and frugal heuristics' (Gigerenzer, 2004) and 'dual processing' (Kahneman, 2011).

The programme theory hypothesis is summarised in Figure 6.1 in terms of a RE context, mechanism, outcome (CMO) configuration.

Figure 6.1 Programme theory 1 – expertise



The data analysis presented below explained how the path to 'expertise' for the radiographers in this study was an extended learning journey of informal and formal instruction followed by continued practice (repetition), feedback and reflection. The Stage 3 data added further insight about how intuitive and analytical reasoning strategies were used by 'expert' radiographers involved in symptomatic MIIR and revealed that improved diagnostic speed in experts seemed to occur because they became more confident, rather than more intuitive, decision makers.

6.3.2.1 Instruction, repetition and feedback

All the radiographers participating in Stage 3 who were trusted to interpret and report symptomatic mammograms independently had undertaken an initial external (university) training programme in MIIR which incorporated instruction, individual supervision and feedback on performance. Although this did not confer 'expertise', it was considered a benchmark of competence in newly 'qualified' MIIR radiographers. The following data extracts illustrated how successful completion of the training programme was a marker for 'fitness to practice':

> *…it's like 'oh you've passed now, get on with it' … you rely heavily on the training courses, and if (newcomers) have got any experience elsewhere, but mostly I suppose that they've trained on an acknowledged training course. [Site 3 G03 CP]*

> *They accepted the training that I'd had through the university image interpretation course… (Interviewer: So as soon as you got your qualification you were flying solo?) Yeah. [Site 3 G04 AdvP]*

> *The training that radiographers have is better (than radiologists) in terms of, I think perhaps more focussed and you're assessed more stringently [Site 8 G06 AdvP]*

Although MIIR training courses are typically of less than a year's duration (London South Bank University, 2015; Universty of Leeds, 2013) most of the participants explained that they already had several years' experience in breast imaging at the start of their formal MIIR training because they were trained and experienced in mammography image acquisition. The following interview extracts illustrated how this provided them with informal opportunities to learn to recognise some common and typical normal and abnormal mammographic appearances:

> *I think looking at mammograms probably for a few years, albeit not writing a report, but looking at mammograms …(you) do a lot of pattern recognition without realising… we've got all the years behind us of taking mammograms and looking at mammograms. [Site 8 G29 CP]*

> *Sometimes when you're positioning you might feel something… it's mostly when you do the further views, paddle views… on clinical examination then you see something on the monitor in the room or on the monitor in the viewing room and you follow it to ultrasound and see if what you thought is the same thing. [Site 8 G28 AdvP]*

These examples illustrated how 'exemplar' pattern recognition memories for common and classic abnormalities were laid down by viewing large volumes of images. As described in the second example above, analytic reasoning skill was developed by correlating mammography image appearances with a patient's clinical history, physical examination findings and the results of other imaging tests.

Examples of these opportunities for learning recorded in observation field-notes at both study sites triangulated the radiographers' interview data. For example participants pointed out areas of concern on mammograms to image acquisition radiographer colleagues when they:

- asked them to perform 'extra views' - *'I showed her where I wanted the extra views'* [FN 9.10.14: Site 3, #4];
- directed (x-ray guided / stereotactic) interventional procedures – '*that bit there' (points to image on screen) 'can you get 47 back and 17 lateral…it's a bit iffy to target – go for this bit (demonstrates with cursor)* [FN 7.11.14: Site 8b, #1]
- asked them to chaperone patients in ultrasound examinations – *'asks who did mammogram and asks her to take patient into ultrasound room…explaining images to medical student and radiographer'* [FN 4.11.14: Site 8a, #2].

The study sample included one atypical participant who did not have any prior experience of mammography image acquisition but had moved into dedicated breast imaging practice from a role as a qualified and experience ultrasound practitioner (sonographer). This participant explained how she was already competent at report writing and confident about autonomous decision making when she embarked on her MIIR training because interpretation and reporting had been integral components of ultrasound imaging examinations:

> *I had experience of independent reporting in ultrasound so I'd got that in terms of the responsibility side of things… but (MIIR) was an additional… skill, if you like, it wasn't something completely new, as a sonographer, you do have responsibility for interpreting – not only doing the examination – but interpreting the examination so I was comfortable with it. [Site 3 G04 AdvP]*

This data extract illustrated that some of her technical (report writing) expertise was generic and transferable. Her use of the word 'comfortable' seemed to indicate that her previous experience allayed anxiety about independent (autonomous) practice. She flagged up her need for supplementary 'task work' - technical (radiography) and clinical (breast disease) - interpretive knowledge and skill development.

The following study data confirmed that exemplar pattern recognition memory stores developed because trainees were exposed to large volumes of real-life cases (repetition) at university and in the workplace during formal training. This next example explained how this resource triggered intuitive 'automatic' pattern recognition reasoning processes:

> *It's repetition isn't it really I suppose, it's pattern recognition, and the more times you see something the more you start to recognise and it just becomes an automatic change in your brain really. [Site 3, G39 newly qualified MIIR radiographer]*

In addition to intuitive pattern recognition the following evidence illustrated how participants developed deductive and analytic reasoning skills by engaging in discussion with more experienced colleagues whilst training:

> *I used to sit alongside the radiologists... they would put the images up and ask me to just give an 'R' (index of suspicion) value within sort of, seconds of seeing the film, so I'd go 'R3 (indeterminate), R2 (benign),' or whatever, and then we would talk about well why? And 'what is it you're seeing?' and we would look at the mammography report, we'd look at the ultrasound, we'd look at the pathology. So I had everything there…I sat, week after week after week doing that [Site 3 G04 AdvP]*

> *When I was learning, when I was doing the image interpretation I was working in a clinic with my mentor so we'd look at the mammograms together [Site 8 G31 trainee CP]*

The first extract above seemed to imply that learning opportunities occurred informally during training as well as within formal mentor-mentee relationships (second extract). Informal situated learning is discussed in more detail in section 6.3.3 of the Stage 3 results.

Although a formal ‘qualification’ appeared to be accepted as confirmation that radiographers could ‘do the job’, radiographers who were newly qualified in MIIR were treated as novices and did not work unsupervised in symptomatic clinics. The evidence presented below, from a newly qualified MIIR radiographer and from an experienced CP radiographer involved in training colleagues, supported the idea that training was just the first step on a learning journey that led to successful involvement:

> *I’m just at the very start... I am really working on my confidence. I think you have to be confident in your convictions… from the symptomatic side I’ll probably sit for quite some time with somebody else over my shoulder and then I think they’ll gradually move back [Site 3 G39 novice MIIR practitioner]*

> *To start with some of them can be very unsure … there are obvious things they’ll pick up… obvious classic cancers, but some of the more subtle ones they may be unsure about; but as time goes on, the more experience they get, looking at things…I think their decision making probably is a bit slow, because they need more time to consider what they’re actually looking at and what they’re actually seeing. [Site 8 G27 CP]*

This evidence demonstrated that training itself was not sufficient to confer ‘expertise’ or autonomous practice; this data highlighted the importance of developing ‘confidence’ as well as competence on the journey to independent practice. The last quotation suggested also that decision ‘speed’ depended on both intuitive cognition - recognising and classifying abnormalities, and on decision confidence. The novice MIIR practitioner participant went on to explain how she might improve her decision speed by being more decisive, an attribute she considered present in her more experienced colleagues:

> *I’m going to try and say, “No, I think that that’s a fibroadenoma,” for example, or that’s a cyst and be very confident in my decision making skills…I suppose that comes with experience …the more experienced you are the more confident you are… because (the more experienced radiographers) have seen more and done more I think they’re more confident in saying what they think. [Site 3 G39 newly qualified MIIR practitioner]*

This evidence strengthened the hypothesis that there was a causal relationship between additional experience – seeing and doing more, and confidence.

When asked to describe the characteristics that made them, or their colleagues ‘experts’ in MIIR, the participants in this study suggested it was being able to interpret and report difficult cases, being good at detecting small, subtle abnormalities and being able to recognise rare and unusual pathology. As illustrated in the following evidence, where the first participant is describing a colleague and the second describing herself, the ability to detect small cancers was considered one of the key characteristics of expertise in symptomatic MIIR:

> *'having an eye'… it's the cancers that she detects.. .the small cancers that she detects [Site 3 G05 AdvP]*

> *I've been given feedback here and there that I've detected very small cancers [Site 8 G28 AdvP]*

This second quotation highlighted the resource of 'feedback'. It had been hypothesised that in addition to encountering a large number of cases and seeing an extensive volume of images over time, experienced practitioners would be able to interpret and report a wide range of mammographic appearances accurately because they had calibrated their decision making by seeking and obtaining feedback on their performance. As discovered in Stage 2 of the study, lack of systematic routine audit in symptomatic services locally and nationally (Britton et al., 2012) made it difficult for radiographers to get balance and timely feedback on symptomatic performance. The following Stage 3 data illustrated how this limitation was overcome.

Both case study sites used in Stage 3 of the study had co-located screening and symptomatic services and all participants were involved in combined practice, that is they 'read' mammography images in the NHSBSP, deciding whether to recall women for assessment or return to routine 3-yearly screening, as well as interpreting and reporting cases by providing a differential diagnosis and clinical management recommendations, in the symptomatic service. The following participant data explained how feedback from the NHSBSP's national quality assurance monitoring process and participation in NHSBSP 'interval cancer' review and PERFORMS – the nationally organised individual performance test of difficult cases, helped them to learn to detect small and / or subtle cancers and interpret difficult and unusual appearances - characteristics they had previously associated with 'expertise':

> *The interval cancers, they're extremely good to look back at to see… because we're always learning… you need to keep looking at them and keep developing from them really. [Site 3 G39 novice MIIR practitioner]*

> *We look at interval cases, any patient that's come in between their screens … we all have to stand there and say 'can you see anything?' …that is a great way of learning… the interval cancers (are) always a very good learning curve, because you see what people have missed. [Site 8 G29 CP]*

These two quotations illustrated that feedback was a learning resource and that learning was perpetual across the entire spectrum of experience from newly qualified novice to experienced consultant practitioner.

A third quotation below described how feedback over time developed confidence and thus decision speed:

> *If you do PERFORMS… you know what you've missed … QA feedback might increase your confidence or decrease your confidence depending on the results but generally we get quicker and more confident as the years go by. [Site 8 G28 AdvP]*

The evidence presented above supported the hypothesis that case review helps radiographers develop insight and learn from mistakes. The Stage 3 data revealed that mistakes occurring in symptomatic cases were brought to the attention of both the original practitioner, and shared with colleagues, when they were discovered. The following data illustrated how beyond this participants were also interested to find out when they 'got it right':

> *With symptomatic it's down to the individual to see how you're doing, by going to the MDTs and relying on feedback from your colleagues. [Site 3 G04 AdvP]*

> *You need to sort of reflect on them, you need to look at your MDT results; you need to reflect on what you've done, and follow things through. [Site 8 G30 CP]*

> *It's interesting to find out finally what the results are... I've made the decision, I remember them, I know I've done it and it's interesting for me to see, post-op, whether it was positive or negative. [Site 3 G03 CP]*

> *If you were unsure, you would then follow it up … if it was a difficult case or something like that I might get (a colleague) to check… it's supportive and there's feedback, the more you are discussing the more you are learning [Site 8 G31 trainee CP]*

These data illustrated that in the absence of formal feedback processes (audit) radiographers were motivated to actively seek out feedback by informal means to help improve their MIIR practice. Again across the spectrum of practitioner experience the evidence demonstrated that radiographers followed up cases at MDT meetings, tracked interesting, unusual or difficult cases through ultrasound, biopsy and surgical stages of the patient pathway and obtained informal feedback from colleagues when they sought informal second opinions about cases they were unsure of.

6.3.2.2 Intuitive and analytic reasoning

It was hypothesised that expertise would result in increased decision speed because of a propensity for fast heuristic (intuitive) reasoning, experts would recognise abnormalities quickly because they had ‘seen it before’ or because it was ‘a classic case’ (Elstein, 2009; Gigerenzer, 2007). Expert reasoning was contrasted with the slow analytic (hypothetico-deductive) reasoning theory of formulating a hypothesis ‘this could be X or it might be Y’ followed by deliberate sequential gathering of evidence to support or refute each possibility, claimed to be a characteristic of novices (Elstein et al., 1978).

In contrast to the programme theory hypothesis during the study observations all radiographers, irrespective of their experience, and thus ‘expertise’, appeared to use a combination of intuitive and analytic reasoning for all cases. The evidence presented below demonstrated how this aligned with, and developed further the ‘thinking fast and slow’ reasoning described in Kahneman’s (2011) dual processing theory.

It had been anticipated that ‘experts’ might resort to slow analytic reasoning for difficult cases but time after time all the radiographers observed in the field seemed to take an initial quick ‘global look’ at the mammogram images (thinking fast) and then engage in a systematic and analytical (thinking slow) process that had two further phases.

Participants explained how they ‘recognised’ and diagnosed obvious abnormalities confidently during the initial ‘global look’, as in the following example:

> *If it was a spiculate lesion then I know ….if it’s a well-defined lesion then I’m very confident that it’s going to be a benign lesion in a relatively young person, and multiple round lesions it’s going to be bi-lateral cysts. So yes, there are things that you recognise [Site 3 G04 AdvP]*

This example included several characteristics that made cases ‘easy’ that were consistent with the substantive theories of intuitive cognitive processing. Common pathology such as cysts activated the recognition heuristic – they were accurately identified because they exhibited classic ‘text-book’ appearances (Goldstein and Gigerenzer, 2002); pathologies encountered frequently activated the availability heuristic because they matched recently encountered exemplars (Elstein and Schwartz, 2002); and appearances such as spiculation triggered representative bias because the majority of cancers exhibit this feature (Bordage, 2007).

This data demonstrated how certain types of lesion triggered intuitive, rather than analytical reasoning, and thus increased the speed with which cases were interpreted – archetypal ‘pattern recognition’ theory in action.

Although participants explained that they were able to recognise intuitively (the patterns of) some pathologies easily and almost instantly, their image interpretation processes did not rest solely on recognising visual patterns in the mammographic images. As in the last example above, when the participant referred to a ‘young person’, the participants also analysed if the visual appearances ‘fitted’ with the patient’s clinical presentation before reaching a diagnosis.

The following two interview responses, when participants were asked to describe what constituted an ‘easy’ case, illustrated further how the MIIR reasoning process included analytical as well as intuitive reasoning:

> *An easy case is an obvious cancer in one breast, that correlates with what can be felt, that is where you expect to find it on ultrasound, you biopsy it and that’s what it comes back as. [Site 8 G27 CP]*

> *If they’ve got very low density fatty breasts and they’ve got previous (mammographic images), which are digital and on the system, straightaway, you know…you’ve got all four images, you can see there’s nothing glaring at you and then you can quickly whizz through … that’s probably the quickest … when you’ve got the previous and you’ve got a fatty breast.[Site 8 G31 trainee CP]*

In the first example intuitive pattern recognition reasoning was combined with analysis of these appearances in the context of the clinical presentation and in the context of information from other tests. In the second example intuitive pattern recognition was combined with analysis of historical records – a case was relatively ‘easy’ because an abnormal area looks ‘obviously’ different, with higher radiographic contrast compared to surrounding ‘fatty’ breast tissue or a new abnormal area is not present on a previous examination.

For all cases, after the global look radiographers made an over-riding concerted and deliberate effort to reinforce their initial judgements before reaching a conclusive decision about the nature of the mammography image appearances. Following a global look at all four routine mammographic projections the participants were observed to undertake a careful, systematic and sequential interrogation of all the images during which they slowly double checked standard size and magnified images to make sure there was no (unsuspected) additional incidental disease and compared the patient’s current images with any prior (historical) mammograms. This observation was described and explained in the following interview extract:

> *There’s no obvious lesion – you look and you go ‘there’s nothing there’… you examine them in a much more analytical way as well; your first impression is that there’s nothing obvious in that breast, you would then examine them on a much closer level which is a much more analytical way of doing it, to confirm what you’ve initially thought, and sometimes what you initially thought, when you do it in a more analytical way, it disproves what you initially thought [Site 8 G27 CP]*

As illustrated in this quotation, the second analytical ‘search-to-find’ strategy appeared to be a cross-check of the ‘intuitive’ diagnostic conclusion - the ‘system 2’ monitoring function described by Kahneman (2011).

Following the careful systematic interrogation of the images the radiographers finally carefully considered the extent to which their judgements about image appearances correlated with clinical information and the findings of a physical examination performed earlier in the patient pathway. The ‘thinking slow’ analytic nature of expert reasoning in this study was illustrated in the following extracts from the interviews of two experienced consultant practitioner participants:

> *You take other things into consideration... other factors about the patient and their symptoms, wider things, rather than just being narrow focused on just what you see on imaging. You might take into account their clinical history, their symptoms, something you actually see when you see the patient, or something they tell you. When it comes to making decisions there are certainly other things that you have to take into consideration. [Site 8 G27 CP]*

> *I feel with symptomatic services it’s a more, sort of, all round service, so you need to make sure - that person has come with a problem, so they want an answer, what their lump is, or why they’ve got breast pain? So you do spend longer on the mammograms I think. [Site 8, G29 CP]*

This last quotation demonstrated how slow, analytical reasoning enabled radiographers to answer the clinical question and explain how the image appearances correlated with the signs and symptoms which prompted the patient’s presentation to the clinic.

Radiographers described cases they considered inherently difficult and that as a result took longer to interpret and report irrespective of their experience. Examples recorded in field-notes [FN] and given in interviews (verbatim participant speech shown in inverted commas) evidenced that this occurred where:

- mammographic appearances were equivocal, for example when there was indeterminate calcification – *‘calcification better demonstrated on CC’; reviews prior mages; uses magnification facility…‘mmm.. there has been a change; I will ultrasound to this see if it’s a cyst’; no cyst – proceeds to obtain tissue sample* [FN 5.11.14:8a, #9 – G29 CP];
- when the mammogram demonstrated a subtle asymmetric density or architectural distortion – *‘can you do compression views? Has she had any previous?’... reviews compression and magnification views … ‘this doesn’t look quite normal so we’ll have to take a sample’* [FN 7.11.14:8b, #7 – G27 CP];
- when the patient had dense breasts

  ‘*dense breasts always need more attention’* [Site 3 G05 AdvP];

- when it was the patient's first attendance and there were no previous images for comparison – *'this is tricky, have we got previous? No, that's a shame', reports 'bilateral masses, well defined but obscured borders (M3 - indeterminate) – need to scan both sides'* [FN 3.11.14: 8a, #5 – G 30 CP];
- when the appearances were unusual because of:
    - previous surgery:

      '*difficult… we're looking for subtle differences …after surgery.. you are looking for subtle things'* [Site 3 G04 AdvP];
    - co-morbidity:

      'obscure disease, medical history other than breast related and I'm seeing something that's unusual, but can't quite categorize' [Site 3 G05 AdvP];
    - non-breast (systemic) disease:

      '*very dystrophic coarse, weird calcification, that was some immune system thing, it was just very strange'* [Site 3 G03 CP].

In contrast to substantive and programme theories that novices might find cases more difficult than experts, these data suggested that whether a case was intuitive, quick and easy to interpret or whether a case was more difficult was also determined by intrinsic features of the case itself - the anatomy of the breasts and the potential pathological features demonstrated on the image, and that some cases were difficult because their clinical presentation was complex. During the observations radiographers interpreting difficult cases needed both an extended initial 'global look' and took more time for the subsequent analytical phases of the reasoning process.

When incorporating the patient's clinical history into their image interpretation decision making process, two different approaches were observed and explored in the post-observation interviews. The approaches appeared to be site specific. These data extracts, firstly from the newly qualified Site 3 radiographer and secondly from her more experienced AdvP colleague, illustrated how they tended to perform their initial quick global look 'blind' and then consult the clinical history, before performing their slow double check paying particular attention to the 'symptomatic' area:

> *I have a look at the images first, and I think that's what a lot of my senior colleagues do as well, I tend to look at the images first just to have a quick once over to see if there's anything that particularly stands out or indicates that it needs further looking into…and then I would look at the request card to look at the clinical history and then go back to the image and marry the two together, I think that's how my brain works. [Site 3 G39 novice MIIR radiographer]*

> *I find that if you look at a request form first, in the way 'is there a cyst? Oh yeah, there's a cyst there' and maybe my satisfaction of search will stop there, because I'm answering the question. And there's lots of incidences of someone coming with… breast pain for a mammogram, and the breast pain's on the right and there's a little cancer on the left of this and calcifications, so that's why… [Site 3 G05 AdvP]*

Conversely at Site 8 the radiographers tended to read the clinical history first then perform the global look and two-stage 'slow check'. These examples illustrated the different approach, with the second one illustrating how the 'satisfaction of search' error was addressed:

> *I see the clinical indication – that's what I'm looking for, that way without even realising your mind is geared to what it is possibly. If somebody just comes with lump or pain, you know usually if it's just pain - M1 (normal), or a mobile lump automatically you think may be a fibroadenoma… the clinical history gives you an indication because if somebody is saying P3 (indeterminate) or P5 (highly suspicious) automatically my mind thinks it might be a cancer. [Site 8 G28 AdvP].*

> *I'm very cautious that you don't focus just on the bit that the request card mentions, be it the outer quadrant, that is something I've put to one side of my mind, then I do my systematic check and then I go back and look specifically at that area. So it's a bit like if I spot something… I make a note, put it in one part of my mind, do the systematic check, then go back over that one specific bit again. [Site 8 G31 trainee CP].*

These data demonstrated the radiographers were aware that reading the clinical history at different times in relation to viewing the images could affect their diagnostic accuracy. When presented with the conflicting arguments for each approach by the interviewer the participants maintained that individual practice was a matter of personal choice. Although a tendency for consistent practice across a Site was evident, radiographers coming into departments from elsewhere were allowed to retain different practices.

None of the participants considered that clinical history 'ordering effects' impaired the overall diagnostic accuracy of the service. The adoption of dual processing, a fast global look followed by a two-stage slow double check to correlate mammographic appearances with clinical history, by all radiographers for all cases, might explain this.

6.3.2.3 Confidence

As their ability to detect mammographic abnormalities and diagnose breast pathology had improved through training, repetition and feedback, radiographers believed they could make interpretive judgements and diagnostic decisions more quickly not only because they had learned to (intuitively) recognise a greater range of abnormal appearances and pathology, but because they had become more confident decision makers. This was illustrated by the following participant, a trainee consultant practitioner when she talked about watching her more experienced colleagues:

> *There's times when … they're very quick to move on and dismiss things, whereas I might have gone a little bit slower. [Site 8 G31 trainee CP]*

This effect seemed to manifest for both 'normal' cases and 'difficult' cases, and as suggested in the above quotation, appeared to be due to confidence in using decision 'stopping rules'. The experienced CP radiographer at Site 3 evidenced two further explanatory examples in her interview:

> *You get confident …thinking 'well no, that's nothing, that's fine rather than picking out things saying 'what's that, and what's that and what's that' … with experience you realise that it's just glandular tissue and it's the way that the breast has been positioned [Site 3 G03 CP]*

> *Diffuse changes can be difficult because you're not sure if there's something else going on in the breast…you think 'well I don't really know what's going on there' but you would be able to describe it and say that 'further evaluation is needed'…in terms of my confidence to describe things I am happy to do that. [Site 3 G03 CP]*

The second example above illustrated that even though the most experienced radiographers couldn't always reach a conclusive diagnosis (named pathology) from image interpretation alone they could still make 'safe' decisions confidently. Where they could not offer a conclusive or differential diagnosis, expertise appeared to be associated with the confidence to issue a descriptive report and an indication that the presence of cancer could not be excluded without additional tests.

When discussing the relationship between experience and confidence the participants explained that even the most experienced practitioners still needed to ask colleagues for help sometimes, as in the following quotation:

> *I have got more experience than some of the radiologists here so I'm comfortable with it, if I wasn't sure what I was doing I'm still not afraid to ask for help. I think I am confident in my own practice, there are some little grey areas… but I've got a lot of experience to back it up. I've achieved a level of confidence, but I'm not super-confident and I don't expect to get any more confident than I am, because...it's okay to ask for help because there's always a room to learn. [Site 8 G26 AdvP]*

This quotation suggested that seeking help from others was a resource for sharing knowledge and skill and that perhaps another characteristic of expertise might be self-awareness. This is similar to the substantive theory of meta-cognition – knowledge of how well you are performing, when you are likely to be making an accurate judgement and when you are likely to be making a mistake (Kruger and Dunning, 1999).

The above quotation confirmed that some radiographers involved in symptomatic MIIR now had more experience than radiologists. In the following quotation one of the CP radiographers at Site 8 explained how a historical shortage of radiologists had triggered radiographer involvement in MIIR:

> *There was a time when there were hardly any radiologists, and we had to step up, and if anything the service improved, it didn't get worse. [G30 Site 8 CP]*

This example suggested that MDT colleagues might learn to trust and respect the work of radiographers involved in symptomatic MIIR and accept them in substitution roles, not only because they can prevent services coming to a halt but also because they can improve services.

The study data contained further examples that the radiographers were recognised and acknowledged as 'expert' practitioners. The following example illustrated a radiologist peer-learning from a radiographer. When asked if she had any particular knowledge or skill strengths that might prompt colleagues to seek her out for a second opinion, the trainee CP cited an example concerning a junior radiologist:

> *On an image interpretation basis… (colleagues) do ask, the (junior radiologist) asked me yesterday to look at something with her, some calcification… people will ask me. [G31 Site 8 trainee CP]*

Recognition of expertise from medical colleagues appeared to an indicator of esteem for the radiographers in this study. The following quotation demonstrated how it underpinned their confidence and autonomy in decision making:

> *I am running the clinics and I do feel confident giving my opinion, and the surgeons do come round to ask your opinion rather than just walk past and go and find a radiologist, because they know… because every case, you know we have an MDT every week, and the cases are discussed, and they are there to see who's reported on it, so the referrers are aware of, how good you are even though it's not audited [Site 3 G03 CP].*

The acceptance of radiographers into inter-professional and multi-disciplinary teams is discussed in more depth in Section 6.3.3.

6.3.2.4 Summary – programme theory 1

The Stage 3 data suggested that the development of expertise in symptomatic MIIR for the radiographers in this study was a learning journey. Progression along the learning journey triggered the development of automatic intuitive and analytic reasoning and thus 'dual processing' over an increasing range of cases (competence); progression along the learning journey also triggered increased confidence which improved decision making speed – this new programme theory is summarised in Table 6.4.

The evidence about instruction, feedback and repetition were consistent with the substantive theory of Ericsson (2004b), that ‘deliberate practice’ led to the development of expertise.

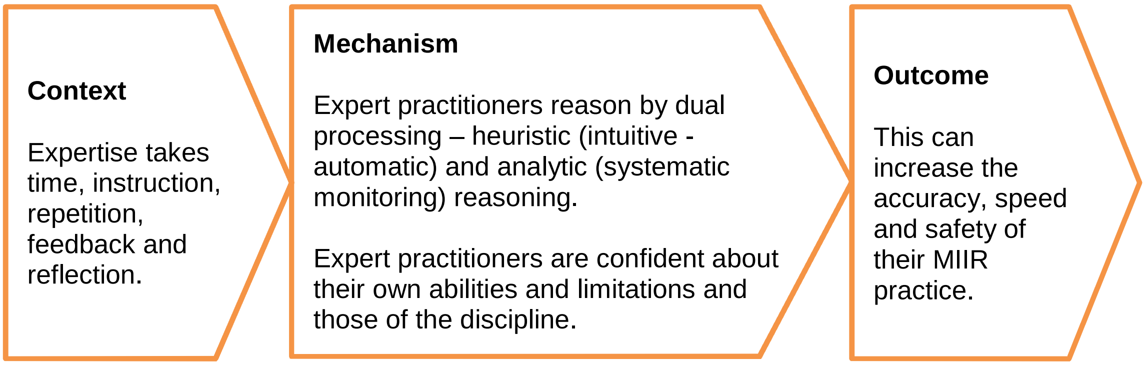
The finding that expert radiographers could successfully make routine daily diagnostic decisions and deal with atypical cases aligned with Raufaste et al.’s (1998) definition of a ‘super’ expert - the ‘highly skilled performer’ who uses a complex variety of patient data (tests / clinical info) and is a ‘world class reflective practitioner’.

Table 6.4 the learning journey to expertise

	Pre-training **Image acquisition role**	**MIIR course** **Trainee Novice**	**Post training** **Development of expertise**
Learning stage **Duration**	Awareness 0 – 3 years	Formal training 1 year Preceptorship 6 months	Continued experience - reflective practice 5 – 10 years
Pattern recognition development **Intuitive reasoning**	Look at images acquired Direction for extra views Assist at biopsies Chaperone in ultrasound	Instruction - exemplar cases	Repetition NHSBSP PERFORMS and interval cancer review
Analytical reasoning development	Knowledge of clinical domain	Balanced feedback Discussion with mentor Observe MDT case discussion	Feedback on mistakes Follow up cases at MDT discussion Discussion with colleagues
Competence **- automatic identification and recognition**	Obvious abnormalities	Classic and common abnormalities	Small, subtle, incidental abnormalities Rare and unusual pathology Difficult cases
Confidence **in decision making**	Anxious Uncertain	Hesitant Slow	Confident Fast – stopping rules recognise limitations of self and discipline

In addition to confirming that the judgements and diagnostic decisions of radiographers might become faster over time because their pattern recognition memory banks became more comprehensive, critical analysis of the data from Stage 3 of this study revealed that analytical reasoning was an inherent component of all symptomatic MIIR decisions. The study revealed that becoming more confident about decision making had greater potential influence on improving radiographer decision speed. Confidence in recognising their own (cognitive) limitations and those of their discipline (technical limitations of mammography) and confidence to consult colleagues without fear of recrimination seemed to enable radiographers to make safe decisions when interpreting and reporting symptomatic mammograms in routine clinical practice. The revised programme theory is illustrated in Figure 6.2.

Figure 6.2 Revised progamme theory 1 - expertise



6.3.3 Social learning in a community of practice

This section of the Stage 3 results presents a critical argument that radiographers were enabled to become involved in symptomatic MIIR because they worked within a ‘community of practice’ (CoP). It was hypothesised that the CoP provided a social learning environment within which radiographers:

- improved their knowledge and skills;
- shared responsibility for the diagnosis of breast disease with other radiographers, with radiologists and with other members of the multidisciplinary breast care team.

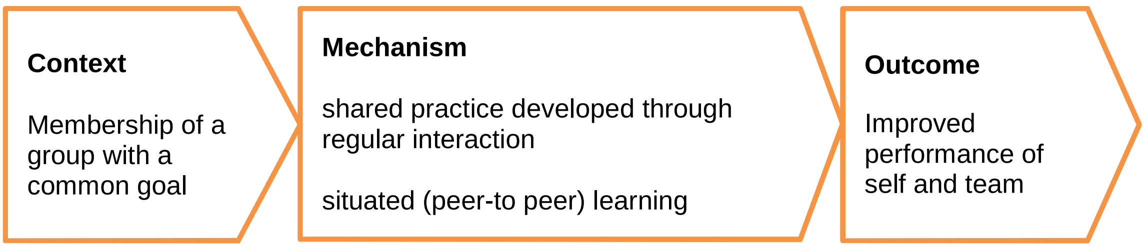
The ‘community of practice’ social learning theory developed by Lave and Wenger (Wenger, 1998; Lave and Wenger, 1991; Lave, 1988) was used as a theoretical lens in this stage of the study because it appeared to explain the way in which participants in Stage 2 of the study had described collaborating with team colleagues to interpret and report mammograms and contribute to clinical decision making in the symptomatic service. Programme theory 2 suggested that radiographer performance, and overall performance of the teams that they worked in, improved because the team members with different professional competences (knowledge and skills) interacted regularly to create and share knowledge across traditional hierarchical and organisational boundaries in pursuit of a common goal.

The following sections present data analysis supporting the programme theories that MIIR is a shared practice (Section 6.3.3.1) and that the teams within which radiographers operated functioned as learning communities (Section 6.3.3.2). Section 6.3.3.3 explains how in real-life practitioners negotiated ownership and responsibility for their new practices because they were able to overcome formal organisational boundaries and control.

6.3.3.1 A shared practice

Wenger's definition of a CoP as a 'group of people who share a concern or passion for something they do and learn how to do it better as they interact regularly' (Wenger, no date) was used as programme theory 2. The hypothesis is illustrated in Figure 6.3 as a realist CMO configuration:

Figure 6.3 Community of practice programme theory



Participants were asked to describe the teams which they felt they belonged to and were then prompted to articulate what the 'shared concern or passion' of the team might be. When questioned about a 'common goal' the participants unanimously talked about diagnostic accuracy, as illustrated in the following quotations:

> *We're all here for the same aims, I think we're all here for the common purpose of making sure that all our ladies are seen with dignity and are given the right results. [G39 Site 3 AdvP]*

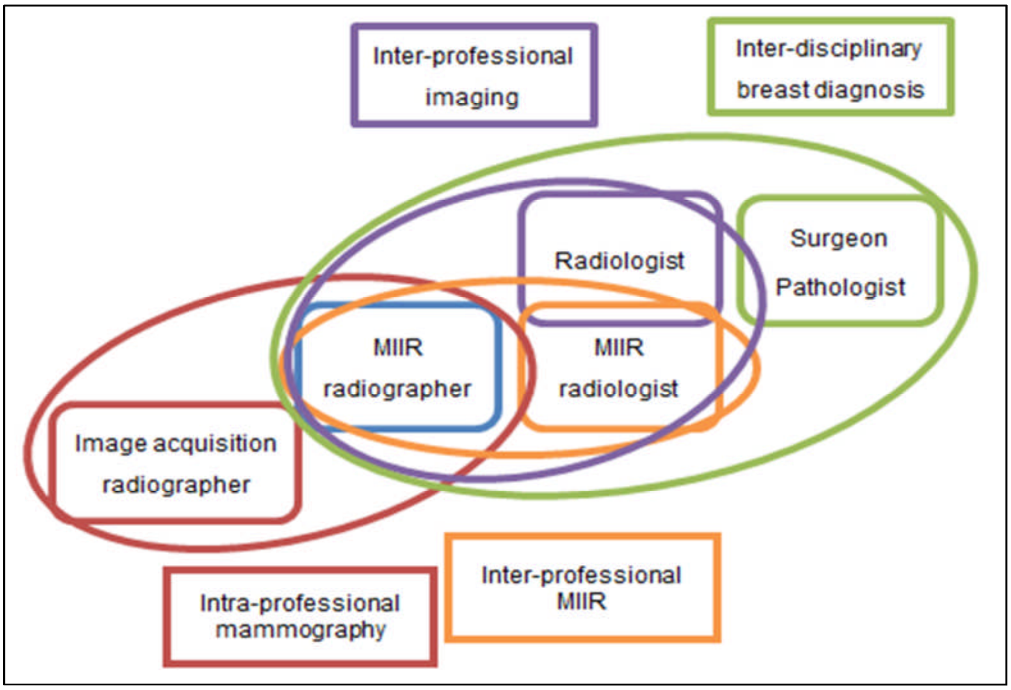
> *Your common goal is to diagnose all the breast cancers…you don't want to miss anything. In the end it's all about the best for the patient… the common goal is the patient, trying to have the best results… so diagnosing and not missing anything…we're all after the same thing. [G30 Site 8 CP]*

The empathic language used by participants in these quotes located patients at the heart of their practice and illustrated that their professional goals were patient-focussed.

The concept that the participants' diagnostic accuracy and confidence might be enhanced because they learned how to interpret and report mammograms better through interaction with team members was explored further. Several opportunities for situated (peer-to-peer) learning were identified in the interview and observation data. Within the 'complex landscape' (Wenger, 2010) of their (MIIR) practice situated leaning was a mechanism for transferring knowledge and skill within and across traditional professional boundaries. Situated learning enabled radiographers to continue to learn (and teach) outside of traditional hierarchical or formal academic relationships.

Figure 6.4 shows four learning communities (four colours) identified in the data and illustrates how they aligned with the composition of the different professional teams. The intra-professional community (red oval) included radiographers whose skill and knowledge was limited to image acquisition (red box) as well as those who had extended their skills and knowledge to encompass MIIR (blue box). The inter-professional MIIR community (orange oval) included only the radiographers and radiologists (orange box) who were involved in MIIR; the inter-professional imaging community (purple oval) including additional radiologists who had skills and knowledge which enabled them to undertake the more complex imaging techniques on other anatomical areas of the body (purple box). Radiographers involved in symptomatic MIIR were also members of an interdisciplinary community (green oval) that included all other healthcare professionals in the multidisciplinary breast care team (green box).

Figure 6.4 Professional learning communities



The data analysis presented next illustrated how knowledge was cascaded (vertically downwards), shared (horizontally) and sought (vertically upwards) within the different communities and what impact this had on the MIIR practices of radiographers.

This first interview extract demonstrated how radiographers involved in symptomatic MIIR cascaded their knowledge (vertically downwards) to image acquisition radiographers within the intra-professional mammography community of practice:

> *When there's something interesting I try and say 'look here – come and have a look at this' and explain what's there. Sometimes I'll try and get (image acquisition radiographers) to point things out to me to see if they've noticed things because before I was an Advanced Practitioner I was always interested in finding things, seeing if I could actually find the things that the radiologists were looking for, so I'll try and pull them in and see if I can get them to spot things. [G30 Site 8 CP]*

This example illustrated how radiographers encouraged image acquisition radiographers to learn informally about image interpretation. In Stage 2 of the study it was demonstrated that knowledge of image interpretation had the potential to improve the performance of image acquisition radiographers so that they produced images of better technical quality. Mammographic images of poor technical quality increase the risk of diagnostic misinterpretation and error (Rauscher et al., 2013; Taplin et al., 2002).

The next two data segments illustrated how situated peer-to-peer learning occurred because radiographers shared knowledge (horizontally) with other radiographers and radiologists in the inter-professional 'MIIR' community of practice. In the first example the CP radiographer at Site 3 explained how members of the intra- (radiographer) professional MIIR community could learn from each other because they had set up informal meetings to discuss what had happened to cases they had reported:

> *We've now got our own team of qualified film-readers, ordinarily everything involves the radiologists but I said 'we're a band of radiographers now'… there's going to be five of us, so 'let's do our own little thing'. We mostly use it for looking at images, mammography images... they will have possibly reported the images, brought them back, it's a good learning tool; they don't usually get to see the extra views that will obliterate the little thing they might have called. So we do that as part of our little team. [G03 Site 3 CP]*

Another example, this time taken from field-notes recorded during a clinic observation event at Site 8, gave a contrasting example – of 'on the job' learning within the inter- (radiographer - radiologist) professional team. The quotation was selected purposively to illustrate that peer-learning occurred in both directions across the traditional professional boundary, in this example a radiologist sought to share the knowledge of a radiographer:

Radiologist (registrar) comes to ask participant G29 (CP) to review some mammogram images. They appear to show two large cysts but the radiologist says 'I can see distortions (suspicious lesions) everywhere'. G29 asks radiologist to explain what and where she thinks she can see abnormalities using the open question 'OK what do you see?' The radiologist considers the images and eventually replies 'Oh no – I don't see anything?' G29 confirms that the images demonstrate only two benign cysts and asks if she is happy to aspirate them alone. Radiologist agrees and proceeds to report images adding that they have been double reported with (named) radiographer. [FN 5.11.14 Site 8a Case #10]

Although in the example above learning could be considered as hierarchical because the experienced CP radiographer had more MIIR knowledge and skill than the radiologist, one of the main findings of this study is the extent to which radiographers (and radiologists) seek out equivalent knowledge and skill in colleagues, (and share their own) by asking for (and giving) second opinions 'on the job' in real-time.

It had been assumed at the outset that radiographers who were qualified and experienced in MIIR would interpret and report mammograms autonomously, independently as single reader, in the symptomatic service. Stage 2 of the study revealed that it was not unusual for radiographers to consult colleagues about cases and sometimes report them 'together' on daily basis. Programme theory 1 explained how experienced MIIR radiographers had the confidence to recognise their own (cognitive) limitations and consult colleagues without fear of recrimination and as a result were able to make safe diagnostic decisions (see section 6.3.2). In addition to seeking knowledge (vertically upwards) from colleagues who could address their own knowledge deficits, it appeared that sharing knowledge horizontally was more about reassurance and confidence. The Stage 3 data clarified that this occurred commonly when cases were inherently 'difficult'. In the following example the most experienced CP participant described how she would seek out a colleague to help her reach a decision about a mammogram if she could not detect an abnormality even though the surgeon had palpated a lump that felt malignant:

Even though it's P5, if you couldn't see it you would get somebody else – get a double read, a second opinion… [G30 Site 8 CP]

In this situation she was seeking reassurance from another team member that she had not failed to see a cancer on a mammogram that she considered to be 'normal', rather than seeking out knowledge because she didn't know how to interpret or report something she had seen. The other common situation that prompted radiographers to seek help from an 'equal' colleague was when they couldn't decide what to do about 'indeterminate' calcifications, as described by this participant:

If it's a difficult one, if I'm really not sure 'is there something there isn't there something there?' then I would ask for a second opinion. So for instance, if it was calcification… I might ask for a lateral view… but if I'm still a little bit unsure…then I may ask for a second opinion and see what my colleagues think of it, if I can't make that decision that… so if you're asking what do I do when it's a difficult case…I ask for a second opinion and I will say 'reported with….' so that the clinician knows that two people have looked at this and its okay, or it does probably want a biopsy. [G04 Site 3 AdvP]

These quotations are examples of expert practitioners knowing when a second opinion might be useful. In both these examples the second opinion was sought not only to give the radiographer(s) more confidence, but also to give other members of the inter-disciplinary team (the surgeon and pathologist clinicians) more confidence in the result of the imaging test.

One of the crucial characteristics of a community of practice is a shared practice – a shared repertoire of resources (Wenger, no date). In this study the practice of the MIIR community was embodied as:

- a shared history of experiences of success, for example difficult cases or stories of near misses correctly diagnosed;
- shared experiences of failure, for example wrong diagnosis or clinical errors;
- shared routines for clinical / diagnostic problem solving;
- community knowledge reified in shared 'tools' for communication, for example lexicons, taxonomies, proformas, and decision support, for example protocols and schemes of work.

Radiographers had developed these tools for communication and decision support over time through sustained interaction with their community in response to problems they had encountered and successfully overcome (Wenger, no date; Cox, 2005). The way that shared experiences of success and failure help communities, and individuals within communities, to improve their performance are now considered in more depth.

By way of illustration, this next quotation about calcifications illustrated how radiographers had learned to be more careful about dismissing calcifications as benign when they thought they might not have seen them with analogue equipment because the community had a shared history of encountering and diagnosing similar cases successfully in the past:

Calcifications, because of digital – some things in the past we'd have called benign we're a little bit more cautious with, we're seeing so much more now… it used to be a case of 'oh, you wouldn't have seen that on analogue, leave it alone' but we've had some surprises where you can just barely see it and it comes back as high grade in-situ *malignancy; everybody's a bit more cautious now so we tend to get each other in and have a bit of a conflab about them. [G30 Site 8 CP]*

This demonstrated how the MIIR team as a community learned to reduce the risk of a false negative diagnosis (missed cancer) because their shared repertoire of resources, i.e. their previous experience, was a source of knowledge.

Sharing experiences of failure also helped radiographers improve their accuracy because they were opportunities for experiential learning:

I think if you get an unexpected result, which we all do, then I go back and have another look at it, and think well 'what decision wasn't right? Why didn't I do this? or ' why didn't I see that?' [G27 Site 8 CP]

In this study all the radiographers and radiologists (participating in Stages 2 and 3) evidenced a common understanding (Wenger, 1998) that no practitioner was perfect, that everybody made mistakes and that everyone was learning constantly. One participant explained that fear of making mistakes when interpreting and reporting images autonomously was a real concern for radiographers and might put them off developing their knowledge and skills in the domain:

I think you almost accept that it's probably inevitable that at some point a mistake will be made and you'll be held accountable. I think that acceptance grows with time really, especially as you hear of it happening to people around you. I think it probably does stop some people going into advanced practice and especially becoming a Consultant, I think that fear is probably the barrier stopping them. [G29 Site 8 CP]

In the above quotation, she described how she learned to overcome fear of error by sharing in the experiences of failure of others in her community.

Radiographers in this study believed that the 'shared practice' of their diagnostic communities extended to include shared responsibility for error. Errors were rarely encountered in the observation data and could rarely be recalled by participants in interviews. The following quotation taken from a participant's interview when asked to reflect about 'mistakes', illustrated a belief that no one individual was ever solely responsible for a missed cancer:

I think you would hope that you would feel that you were part of a team… especially symptomatically because the image is only one part of it… there should be (safety nets) because the MDT decision is an agreed decision…. it's difficult to comment when I haven't experienced it (an error) but I would hope that… I mean this is a good team, so I would hope that you'd feel backed up by the team. [G29 Site 8 CP]

A further participant explained how sharing responsibility within a 'community of practice' made her more confident because although she was nominally single reporting, she felt that responsibility for an accurate diagnosis was contingent on the rest of the triple assessment process, and thus also on other members of her community:

> *It doesn't feel like (single reporting) actually…no it doesn't because you know that you're putting down your opinion, what you honestly feel at the time, and then it's going back to another person to read and then they have their thoughts about it as well, so yes, it is… you do feel that it's a shared responsibility with symptomatic work. Over time you realise how the team works and how it all starts to fit together; seeing examples of how things haven't correlated and how it's been picked up, so I think yes your confidence does grow with the shared responsibility. [G29 Site 8 CP]*

The sense of shared (community) responsibility for errors stemmed from both triple assessment, the multidisciplinary approach upon which symptomatic breast diagnosis was predicated and a 'no blame' culture that did not apportion culpability at an individual level. In the following quotation one radiographer described how this helped her rationalise and deal with mistakes:

> *You feel really bad because you've missed something but then if everybody else can't see it … you try not to blame one person … because of triple assessment - you're all trying your hardest to make a diagnosis and if you all agree that something is benign and it comes back as a cancer in the long run you've all done the right thing. [G30 Site 8 CP]*

These examples demonstrated how MIIR radiographers appeared to gain a sense of security from collective responsibility within their community of practice (Wenger, no date).

Throughout the study, radiographers claimed that blame was never attached to mistakes and cases observed during the field work corroborated these claims. These two examples demonstrated how individuals were not held to account when errors came to light. The first example from Site 8 occurred when a patient re-presented with a cancer that had not been diagnosed when she attended six months earlier, it illustrated how the MIIR community of practice claimed collective responsibility:

> *Consultant members of imaging team showed physical demonstration of solidarity with one member (G30) who had not detected or reported a cancer on a mammogram for a patient who presented six months earlier. All radiographers and radiologists at the MDT meeting moved physically towards each other, and physically nearer to the images on the monitors, when the surgeons suggested that it had been present (visible but not reported); the imaging team 'as one' counterclaimed that no mammographic abnormality was present on the prior mammogram and that none of them would have reported it differently. [FN 13.11.14:8a, #1]*

In the second example a mammogram that had been incorrectly reported as normal (R1) came to light when it was presented at the MDT meeting:

> *Surgeon presented case history, radiologist put up mammograms and reading from the report says 'I've got R1 (normal) here but there is some obvious skin thickening and the ultrasound and pathology reports say malignant'. There is no mention of who reported the mammogram. [FN 10.10.14: Site 3, #13]*

When asked about this following the meeting the CP radiographer explained:

> *We work as a team, if that had been seen by somebody else on the day and anybody had thought 'oh I don't think you're right' we would have had a discussion… and it's not a judgmental thing in the MDT. [G03 Site 3 CP]*

The above evidence demonstrated that radiographers felt a shared sense of responsibility, for successes and for failures, with other members of their 'community' and suggested that this improved their confidence. Wenger contrasted the sense of 'horizontal' accountability that exists within a community of practice to that of 'vertical' accountability occurring in traditional organisational hierarchies (Wenger, 2010).

This finding was interesting because it represented a different paradigm of professional accountability - collective decision making whereby successes, but more importantly failures were both everyone's and no-one's (individual) responsibility (Goodwin, 2014). Bell et al. (2011) cite literature about the concept of collective accountability from more than 25 years ago (French, 1982, cited by Bell et al., 2011) but point out how there still remains a lack of clarity about the responsibilities of individual practitioners working within team-based care 'systems'. As pointed out by Goodwin (2014), the concept of collective accountability conflicts with existing Codes of Professional Conduct that, such as those which govern the practices of radiographers and medically qualified practitioners. It was not possible to determine, from the evidence collected in this study how the radiographers' professional Codes of Practice encompassed the collective responsibility they believed they had for their new practices.

6.3.3.2 The community as a learning system

Community of Practice theory acknowledges that each member of the community has different experiences of practice and that this makes their knowledge and skill competences different. This substantive theory suggests that communities operate through transactive memory - they use 'group knowledge' which encompasses the knowledge in each individual's memory and 'meta-memory' - information about the different team members' domains of expertise (Wegner, 1995). CoP theory suggests that individuals become legitimate members of a community by participating in community activities because this is a learning journey (Wenger, 2010). The concept of 'centripetal participation', movement towards a central position within the community as participation in the community's shared practice increases (Lave and Wenger, 1991), provided an explanation for how newcomers integrated into the teams at the sites studied and explained why AdvP radiographers were 'marginal' members of MIIR and MDT teams.

The communities (teams) studied in Stage 3 were well-established and had a relatively stable membership but they accommodated newcomers with ease. New practitioners, to the organisation or to the 'shared practice' of MIIR, became legitimate community members in two ways. New home grown (novice MIIR) team members achieved community competence through traditional learning routes – formal training and a preceptorship period (see section 5.3.4.2.5). New external team members achieved community competence through social assimilation as illustrated below. In this first example a CP radiographer described what happened when she moved from her previous hospital to a new job at Site 8:

> *I had to do a log of cases where I reported them and they were double reported… I had to go back to see if anything had been changed… it was just to make sure that I was reporting in line with everybody else… I think it was to clarify that I was writing reports in the same way as everybody else here. [G29 Site 8 CP]*

This example illustrated how she was able to claim legitimate membership of her new MIIR community because she learned and adopted the existing practices of that community. Whilst cognitive learning theorists might attribute this to 'conformation bias', also known as the 'herd effect' (Gigerenzer, 2004), in terms of social learning theory this was explained as learning by 'expectation of fit' - community competence 'pulled along' newcomer experience (Wenger, 2010). The evidence was consistent with the theory that newcomers developed an identity, i.e. they became legitimate members of the community because they learned from their peer group until their experience reflected the competence of the community.

A counterpoised example illustrated the way that new surgeons learned to trust the expertise of radiographers:

> *You always (have difficulty) when new surgeons start if they're not used to working with the radiographers, we've had it happen… and after a few weeks they realize 'oh, okay, these girls know what they're doing'…. in MDT, we offer opinions and we get back up from surgeons who've been here for a long time, they realise. [G30 Site 8 CP]*

In this example the new surgeons appeared to learn to recognise and trust the radiographers' expertise because the MDT was a platform in which radiographers display their knowledge and demonstrate their expertise. In addition new surgeons witnessed that surgical colleagues higher in their professional hierarchy respected the contribution of radiographers.

Newcomers can also become legitimate community members because they 'pull community competence along' (Wenger, 2010). In the next example the new practitioner demonstrated how she was able to increase the transactive memory of her new community because she had different experiences of practice that did not reflect existing community competence:

> *When I came here they just used to do arbitration with a third person, whereas (where I was before) it was all consensus. So when I came here I brought that up and we changed to consensus, so that came over with me and I brought the forms that we used to use so we just slotted in and used the forms that I used before, here… so yes that was a huge change really. [G29 Site 8 CP]*

This was an example of how community competence was realigned because the community embraced and adopted learning from a new member's experience (Wenger, 2010).

In the following example a radiographer found it more difficult to realign community competence when her own experience was different to the competence of the community than a radiologist did. In her interview an AdvP participant explained how she tried to change the way her colleagues coded the mammographic index of suspicion for cancer in reports because she had learned to do it a different way after attending an external course:

> *When I was a student we were using R1, R2, R3 and I said we're taught it's M1, M2 - it's M we are supposed to use, this is the new way. I suppose because you're a student people don't listen to you or maybe I didn't make a convincing argument. Then when one of the consultant radiologists came she said, 'why are your reports R1, R2, R3? They should be M', so we automatically changed it, we changed it straightaway, she was a consultant radiologist and we changed all the codes. [G28 Site 8 AdvP]*

The participant suggested that her student status was the reason she struggled to convince her community to embrace her new knowledge, her 'claim to competence' was rejected by the community. The example illustrated how much easier it was for the consultant radiologist to come in and change the practice of the community although it was not possible to say if this was because she had a professional (medical) or cognitive (MIIR qualified) advantage over the participant.

A contrasting example from Site 3 illustrated how a new locum radiologist tried, and failed to contest the practices of their community. In this interview extract the CP radiographer illustrated how the locum radiologist had attempted realignment by encouraging the community to learn her new ways of working:

> *When you introduce new people into the team you always go through a period where it's unsettling… particularly with a locum, because she's with us for two days then she works elsewhere for the rest of the week. We have a lot of conversations as in, 'why are you doing this? Why do you do that? What's the point of that?'. It's odd because it's almost like it's criticism against how we do things. It's never a 'oh that's a good idea!' It's always 'I don't see why you do that. Why do you do that? That doesn't make any sense. Why are you doing this?', it is always a little unsettling and I think you expect them to conform and fit it, so it's a bit challenging when you get somebody who doesn't. [G03 Site 3 CP]*

She went on to explain how the locum ended up learning to 'fit in':

> *She's very good, she's very nice … and because she's (only) a locum, she is doing things as we do them, although she argues the point as to why we do them like we do. It's like labelling the pathology pots and how many pots you put in a bag, it's not what our pathologists want, so she has to alter her practice.[G03 Site 3 CP]*

Cox (2005) suggested that use of temporary staff in the modern workplace limited the time that they had to build a 'team' relationship and that the transient nature of their tenure might preclude commitment to the shared practice of the community. Wenger (1998) recognised the existence of 'outliers' or 'mavericks' who didn't conform to group norms and / or took longer to establish their identity within the community. The next example taken from field-notes recorded during an observation event at Site 3 illustrated this. In this example the actions of a radiologist did not align with community competence:

> *CP (G03) is preparing for the MDT meeting and comes across a case of probable fibroadenoma (benign mass) but doesn't understand why it is on the list until she realises that a radiologist reported it but did not follow protocol and perform a biopsy. In the MDT meeting the CP shows the images and agrees with the surgeon that it should have been biopsied, she doesn't know why it wasn't; the CP suggests that the surgeon explains to the patient that 'it all looks benign' but the protocol is to perform a biopsy. [FN 20.11.14:3, #13; 21.11.14:3, #18]*

In her interview the CP radiographer explained that radiologists did not always seem to hold the 'team goal' (the best patient experience to get an accurate diagnosis) in their deliberations and decision making because they did not always adhere to agreed protocols. As a longstanding and respected team member, in the context of CoP theory a central community participant, the CP radiographer had to compensate for the actions of medical colleagues who, by choice because they deviated from ‘group norms’ or because of their temporary organisational role (locums), were marginal community members, to optimise the overall performance of the team.

Another group of practitioners who met Wenger’s definition of ‘marginal members’ of their MIIR community of practice were the AdvP radiographers at Site 8. They could not fully participate in the community’s shared practice (independent reporting, clinical decision making in MDT meetings) because their individual competence (range of knowledge and skill) did not reflect the competence of the community. These radiographers could not function in the role of a radiologist because they were not multi-skilled like the CP radiographers and radiologists.

At this site AdvP radiographers involved in MIIR learned to align (improve) their competence (and confidence) by engaging with the community as legitimate peripheral participants in double reporting and by passive observation of MDT meeting. Their attendance at MDT meetings was facilitated by holding them at lunchtime, and encouraged by providing a ‘free lunch’, this appeared to motivate AdvP radiographers to give up their break to attend voluntarily.

In contrast the AdvP radiographers at Site 3 attended MDT meetings only occasionally and sporadically; this was because the meetings were scheduled mid-morning and only the CP radiographer was released from imaging patients to attend. The ability of the AdvPs to learn and gain legitimate membership of the community, and therefore their ability to fulfil the role of the radiologist in this setting was thus limited.

This supported the theory that individuals could change from marginal members of the community through centripetal participation; through legitimate peripheral participation (passive attendance, supervised and mentored novice practice) AdvP radiographers learned more and gradually became more fully participant in the practice of their community.

In contrast the AdvP radiographers at Site 3 were legitimate members of the MIIR community because they were multi-skilled; their competence aligned with that of the community (CP radiographers and radiologists) and they shared in their practice fully by attending MDT meetings and participating directly in clinical decision making.

This final quotation illustrated the principle of ‘centripetal participation’:

> *I work in the mammography team but I’m also starting to become a member of the film reading team, so I’m very much ‘on the subs bench’ from a film reader point of view. Then as your skills are recognised you keep getting brought in more and more, it’s experience and getting to know how they’re working, by working with them occasionally and then*

you work with them more and more. [G39 Site 3 AdvP newly qualified in MIIR]

This evidence demonstrated how as a newly qualified MIIR radiographer she might move from marginal member status to become a full member of her community through sustained interaction over time (Goodwin et al., 2005):

6.3.3.3 Overcoming organisational control of practice

In the original settings within which community of practice theory was developed knowledge was managed and division of knowledge labour organised through informal social processes rather than according to externally controlled organisational processes (Wegner, 1995). Cox's (2005) critique challenged the emergence of CoPs in the modern working environment. He claimed that because relationships and understandings are usually structured by the work itself in a management created context, interaction was likely to be heavily structured by the task and by formal controls.

Membership of the MIIR 'community of practice' was controlled to some extent by external organisational processes, i.e. radiographers were nominal members of teams (communities) because of their professional qualifications and job roles and at a functional level they encountered organisational / operational / logistic controls (task boundaries, role silos and environmental restrictions) on their practice. Table 6.5 illustrates how the limiting conditions of the modern workplace identified by Cox (2005) manifested in this study and how the participants overcame formal managerial controls so that they could 'get the job done' on a day-to-day basis by operating as a 'community of practice'.

This summary demonstrated that although the 'community' to which the MIIR radiographers in this study belonged was organisationally defined their function was characterised by informal (horizontal) relationships and understandings which had they had developed through mutual engagement in their shared endeavour – an accurate diagnosis (Wenger, 1998).

Table 6.5 Limitations to development of a community practice

Potential barriers	**Study findings of how radiographers overcame limitations and operated as a community of practice.**
Frequent reorganisation, so that engagement between individuals is not sustained	Site 3 - stable small team operating on single site; control of own rotas (division of labour within team) Site 8 - large team spread across two sites; nominal managerial control of division of labour manipulated informally by team members. Chaperone policy and communal reporting spaces encourage situated learning (peripheral participation)
Employment of temporary (locum) or part time staff – people come and go, no build-up of relationships, individuals not committed to task.	All CP and most AdvP MIIR radiographers work full-time, and full-time in the breast service. Locums radiologists at Site 3 had tendency ‘to fit in’.
Organisation (management) ‘owns’ task – formally defined work; control by other professions (registration – historic traditional professional boundaries); state (external) defined– limits task being appropriated and defined locally	Some task protocols and guidelines exist - not as many as in BSP; adhered to by radiographers more than radiologists Leeway exists for individual variation. Operational sense of shared responsibility in contrast with professional code of conduct models.
Individualised work – no collective engagement, only relations between individual & supervisor	Organisational role is for single reporting but in practice interpretation and reporting are social and cognitive collaborative and collective practices.
Competition inhibiting collaboration	Culture is collaborative not competitive; working to a common goal, no individual blame
Time pressured environment – lack of time to develop creative understanding	Rapid access clinics time pressured; staff manipulated distribution of labour to address bottle-necks. MDT meetings at Site 8a were rushed and appeared less collaborative. Protected time available at Site 3 for offline learning
Spatially fragmented work, no available common, unsupervised space in which to assemble.	Communal reporting spaces available at both sites. At Site 3 this was more conducive to concentration (quiet and dedicated for task) than at Site 8 where the communal space was a (bright, noisy) thoroughfare. Dedicated MDT meetings spaces; at Site 8 not optimally organised for collaboration.
Heavily mediated activity – computers, so that interaction is arguably less immediate and intense	Despite advent of digital imaging and electronic patient records, practitioners continue to use transient immediate media e.g. informal paper records and speaking to colleagues directly in clinics. Site 8 – persistence of ‘pink page’ paper record in case-notes, referred to more often than complete electronic records.

6.3.3.4 Summary – programme theory 2

The Stage 3 evidence supported the programme theory that radiographers involved in symptomatic MIIR functioned within professional teams operating as ‘communities of practice’. The social environment of these teams, offered radiographers the potential to learn to interpret and report symptomatic mammograms more accurately and more confidently. Substantive ‘community of practice’ theory (Lave and Wenger, 1991) explained how becoming a legitimate member of the multidisciplinary team was a ‘learning’ journey for the radiographer and explained how radiographer knowledge, skill and confidence could improve because they interacted with team colleagues on a regular basis (Wenger, 1998).

The final section of the Stage 3 results critically appraised the data which examined the extent to which the MIIR decision making behaviours of ‘expert’ radiographers was the same as, or different to, that of radiologists and how this influenced the transfer and sharing of roles and responsibilities between the two professions in the symptomatic service.

6.3.4 Role substitution or innovation

The final programme theory tested in Stage 3 of the study hypothesised that, despite the development of expertise, radiographers involved in symptomatic MIIR would never achieve like-for-like role substitution for radiologists in the symptomatic breast service because their different professional training, experiences and cultures triggered different reasoning and decision making behaviours. The theory suggested that the MIIR practices of radiographers and radiologists would never be completely indistinguishable because, for example, different attitudes to risk and error would affect their categorisation of indeterminate abnormalities and use of additional imaging or further tests for clarification / confirmation, and different knowledge bases and professional confidence might generate differences in the content and style of their reports.

Analysis of the data collected in Stage 2 of the project (presented in Section 5.3.5.4) reinforced the theory that radiographers undertaking MIIR might substitute in the radiologist’s role in the symptomatic service but confirmed that the scope of the radiographers’ clinical knowledge was limited to ‘breast’ and their imaging skills and expertise were restricted to mammography and ultrasound. Radiologists in comparison had clinical knowledge that encompassed the whole body and imaging skills and expertise that extended to include cross sectional (computed tomography – CT, and magnetic resonance – MR) and functional (radionuclide - RN and positron emission tomography - PET) imaging.

In Stage 3 of the study it was hypothesised that radiographers could appropriate some of the work undertaken traditionally by radiologists in the symptomatic service but rather than substituting in the radiologist role the radiographers had created and were occupying an innovative ‘hybrid’ clinical - technical role (Figure 6.5).

Figure 6.5 Programme theory 2 - role innovation

In this new role it was hypothesised participants would be ‘more than a radiographer’ but ‘not quite a radiologist’ because their role and responsibilities traversed the traditional boundaries between medical (radiologist) and non-medical (radiographer) imaging practice. Literature reviewed when devising the initial programme theories in Stage 1 suggested that role innovation represented a radical new approach to skills and competence and the creation of a new type of healthcare worker (Sibbald et al., 2004). Hoskins explained that new roles reflected maturation and evolution of role substitution through development of a discrete and specific body of professional knowledge which underpinned practice (Hoskins, 2012). Schein (1971) had suggested that in contrast to occupation ‘content’ innovation, which involved the development of new knowledge and techniques, ‘role’ innovation involved rejecting existing norms which govern practice and a professional role and conducting practice in a radically different manner.

The purpose of Stage 3 of the study was to test the theory that there were fundamental differences between radiographers and radiologists that affected the way they reasoned and made decisions when interpreting and reporting mammograms in symptomatic breast services and that differences in the practices of radiographers and radiologists led to different outcomes, for example diagnostic accuracy, decision speed and resource use.

The evidence presented in Section 6.3.4.1 explored inter-observer variation between the practices of individual practitioners and inter-professional variation between the practices of radiographers and radiologists interpreting and reporting mammograms in the symptomatic clinic.

The results presented in Section 6.3.4.2 compared the relative roles of radiographers and radiologists in (multidisciplinary team) clinical decision meetings. In this study it was unusual for a radiographer to substitute for a radiologist in an MDT meeting – one of the Stage 3 fieldwork observations was arranged purposively to sample data from this rare event.

Section 6.3.4.3 critically evaluates the extent to which the radiographers participating in this study have renegotiated the professional boundary demarcations between radiographers and radiologists.

The final section, (6.3.4.4) presents a short critical review of the potential financial and clinical consequences of role innovation and considers radiographer motivation and job satisfaction in their new role.

6.3.4.1 Substitution in rapid access clinics

6.3.4.1.1 Training

Robust external training has already been identified as an important resource that enabled radiographers to begin to develop expertise in symptomatic MIIR (see section 6.3.2). One of the radiographers at Site 3 explained how radiologist training differed from her own structured and formally assessed 12 month university course (Universty of Leeds, 2013; London South Bank University, 2015) and highlighted that involvement in symptomatic MIIR work did not seem to be given high priority by radiology trainees:

> *The radiologist trainees don't have the time or the structure… they don't do a formal image interpretation course, they attend courses… which I believe are lectures… I'm not aware of there being any assessment…. they sit and observe symptomatic work…they actually mainly spend time either in ultrasound or screen film-reading…they're very keen to get into ultrasound and start learning how to do aspirations and biopsies, but then they sit and watch a lot of screening films that are normal…. they don't report… they're sitting alongside people that will teach them what they're doing but they're not independently reporting anything [G03 Site 3 AdvP]*

Demonstrating that this was not a local situation, a participant from the other case study site (Site 8) explained how their radiology trainees who intended to specialise in breast imaging, and thus by inference needed to improve their skills and knowledge beyond a basic awareness that all radiology trainees might have, had to be proactive about increasing their volume of cases and seeking feedback on performance to improve their diagnostic reasoning and confidence:

> *It's down to them on an individual basis, their ability to take the time to sort of do the hours if you like. I have noticed a difference in their approach to it … the couple of registrars who want to go into breast work are very proactive in film reading, in understanding and getting feedback, so I feel that they're quite well trained. But the ones who aren't that bothered wouldn't be, so it's down to them on an individual basis as to how good they get… it's not as structured ….it's sort of very much down to them. [G31 Site 8 CP]*

A quotation from an advanced practitioner with long-standing experience in MIIR at Site 8 illustrated the importance of successful completion of a robust training, its recognition as a benchmark of competence and its value in triggering the development of expertise which enabled radiographers to appropriate the MIIR role from consultant radiologists:

> *Radiographers are better trained at film reading than the doctors are… because we have to be… and I think that was kind of, how we got it completely out of the doctor's clutches, by the fact that we had to do a formal qualification in it. [G26 Site 8 AdvP]*

In the rapid access clinics at Site 3 both AdvP radiographers and the CP radiographer substituted fully for radiologists - they undertook MIIR, initiated, performed and reported ultrasound and tissue sampling examinations without a radiologist present in the clinic. When pressed that differences in medical knowledge and different training regimes might lead to fundamental differences in the way radiographers and radiologists interpreted and reported mammograms it was not unusual for participants to disagree, as illustrated in this quote from one of the advanced practitioners at Site 3:

> *I wouldn't have said that…I would have said that radiographers and radiologists interpret in the same manner [G04 Site 3 AdvP]*

Radiographers believed that their interpretation practices and reports in routine clinical practice were indistinguishable from those of radiologists. There was no evidence in either the interview or observation data to support the theory that there were profession-based differences in the clinical knowledge of radiographers and radiologists that restricted the range of mammography cases that radiographers could interpret. Both the consultant and the two advanced practitioners at Site 3 explained that even though their formally acquired clinical knowledge was limited to 'the breast' they had learned to recognise non-breast conditions that affected mammographic appearances because they encountered such cases in the course of their normal working practices:

When they're in heart failure and things and you get the classical signs… so, yeah, I think that's just a learning thing. It (the case) comes through and I think once you learn it, it becomes one of your things to recognize. [G03 Site 3 CP]

I think that you pick up as you go along…you come across different things… I can't always remember the names of things, but I will think 'oh yes I've seen that before' and 'yes I'm comfortable with what that is. I think you do pick up knowledge. It's like everything else, you pick up, as you go along, depending on the different experiences that you've had. [G04 Site 3 AdvP]

This additional, experiential learning more closely aligned the knowledge of radiographers with that of radiologists and thus appeared to facilitate their substitution. The AdvP quoted above went on to explain, however that knowledge gaps did not necessarily preclude substitution because radiologists were equally as likely as radiographers to come across pathology that they had not encountered before. When this happened the resultant decision making process appeared to be the same irrespective of practitioner professional background:

I don't think the radiographers would be unable to report… if a radiographer had seen something on the mammogram that they didn't know what it was, that could happen with the radiologist, they don't know what it is and therefore it's a bizarre appearance…it might be something that they've not come across before so they're going to ask another colleague that may have, or they may look through a book, or think 'okay, we'll just investigate this and see.' [G04 Site 3 AdvP]

6.3.4.1.2 Reporting style

The Stage 3 interview evidence suggested that inter-practitioner differences in reporting styles were greater than any systematic inter-professional differences in the reporting behaviour of radiologists and radiographers. Direct comparison of actual reports was not included in the scope of this project. When asked if she agreed with the theory that there were fundamental differences in the way radiographers and radiologists reported mammograms the consultant practitioner at Site 3 disagreed and counter-claimed that an 'outsider' would not be able to tell the difference between the report of a radiologist and that of a radiographer in her department:

I don't think (an outsider) could pick between radiologist and radiographer reports…I think they could pick between individuals, but I don't think they'd pick between the radiologists and radiographers. [G03 Site 3 CP].

One of her advanced practitioner colleagues explained further how differences in reporting style were characteristic of individuals; she again contested the theory that there were fundamental inter-professional differences in the mammographic interpretation and reporting practices of radiographers and radiologists:

> *The same report can be written five different ways but the same information is being provided to the referring clinician; that variation could be between five radiographers or between radiologists and radiographers but the bottom line 'what have you reported on', 'what have you seen' and 'what value you are going to give it', I don't think is different. [G04 Site 3, AdvP].*

At Site 8 one of the CP radiographers explained how some radiologists modified their reporting style after undertaking the same MIIR courses that radiographers had been required to take:

> *Some of the consultant radiologists have actually gone on training courses for radiographers, whereas others are self-taught, and you can tell, there's a big difference…sometimes radiographers describe more, I think very often we use a lot more description than the radiologists… you can tell the difference between the radiologists who've actually gone on courses designed for radiographers and the self-taught ones, it tends to be the older radiologists that are quite blasé… they're more self-taught and a little bit more relaxed in their reporting.. [G30 Site 8 CP]*

This evidence suggested that different task-specific training was the trigger for different reporting styles rather than any difference in general training or professional culture.

6.3.4.1.3 Diagnostic speed-accuracy

Previously, in Stage 2 of the study, clinical lead radiologists and radiographers had suggested that the MIIR decision 'speed-accuracy' of appropriately trained and experienced radiographers was at least as good, and in some cases was better than, radiologists. This quote from the CP radiographer at Site 3 illustrated again that differences between individual practitioners were greater than differences between the professions:

> *I think individuals take longer or shorter… but I don't think that would influence whether they'd employ a radiologist as opposed to a radiographer… because we've got radiologists who take longer than some of us. [G03 Site 3 CP]*

When asked about the accuracy of their interpretive judgements and decisions, the following quotation summarised the participants' claims that NHSBSP QA data and feedback from MDT meetings evidenced that they perform to a similar level of accuracy to their radiologist colleagues.

> *You think you're as safe and as accurate as the radiologist, you've got the PERFORMS and the QA in screening and you've got the MDT*

> *feedback in a way, there's no suggestion that one is working at a higher or a lower level in terms of accuracy. [G06 Site 8 AdvP]*

An experienced consultant radiographer colleague at Site 8 suggested that high radiographer accuracy could be underpinned by a tendency to pre-empt self-criticism in their new role because this motivated them to be more careful. This evidence aligned with the view of Larrick (2004) that 'fear of failure' and the possibility of (social / professional) humiliation prompted people to take more time and / or seek more information when making judgements and decisions.

> *I think as radiographers we felt, and still to an extent, feel, that we have to have every base covered. That we have to make sure that we have done everything we possibly can, so that nobody… 'oh you didn't do this', or 'you should have done that' or 'why didn't you do that?' And I do think sometimes that the radiologists don't necessarily do that…to be honest I think that is beginning to change… I think ten years ago a lot of them would've been reasonably blasé, I don't think that happens now... I think now radiologists are more cautious too. [G27 Site 8 CP]*

The above quotation is insightful because it demonstrated how radiographer 'good practice' might operate as an exemplar for radiologists seeking to reduce their risk of error, and perhaps subsequent litigation. This suggested that equivalence in practice between radiographers and radiologists occurred not just because radiographers were trying to emulate or were learning to conform to radiologist (decision making) behaviour but because inter-professional learning was reciprocal.

A further example of radiologists learning from radiographers occurred during the interview of the CP radiographer at Site 3. When responding to the programme theory hypothesis that radiographers interpreting and reporting mammograms had an advantage over radiologists because they knew about the technical aspects of mammography production and were used to positioning patients, she explained how radiologists learned this during discordant double read resolution in the screening programme:

> *When you've done mammography you learn to look at the position the breast is in, so when you're comparing two sets of images and you're thinking 'oh she's got a new density here', if you do mammography you instantly look at how that breast is positioned, and some things can be explained away purely by position, and I think that falls instinctively to the (radiographer) who's done mammography and not necessarily to a radiologist who hasn't. But I do think they quickly cotton on to that because when we have consensus read and I will say 'well that breast is entirely differently positioned, I think it's due to position… if this bit of breast has turned back here or whatever… [G03 Site 3 CP]*

This participant's evidence supported the programme theory and gave another example of learning occurred through participation in group activity - 'social' learning as described in Section 6.3.3.

6.3.4.1.4 Use of additional mammographic images

It was hypothesised that radiographers' patient positioning and image acquisition knowledge and skill might influence their decisions about requesting repeat images. For example, a radiographer might be more likely than a radiologist to request a technical repeat or a supplementary projection (extra lateral, compression, magnification views) because they could recognise when an abnormal mammographic appearance might be due to a positioning artefact. In comparison a radiologist would lack this 'image acquisition' knowledge and might be more likely to proceed to an ultrasound examination. The study design did not allow the collection of any quantitative data, but the following quotation illustrated that this hypothesis appeared to be true:

> *We know what the optimum mammogram is and what should be achieved and we don't accept what maybe radiologists would accept [G06 Site 8 AdvP]*

However a further data extract highlighted that differences in this behaviour were also influenced by having ultrasound competence, irrespective of professional background. The AdvP radiographer at Site 3 first talked about her experience learning to report mammograms:

> *I've sat with radiologists and I've sat with radiographers and I noted that radiographers would ask for additional views more than radiologists, and I don't know whether that is just because they wanted to make sure that they have all the possible data at the time of interpretation whereas the radiologist would think 'actually, yeah, I can see that there's something there, I don't know entirely whether it is composite shadows or … but that is the symptomatic side, so I will get it scanned'. [Site 3 G04 AdvP]*

She went on to explain that she tended not to ask for extra views because she was trained in ultrasound before MIIR and this gave her confidence in this as a 'problem solving' tool to determine the nature of equivocal mammographic appearances. It is also possible that she did not rely on extra mammographic views because she was not herself competent in mammography image acquisition.

Her next statement was more in keeping with the theory that differences in behaviour had a professional origin because the radiographers she referred to next were also trained in ultrasound – they were performing ultrasound examinations on patients whose mammograms she had reported:

> *That's been my own personal experience, that radiographers ask for additional views, where a radiologist will think 'okay well…'. I feel like I've sort of adopted that way, I don't know whether that's come through me being a sonographer first and thinking 'I'll just do an ultrasound and then…..if I need it, if we don't get an answer'… and sometimes I have had them come out to me and say 'well have you had a paddle view done?' and I'll say 'no' and again that would be typically a radiographer that would say that to me. [G03 Site 3 AdvP]*

The study data suggested that radiographers might be more likely to request additional mammographic views than radiologists but that the reasons for this might be complex and multifactorial. Knowledge and skill in mammography image acquisition and knowledge and skill in ultrasound seemed to be influential, the data presented in the next section suggested further that fundamental differences in professional culture - confidence, caution, knowledge gathering, protocol adherence and fear of error, were also influential.

6.3.4.1.5 Professional culture

Different professional cultures for medical (radiologist) and non-medical (radiographer) professionals seemed to explain different approaches to knowledge gathering, risk of error and reporting strategies. The data suggested that radiographers had a tendency to be more cautious to avoid making mistakes and were more likely to follow set procedures. This quote from the AdvP radiographer at Site 8 who had recently qualified in MIIR illustrated how radiologists might be more confident to deviate from standard procedures:

> *Would I call them (radiologists) cautious or would you call them considered? I suppose we go from ABCDE, we go through, we would work through those methodologically because we're working under protocol, whereas I think the doctors could perhaps, because of their confidence or their experience, could perhaps miss out B and go to D. So yes we're quite protocol driven. I think we would always follow the protocol because that's the way that we've been brought up… to follow protocols and guidelines, whereas they're perhaps a little more laisse-faire… I don't know whether it's a confidence thing or whether it's just power a little bit. [G39 Site 8 AdvP].*

This insightful data segment highlights the complex interplay of power, authority and confidence – it suggested that radiographers adopted a 'subordinate' role where they 'did as they were told' in comparison to radiologists who had the power to 'do as they like'.

This evidence was concordant with substantive theory that radiologists would be more likely to exhibit ‘over’ confidence, and thus be more susceptible to error, because of their medical training and background (Berner and Graber, 2008). The following excerpt from the transcript of a Site 8 CP radiographer interview suggested however that the phenomenon was again, perhaps a characteristic of individuals rather than being entirely profession-specific:

> *Some of our radiologists are more like the radiographers… quite cautious, whereas some are happy to say something is benign. When I think of it, you’ve got two completely different types of radiologist here, we’ve got some that actually are like radiographers - if you do a hook wire – because I hate for mine to be more than a centimetre out, and I know of a couple of our radiologists who are like that, but then there’s others who will do one and it’s in the wrong quadrant of the breast and ‘oh it’s okay’.. so there’s a variety. [G30 Site 8 CP]*

This interview data was corroborated with observation data – the participant was referring to an example that had occurred at Site 8a when she was being observed interpreting and reporting an image of a hook-wire that had been inserted to localise a tiny (impalpable) cancer prior to excision:

> *G30 looking at specimen image of another wire – she remarks that the ‘doctor’ did it and she would not have been happy with its position. [FN: 3.11.14; Site 8a Case 2a]*

One of the participants further substantiated the hypothesis that the different general professional training and backgrounds of radiographers and radiologists might foster different attitudes to risk and error which would be reflected in their MIIR practice:

> *…shorter reports and not being so worried about when things don’t go quite right, whereas I think radiographers want things to be perfect all the time. You can’t have it perfect all the time, but you want it to be as close to perfect as possible, but I think radiologists sometimes… it’s just the way they’re taught at medical school, I think it might be something that they get taught that we don’t… to stand back and be a little bit more relaxed about things.*
>
> *(Interviewer: some have suggested that they’re taught and conditioned that they will make mistakes and people will die, and they get hardened to it)*
>
> *Yeah, and we’re taught the opposite in a way aren’t we? That you must not make a mistake, and there’ll be dire consequences if you do, so don’t make a mistake! You try so hard not to, and you want things to be just so. [G30 Site 8 CP]*

This data appeared to reflect that radiographer training and practice habituated them into believing that (technical image acquisition) mistakes were not acceptable. One explanation for this is that many of their technical mistakes require repeat image acquisition which has serious (legal) consequences under the Ionising Radiation (Medical Exposures) Regulations (2000). This contrasted with some of the evidence collected from radiologists in Stage 2 of the study which acknowledged their professional acceptance of mistakes – and their consequences. A representative quote from a radiologist interviewed during Stage 2 is provided here for comparison:

> *I think the baptism of fire that many doctors of my age had is very useful at allowing you to live with difficult decisions and allowing you to make them. Knowing that sometimes you just plain have to… you don't have an option to vacillate or not decide – you have to… make the best possible decision you can and get on with it. That's … more difficult … for radiographers that haven't been exposed to the same level of risk in their early careers. It hasn't been as risky for them. As a house officer – the sort of decisions I was making would have resulted in deaths if I'd got it too wrong … knowing that you were always that close to disaster and that tired and that stressed, with that much responsibility obviously does change us. I think we are different. [Site 7 L01 radiologist]*

The evidence in this study suggested that radiographers who subsequently became involved in MIIR transferred their fear of making technical errors into fear of making clinical (interpretation and reporting) errors. This evidence aligned with the Stage 2 data which suggested that radiographers were more critical of themselves than radiologists when they made errors. This was illustrated in the following extract from a Site 3 AdvP interview:

> *I think (radiologists) probably 'take it on the chin' better than a radiographer does… it's part and parcel of the job that everybody's going to make mistakes sometimes… when I've seen (radiologists) talking about it, it's been okay – they can learn and move on, whereas I might have sleepless nights. I think initially… it depends how big the mistake is, but I think if I make a mistake, then I do reflect 'why did I make it?' …reflecting – it's 'look, learn, reflect and…move on'. [G05 Site 3 AdvP]*

This participant was agreeing with the suggestion that radiographers and radiologists had a different attitude to mistakes but illustrated how she had also learned to 'move on'. A similar quotation from an AdvP radiographer at Site 8 highlighted the reflective nature of radiographers' practice and a need to 'prove' that they are worthy of higher status:

> *Yeah, I think it is fearful of making mistakes and being determined to learn from them. You know you make a wrong decision… I think radiographers are more likely to get hung up about it and following that be more conscientious. And they'd worry about it more and they'd probably do (it differently) in the future, while radiologists probably wouldn't dwell on it quite so much… I think it's because radiographers feel like you need to be proving something maybe and that you, in*

> *some respects, you're still catching up with the radiologists… just the nature of the hierarchy. [G06 Site 8 AdvP]*

The issues raised by this participant highlighted the nature of 'vertical' substitution. Transferring duties across professional boundaries to an occupation group with different training and expertise (Nancarrow and Borthwick, 2005) was not just about transferring the task but about transferring the responsibility that goes with the task. This evidence very powerfully illustrated that substitution into the role of a radiologist required radiographers to 'step up' into a role of higher social status.

One very experienced CP radiographer at Site 8 again alluded to historical inter-professional differences that were disappearing because radiologists were changing their 'traditional' behaviour. In this quotation from her interview she revealed how external quality monitoring was a triggering influence:

> *To be honest I think it's beginning to change with radiologists. I think ten years ago a lot of them would've been reasonably blasé, I don't think that happens now… I think now radiologists are a lot more cautious as well….because quality assurance reference centres will pick you up for every little thing… its going back to screening but I think it creeps into symptomatic serves to an extent as well. When they do a QA visit they will, for all of us, pick out a bunch of our assessments to see what we actually did. We discovered that certain radiologists were not necessarily following what we had thought was our procedure all the time for each patient, so that was what led to us meeting as a group and writing protocols. We have all the protocols written down now to try and make sure that everybody does exactly the same thing because QA will pick you up on every little, tiny, thing. [G27 Site 8 CP]*

This insightful evidence illustrated how external factors had triggered change in radiologist reasoning processes and how in addition external scrutiny had triggered a collaborative inter-professional 'team' response to develop protocols which acted as 'decision support tools' to change the reasoning of both radiographers and radiologists.

6.3.4.1.6 Autonomous independent practice

During the fieldwork two of the three qualified and experienced CP radiographers at Site 8 worked as single-handed consultants in the rapid access clinics at Site 8b. On the mornings of 7.11.14 and 14.11.14 these radiographers took responsibility for imaging in the rapid access clinic without a radiologist on site (FN observations 7.11.14, 14.11.14). They had full responsibility for all image-based diagnostic techniques required to support the clinics and they were responsible for supervising the radiographic staff. Although this was a typical and routine occurrence for the three experienced CP radiographers at Site 8, the trainee consultant practitioner explained that she did not do this yet because there would be no one to help her make decisions if she got stuck with anything:

> *When you're at (Site 8b) on your own, then you are totally solo. I don't know…I suppose, I've not actually been there…because you'd have to make the decision. [G30 Site 8 trainee CP].*

Observation data demonstrated that in daily practice radiographers recognised their 'medical' knowledge limitations and knew when and how to seek advice from medical colleagues. An advanced practitioner at Site 8 explained how the existence of decision support tools (protocols and guidelines) and the availability of clinical colleagues (surgeons) helped her overcome her lack of medical knowledge when working autonomously in the clinic:

> *I'd asked 'under what conditions can I give lignocaine?', for instance, and 'under what conditions should I use the one with adrenaline?' … so that information you haven't got… you want to have set guidelines if you like, that you can refer to, as part of our 'Scheme of work'. But if there's additional medication that the patient's on that you're unsure of, I feel I could always go and ask the clinician, and say 'look, I need to give lignocaine for this, I'm going to do a biopsy, the patient's not sure of her medication, is there anything that would contradict me doing that?' So drugs and things like that, I could ask those questions of the clinician that's round the corner… any of those types of questions, we just pop round and ask. [G04 Site 3 AdvP]*

The surgeons knew that radiographers undertaking MIIR in the rapid access clinics lacked comprehensive medical knowledge but nevertheless acknowledged their diagnostic expertise. Their confidence in their non-medical colleagues was reflected in the 'can go' policy observed at Site 3. This was described in the following field-note extract:

> *Surgeons put 'can go' on some mammogram request. Radiographer explains that this means they are authorised to send the patient home from clinic once they have had their mammogram if they interpret the mammogram as 'normal'. [FN 14.10.14; Site 3 Cases #10 and #11].*

As predicted by the programme theory, and substantiated by the interview data in Stage 2, the observations included occasional cases that were beyond the scope of practice of the radiographers (limited to the breast and axilla). Where cases required a radiologist, who had a wider anatomical scope of practice because of their general medical and radiological training, surgeons knew to approach them rather than a radiographer. The following representative example was recorded in field-notes during a clinic observation at Site 8a:

> *Radiologist busy reporting mammogram but surgeon interrupted him for advice rather than speak to CP (G31 – trainee CP) who is free. CP*

> *radiographer (G30) subsequently explains that case had been discussed previously at MDT and related to a large axillary mass that turned out to be a muscle problem – surgeon had remarked at the time 'you don't go there'. [FN 10.11.14 Site 8a case 1a]*

Paradoxically however the following example from field-notes recorded whilst observing an MDT meeting illustrated how surgeons also recognised that radiographers might have greater expertise than radiologists:

> *Surgeon approaches and asks CP radiographer (G27) if patient is suitable for VAE (vacuum assisted excision). G27 verbally agrees; CP radiographer G31 is nodding and making eye contact with surgeon to indicate that she agrees with this decision. Radiologist in background did not get involved, just observed discussion passively. G27 explains afterwards that radiologists do not do VAE procedures, there are not enough cases for all CP radiographers and all radiologists to do enough to maintain competence and radiologists only work in the breast unit part-time; CP radiographers are there all the time so can do more and are always available. (FN: 13.11.14, Site 8a, Case #4).*

This data was another example supporting the programme theory that patient volume was an important contextual factor which triggered the development of expertise, and how low volume could operate as a barrier to developing the expertise of multiple practitioners.

The above data from the Site 3 participants contradicted the hypothesis that radiographers could not substitute fully for radiologists in the MIIR role. During the observation events at Site 3 the consultant and advanced practice radiographers did operate autonomously and independently without the presence of a radiologist. The following quotation from an advanced practitioner confirmed that it was normal practice for the radiographers and radiologists to work interchangeably in this role:

> *The way the clinics are run in the breast unit… yeah, actually, in answer to that question, can the radiographer take the role of a radiologist in the breast unit? … the answer to that is yes, they can, because the way this unit is set up… the clinical side is either run by the consultant practitioner or advanced practitioner, or radiologist, and we all interlink, you know, we can swap the rota as it suits, so we fit into each other's roles to do the job that we're here to do… so for that role in itself, yes. [G04 Site 3 AdvP]*

At Site 8 only the consultant practitioner radiographers substituted for radiologists in the rapid access clinics. Substitution at Site 8b, for example, involved undertaking MIIR, initiating, performing and reporting ultrasound and tissue sampling examinations and liaising with clinicians and nurses to manage the patient journey, and operationally manage the clinic, without a radiologist present on site. The hierarchical differentiation between radiographers occurred because none of the AdvP radiographers were multiskilled with competence in MIIR, ultrasound and tissue sampling.

The above evidence appeared to falsify the programme theory arising from Stage 2 study findings. An experienced consultant practitioner at Site 8 provided a possible explanation for this:

> *I suppose there's always been a bit of a thing about radiographer reporting… giving a clinical opinion or giving a medical opinion of what it might be, was always a bit frowned on because you weren't medically trained', but I think we all probably in a mammogram report if we think it's possibly a cyst or possibly a fibroadenoma we will say that. We don't have an issue with doing that and our radiologists don't seem to have an issue with us doing that. Its how it used to be, that radiographers gave a descriptive report…*
>
> *(Interviewer: But you don't think that happens now?)*
>
> *To be honest I think you should read some of the radiologists reports… sometimes it's just a descriptive report … but I mean, we all say the same sorts of things…'typical features of a fibroadenoma' or 'simple cysts' or 'this looks like a malignancy'. [G27 Site 8 CP]*

It is possible that the Stage 3 data contradicted the theories arising from Stage 2 because the original participants had been asked to 'tell the story' of how radiographers became involved in symptomatic MIIR at their site. The above quote suggested that differences in radiographer and radiologist reporting practices might be a historical phenomenon, occurring early in the role development of radiographer professionals and perhaps no longer apparent in established practice. This would support Hoskins' theory that 'role innovation' reflected 'maturation and evolution of role substitution' (Hoskins, 2012).

6.3.4.1.7 Summary

The evidence presented in the above section of the thesis supported the theory that medical and non-medical practitioners might have a tendency to approach symptomatic MIIR differently because of their different professional backgrounds and their different task-specific training routes.

The data confirmed the suggestion that differences in practice might be predominantly of an affective nature – radiographers being more cautious, having greater fear of error and thus being more likely to adhere to protocols, for example. These differences did not however appear to result in fundamental inter-professional differences in mammography case mix, resource (additional examination) use, report style or decision speed when performing MIIR in symptomatic clinics. The evidence implied that radiographers might be less likely to make errors.

The data suggested that inter-professional differences in affective decision making behaviour might be historical in nature and becoming less conspicuous. Furthermore the data identified external training and external monitoring as triggering influences for changing radiologist practice and aligning it more closely to that of radiographers.

The Stage 3 field work evidenced that expert multiskilled radiographers performed in the same way as radiologists in symptomatic rapid access breast clinics at both case study sites thus falsifying the programme theory that radiographers could not fully substitute for radiologists in this role.

6.3.4.2 Substitution in clinical decision making meetings

None of the radiographers participating in Stage 3 undertook or assumed full responsibility for the radiologist's role in (multidisciplinary team - MDT) clinical decision making meetings. As anticipated in the programme theory they could not substitute in this role because they did not have the clinical (non-breast) and technical skills to comment on the full range of (whole body) imaging used for cancer staging. The experienced CP radiographer at Site 3 explained during her interview that there were two components to MDT meetings. For the first 'diagnostic' part she explained how it was possible for radiographers to fulfil the role of a radiologist, she had done this herself, but the second (surgical) part of the meeting she believed would always be beyond the scope of practice of radiographers:

> *In terms of the diagnostic part of the MDT, I think the radiographer could do that. I think they can… I do - I only present the diagnostic cases, so it is literally the breast and axilla bit that I do and that's accepted. But I think, in terms of CT and everything, that's a different thing entirely… it's a whole new ball game to learn something like that, and it's so massive.... I don't think we'll ever take over doing things like that. You need a proportion of radiologists for dealing with CT, MR and bone scans. The surgeons also know who to go to, to speak to, to discuss, you know, the MRI or the CT or whatever… although they do acknowledge our specific expertise. [G03 Site 3 CP]*

This evidence appeared to suggest that by distributing the body and the techniques for imaging it between the two professions radiographers and radiologist worked in parallel to cover the whole diagnostic process. The specific expertise of radiographers enabled them to take responsibility for routine imaging of the breast, with radiologists' expertise being called upon for imaging other areas of the body and using more complex techniques.

On the rare occasions, during unexpected or planned absence of the CLR at Site 3 where the experienced CP radiographer (G03) led the first pre-operative ‘diagnostic’ part of the MDT, substituting the radiographer for the radiologist allowed the meeting to proceed as scheduled and ensured that decisions about patient management could be made without breaching cancer wait targets. One of the field-work data collection events was organised specifically to observe this [MDT observation Site 3, 21.11.14].

A radiologist was always present for the second, ‘surgical’ part of the meeting to present and discuss the post-operative staging cases. Table 6.6 illustrates the range of cases discussed during the surgical components of one of the MDT meetings observed. All these cases are taken from the meeting observed at Site 3 on 10th October 2014 but they are representative of the range of cases observed during all the MDT observations at both sites. These examples illustrate how the scope of practice of radiologists encompassed a wider and more complex range of body systems, imaging modalities and clinical competences than that of the consultant radiographer. Arguably it would be feasible for radiologists to attend MDT meetings in a virtual capacity and present and discuss cases using ‘teleradiology’ facilities (Kunkler et al., 2007).

Table 6.6 Clinical decisions beyond the scope of the radiographer

Clinical case details	**Radiographer scope limitation** anatomy	 technology	**Case ref.**
Radiologist presents and interprets staging results	Chest & abdomen	CT	#5
Surgeon and radiologist discuss multiple metastases; need to decide if patient is responding to chemotherapy or has new lesions?	Liver	CT	#6
Surgeon asks if cause of chest wall pain has been demonstrated, significance of pulmonary lymph nodes and whether abnormal bone scan appearances are degenerative or metastatic	Chest Skeleton - bone scan	CT RNI	#7
Radiologist decides that a small ovarian cyst is a normal (functional) variant in woman aged 51 years	Pelvis	Non-breast ultrasound	#8
Radiologist interprets abnormality as benign not metastatic chest lesions, decides there is no recurrence of bowel cancer and recognises that patient has large hernia and total hip replacement	Chest, abdomen and pelvis	CT	#10
Surgeon asks radiologist about pleural mass / nodule; radiologist recognises lumbar spine metastases and warns of risk of vertebral fracture; incidentally she notes patient has abnormal gall bladder and needs investigations for cholecystitis.	Chest, spine and gallbladder	CT	#11
Surgeon presents patient with previous history of mastectomy referred via Accident & Emergency with abnormal head scan. Radiologist interprets brain lesions as metastases and notices bone, lung and liver abnormalities; she suggests pattern is more in keeping with breast recurrence than new lung primary.	Brain, lung, skeleton Cancer aetiology and progression pattern	CT	#12

With the exception of the MDT observed above (Site 3, 21.11.14) where the consultant practitioner led the diagnostic part of the MDT in the radiologist's absence, it first appeared to the researcher that radiographers who substituted for radiologists in rapid access clinics had a subordinate 'radiologist hand maiden' role at MDT meetings. The following examples from field-notes recorded at Site 3 and Site 8 illustrated however, that in reality they were performing an important 'monitoring' role for the radiologists because they prompted them about cases being discussed and supplied them with pertinent information from patient imaging records. For example:

> *Surgeon asks radiologist if they are ready to start. Radiologist presents case; pathologist presents biopsy results. Radiologist asks if case should go on 'follow up'; radiographer (G03 Site 3 CP) reminds radiologist this was a 'stereotactic' procedure and reads from the procedure record sheet to inform her how many tissue cores were obtained. Radiographer makes notes on record sheet whilst surgeon and radiologist discuss technique and patient management. [FN 10.10.14 Site 3 Case #2]*

> *Radiographer (G31 Site 8 trainee CP) points out calcification abnormality in mammogram image to radiologist & prompts her to compare with priors (mammograms for previous attendance). [FN 12.11.14 Site 8b Case #2]*

The interview data identified this as an important role in clinical decision making because it enabled radiographers to 'double check' the integrity and accuracy of the information data the radiologist was presenting. The following two quotations explained the importance of the role of the person 'assisting' the radiologist to present imaging cases in the MDT meeting:

> *We tend to have two people who sit doing imaging now, today that was a radiologist and radiographer. When you're doing an MDT you're given quite a limited time for preparation; very often you don't do it immediately beforehand. As the radiologist was presenting it and she was looking through things, I was just prompting a little bit to say, size wise and position wise and things like that, just to give her a helping hand. [G03 Site 3 CP]*

> *If (the radiologist is) reading the notes in an MDT… you have to sort of say 'no excuse me, we have got this….'; so if there's something that they've missed or, you know, hadn't noticed on the paperwork… [G31 Site 8 trainee CP]*

This finding was another example of radiographers operating in a 'safety net' role for radiologists (see Stage 2 results: Section 5.3.2 - A commenting system case study; Section 5.3.3 - A delayed second reading case study). It also demonstrated how the two professions working together could reduce the risk of clinical error.

The radiographers participating in Stage 3 expressed no desire to extend their clinical scope of practice beyond 'breast' diagnosis but the most experienced consultant practitioners were expanding their role by extending their technical expertise to include interpreting breast MRI images. The study data revealed two triggers for this. The Stage 2 data had suggested that MRI trained radiographers might help services meet the NHSBSP standard for double reporting family history cases, but the trigger identified by the Stage 3 participants was different. The following quotations explain how a working knowledge of MRI helped radiographers localise areas of concern when performing 'second look' ultrasound examinations and tissue sampling:

> *We try and get involved in the MRI reporting as much as we can, and we try and learn as much as we can from the radiologists. So when it comes to a second look ultrasound after an MRI and you've got a report there, you haven't got the person who reported it, you've then got to interpret the MRI report, and then try and find the areas on the ultrasound, that is quite difficult… but we have had some training, and it's made it easier [G30 Site 8 CP]*

> *The way I've become more proficient of what I'm looking at in MRI is because very often the clinic where these patients come back for second look ultrasound, is an ultrasound clinic that I'm doing. I've been lucky with the radiologists that I've gone to and said 'can you tell me more about MRI?' I've been across to MRI and sat and watched some being done, and the reporting as it's done…I went through need really, through a situation for me that was about doing a lot of second look ultrasound after MRI… I needed to know [G03 Site 3 CP]*

The trainee CP radiographer at Site 8 had a CT background but still considered limiting her future skill development to 'breast' and to 'diagnosis' to be more feasible than extending her professional remit to cover other areas of the body and to staging examinations:

> *I've done a lot of CT … I've seen CT scans…I do feel I've got an advantage there. I can look at CT scans and I'm quite good at spotting things… I think possibly (I would like to develop skills in) MRI breast. I think CT, you know whole body, that sort of staging side of things, it's too big. But possibly second reader in MRI breast, yeah, I think with training, I can't see why we couldn't. [G31 Site 3 trainee CP]*

The sentiments expressed here were consistent with those expressed in Stage 2 about clinical specialisation where participants discussed the choice between being a 'jack of all trades', all techniques or all areas of the body, or a 'master of one' – the breast.

6.3.4.3 Professional boundary negotiation

During the rapid access clinic fieldwork undertaken in Stage 3 radiographers worked alongside radiologists interchangeably – no fundamental differences were observed in their performance of the symptomatic MIIR role. At operational level when multiple consultant radiographers and radiologists were present in a clinic they appeared to have equal professional status. In an interview one of the participants confirmed that no single practitioner was formally allocated a ‘lead’ role and that no ‘inter-professional hierarchy’ existed on a day-to-day basis at clinic level because the consultant radiographers and radiologists worked together as an integrated team and shared the workload equally:

> *(Interviewer: When you’re working alongside radiologists in the clinic do you feel that you’re on an equal level or is somebody in charge?)*
>
> *I would say the majority of the time, yes… equal. There’s probably one individual I would say no, I would defer to possibly a little bit but all the others I would say yes equal absolutely. [G31 Site 8 trainee CP]*

The continuation of this quotation explained that she felt ‘equal’ because the radiologist treated her in the same way she might another radiologist colleague – she was happy to leave her alone to finish her work:

> *One of my (radiologist) colleagues will come round and say sort of ‘I need to go at 12 o’clock, do you mind if I leave early, is that okay?’, and I’ll go ‘oh yeah, that’s fine’ or they’ll say ‘can you take over this case because I need to go?’, and that’s fine, there’s not a requirement for (a radiologist) to be here. [G31 Site 8 trainee CP]*

This equivalence did not persist in the clinical decision (MDT) meetings. It was the ‘norm’ for a radiologist to assume the imaging ‘service lead’ role during MDT meetings at both sites and radiographers typically had lower hierarchical status. One of the AdvP participants described this in terms of the ‘traditional’ demarcation of a medical / non-medical professional boundary:

> *Our consultant radiographer is very much respected within the MDT, and I’m just wondering... would it be accepted within the sort of higher levels of the MDT if it were just radiographer led…. by the clinicians, the surgeons, the oncologists… whether that would be accepted or not I don’t know. [Site 8 G39 AdvP]*

At both sites the Clinical Director of the service was a radiologist. An AdvP at Site 8 alluded to a ‘norm’ of doctors being ‘in charge’ and justified it in terms of the responsibility and training differentials between the professions:

> *I’m used to having consultant radiologists around… and the Clinical Director always being a clinical radiologist… I think you have got to have … within that role of ultimate responsibility…. more clinical responsibility …they are medically trained. [Site 8 G06 AdvP]*

A further participant reinforced the existence of a traditional professional hierarchy between medical and non-medical healthcare practitioners when she responded to the question ‘could a radiographer substitute in the role of clinical director for the symptomatic service?’:

> *I think from the point of view of clinical director, consultant radiologists have more clout with Trust management simply because they’re a doctor. I don’t think that’s got anything to do with their actual skills at image interpretation, I think that’s got everything to do with influence, because they are a medic. I don’t think we would have anywhere near the same amount of clout with senior management in the Trust.[G27 Site 8 CP].*

The above quote suggested that an inter-professional barrier existed at meso (local or service level). Although no radiologists participated in Stage 3 of the study a data extract from a radiologist interview from Stage 2 suggested that a professional ceiling operated at macro (national) level to prevent radiographers assuming clinical responsibility for breast services:

> *We are told that the director (of screening) has to be a doctor, it can’t be a consultant radiographer that’s what (national director) has said… there have been Trusts across the country like [named Trust] where there is no radiologist but there is an excellent consultant radiographer but ‘no sorry can’t be’…. well I don’t see why a consultant radiographer can’t be director of screening. Provided they are suitably trained and supported… it's not about your clinical ability, it's about your organisation and your managerial ability and understanding what breast screening is all about. And I don’t see why a radiographer can’t do that. [L21 Site 9 radiologist]*

Despite having a medical ‘clinical director’ with responsibility for the service a ‘meso’ level, the radiographers believed that they were responsible for the consequences of their own decisions as independent professionals. This was illustrated in the following quote which explains how a radiologist might be held responsible for radiographer performance only in their strategic role as service director:

> *I suppose the doctor, as clinical head of department would have (responsibility) but I think at the end of the day if something goes wrong with a patient and it’s my patient then really the buck stops with me. My clinical director might be involved because they’re head of the department as any manager would be. [G31 Site 8 trainee CP]*

This quotation supported the programme theory that responsibility, and therefore accountability, were shared concepts – an idea explored in programme theory 2 – see Section 6.3.3.

6.3.4.4 Balancing cost and clinical efficiency

In this study consultant radiographers and radiologists appeared to work interchangeably in the symptomatic MIIR role and as such it was inferred that substitution did not adversely affect workload capacity. Further evidence was sought to support the hypothesis that involving radiographers in symptomatic MIIR would generate capital and operational financial efficiencies because they did the same amount of work as radiologists but cost less to train and employ.

At Site 3 the CP radiographer provided a copy of a business case for employing a new consultant radiographer. In this the 5-year overall cost of training and employment had been calculated at 50% of the cost of training and employing a radiologist [FN 15.10.14; Site 3]. At Site 8 the operational manager explained that their service and examination costings were based on an hourly revenue rate for a consultant radiographer of 70% that of a radiologist [FN 13.11.14: Site 8a]. These figures are comparable with those reported in the literature – with the direct hourly employment rate of a radiographer being approximately 36% that of a radiologist (Brown and Desai, 2002) and reductions in imaging procedure costs of between 20% to 40% being possible when radiographers perform examinations instead of radiologists (Chu et al., 2008; Ng et al., 2003; Brown and Desai, 2002).

At both sites the participants believed there were no significant differences in the rapid access clinic workload of radiographers and radiologists. No objective quantitative data was collected about diagnostic accuracy – although the radiographers' evidence suggested that they were as, if not more accurate than radiologists, cost savings therefore should not be at the expense of clinical safety.

Echoing a comment on Brown and Desai's (2002) paper about the purpose of role substitution (Troughton, 2002), an experienced CP radiographer from Site 8 explained that saving money was not the prime driver for involving radiographers in symptomatic MIIR. Although they were cheaper she explained, adding to the MIIR workforce had beneficial consequences for patients and organisations:

> *We're certainly cheaper, but it's not just about that… you can ensure that you meet your targets, that your patients get seen in a timely manner, that they don't end up waiting. It helps the capacity issue… and from the patient's point of view, if you go to your GP with a symptom, you're going to be worried about it, you want to be seen as soon as you can... you don't want to be waiting 4-5 weeks for a clinic appointment. And using us to run our own clinics, from a purely breast imaging point of view, allows us to meet capacity issues that the Trust might have, I think it enhances the patient pathway because it allows us to run one-stop clinics [G 27 Site 8 CP]*

She went on however to highlight the need for a balance between the professions and explained how difficult MDT meetings might be if there were no specialist 'breast' radiologists:

> *I think you need to make a decision about the balance that you've got between consultant radiologists and consultant radiographers; you can't run the service completely with radiographers. You need the input of the radiologists unless you're prepared to get a general radiologist to come and look at your CTs and your bone scans in an MDT, which I think would cause problems. [G27 Site 8 CP]*

Again this developed the idea that radiographers and radiologists had to work together if changes in roles and responsibilities were to be successful.

The radiographers undertaking symptomatic MIIR in this study accepted that they were doing similar work to a radiologist in their new role but would not get paid as much. The following interview quotations illustrated their acquiescence:

> *I suppose it is a little bit galling if somebody comes in brand-new, a brand-new radiologist with very limited experience, they'll already be on nearly double what I'm on but, you know, I can't get hung up about that I'm afraid; whether that's right or wrong, you're not going to change it. [G31 Site 8 trainee CP].*

> *Never in a million years would they pay reporting radiographers, whatever you want to call us, consultant radiographers, advanced practitioners, the same even when you're doing the same job as a consultant radiologist, it wasn't going to happen. [G03 Site 8 CP]*

> *When I was a (practitioner grade) radiographer, I never dreamed I'd be doing what I am doing and earning what I'm earning, I'm happy with my lot. I accept the fact that I haven't got the breadth of knowledge that (radiologists) have got, and never will. I've got my own speciality and my knowledge is ever increasing in that speciality [G29 Site 8 CP]*

The following data extracts from the interview of the Site 3 CP radiographer captured the essence of what motivated participants in this study to become involved in symptomatic MIIR and where they derived their job satisfaction:

> *I think it's the same with all jobs - you do it if you want to… you choose to do it. For me, it's the job… the money is very nice, it's better than just doing mammography all day long… the challenge of learning and doing the role I'm in now is worth more than just 'the money'.*

> *I feel I'm very involved throughout the department, that my opinion is valued, that I know what I'm doing. Its complete - I do everything… from looking at the mammogram, through to doing their ultrasound, doing the biopsy, discussing them at MDT and giving my opinion.*

> *Symptomatic ladies come with a symptom, so they know something's going on, but most of them are sitting there praying and hoping it's going to be nothing. So when it's not, it's handling that situation to the best of your ability, so that it's not kind of like 'the end' for them. It's very stressful, but it's very, very rewarding - it's all about doing a good job – with that woman. [G03 Site 8 CP]*

In contrast to radiologists who might not find ‘breast’ a particularly attractive area of specialisation (see Stage 2 results presented in Section 5.3.5.2), the discipline appeared to have a broad range of motivating factors that inspired and sustained the involvement of radiographers in this domain of practice.

6.3.4.5 Summary - programme theory 3

The Stage 3 study data evidenced that:

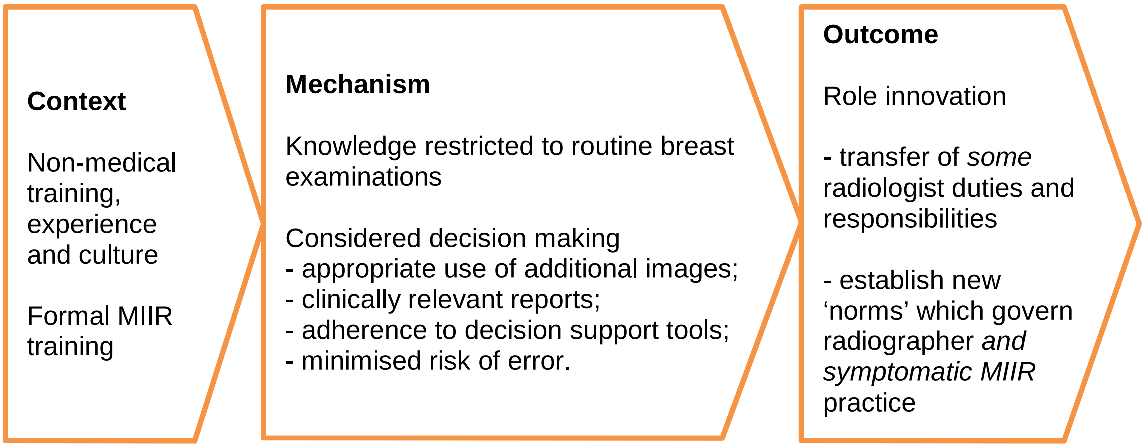
- radiographers might make more cautious and considered decisions when interpreting and reporting mammograms than radiologists;
- different image interpretation processes, for example requests for additional images and reporting styles might not be characteristics of professions, but occur between individuals within both professions;
- reasoning ‘process’ differences probably do not generate systematic differences in diagnostic outcomes (accuracy, speed);
- inter-professional differences were not a barrier to role substitution in symptomatic breast clinics;
- radiographers have the potential to perform MIIR at lower organisational cost than radiologists.

The data supported the assertions that radiographers:

- could not work in isolation without radiologists in the symptomatic service, and in particular could not replace radiologists in the MDT because differences in the training and professional backgrounds triggered different scopes of practice;
- were limited to acquisition, interpretation and reporting of routine ‘breast’ imaging examinations such as mammography and ultrasound whereas radiologists’ practice encompassed ‘whole body’ and complex imaging examinations such as CT, MRI and RNI;
- operated in a new ‘hybrid’ clinical - technical role which bridged the traditional professional boundaries of radiographer and radiologist practice.

The Stage 3 study findings required only minimal changes to the ‘mechanism’ and ‘outcome’ components of the second programme theory tested (Figure 6.6).

Figure 6.6 Revised programme theory - role innovation



The study evidence aligned with the hypothesis that radiographers had created and were occupying a different new role because their non-medical status precluded them from substituting in the exact role of a radiologist.

The radiographer's new role appeared to be clinically effective because radiographers seemed to undertake the same volume of work to the same standard as radiologists. The role seemed to be cost-effective because radiographers were paid less than radiologists would otherwise be paid to do the work. Radiographers were incentivised to undertake the new role because it enabled them to have greater involvement in patient care.

6.4 Chapter 6 summary

This chapter of the thesis critically analysed the data collected during Stage 3 of the research. Throughout this chapter participant evidence was critically evaluated and applied to refine programme theories about the development of expertise and working in professional teams.

The critical arguments presented in this chapter illustrated how expertise and team working were fundamental 'resources' that enabled radiographers to undertake, not only symptomatic MIIR, but all other duties in the traditional domain of a radiologist in the one-stop diagnostic breast clinic environment.

This evidence presented in this chapter suggested that radiographers could not substitute for radiologists across the entire symptomatic breast service because their scope of practice was limited to routine breast examinations and did not encompass non-breast and more complex cross sectional and functional imaging.

The chapter concluded by proposing that the radiographers occupied an innovative new role which enabled them to undertake routine work that would otherwise need to be performed by a radiologist and which enabled them to share responsibility for diagnosis of breast disease across professional teams.

Radiographer role innovation appeared to offer the potential of a cost and clinically effective solution for maintaining breast diagnostic service provision where clinical demand outstrips medical workforce capacity.

Chapter 7 Discussion, conclusions and recommendations

7.1 Introduction

This research project explored the involvement of radiographers in symptomatic mammography image interpretation in UK NHS diagnostic breast services. It sought to identify and test theories that could explain how and why radiographers were able to undertake work traditionally in the professional domain of radiologists, identify the conditions and characteristics which triggered this, explain why it varied across services and between practitioners, and establish the outcomes of change in professional practice.

Due to the recursive nature of the RE methodology employed study findings have been discussed throughout this thesis as they were presented, and as they were used to modify and refine the original programme theory hypotheses. This closing thesis chapter critically reviews six key findings that emerged from the study and presents final versions of their programme theories. The chapter considers the potential contribution of the study findings to the current knowledge base and concludes with recommendations for clinical and professional practice and policy and identification of further research endeavour which could usefully extend the impact of this project.

The following sections of the discussion chapter consider how:

- involving radiographers in preliminary clinical evaluation (PCE – commenting) might streamline the patient's clinic journey and offer potential to improve diagnostic accuracy;
- involving radiographers in formal double reading was resource intensive compared to informal 'instant' double reading and could result in diagnostic delay;
- radiographers were able to undertake task substitution autonomously after developing MIIR expertise through training, repetition and feedback;
- clinical specialisation enabled radiographers to role substitute in one-stop clinics because they had expertise in all routine breast imaging techniques;
- expertise was a combination of competence and confidence and was developed through cognitive and social learning.

7.2 Preliminary clinical evaluation

The way that radiographers were involved in preliminary clinical evaluation in this study was different to previously reported radiographer red dot and commenting schemes.

Radiographers were required to give a written diagnostic opinion, a ‘free text’ description of any abnormality they identified as described by Hardy and Culpan (2007) and images were still definitively read by radiologists (Culpan, 2006). However, in this study the intervention was not triggered by the need to provide a timely and informed opinion to assist non-specialists (breast surgeons) to make correct diagnoses in the absence of a radiologist (Culpan, 2006). The intended outcome of involving radiographers in PCE in this study was to identify cancers that radiologists might otherwise overlook. The ‘mechanism’ for increased cancer detection was ‘double’ reporting – radiographers ‘first read’ the images they produced and highlighted potential abnormalities for radiologists who undertook the second ‘definitive’ read whilst the patient was still present in the one-stop clinic.

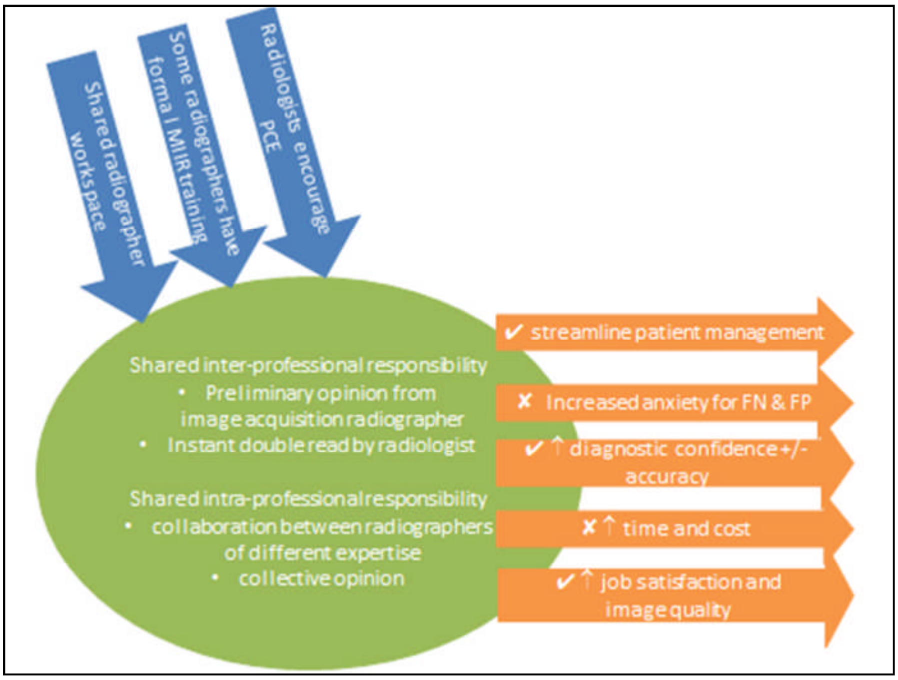
Mucci et al. (1997) had suggested that where radiographers were involved in abnormality signalling without formal training they would not detect as many cancers as a radiologist but would consider more cases to be abnormal overall. This thesis has demonstrated this to be an intended consequence of the intervention. In this intervention radiographers had responsibility for sensitivity - flagging up possible abnormalities, and radiologists had responsibility for specificity, downgrading and dismissing false positive cases. Responsibility for MIIR was shared across the inter-professional boundary between radiologists and radiographers, even though a medical / non-medical power differential still existed because the radiologist had ultimate authority and could overrule a discordant radiographer opinion.

Contrary to the initial programme theory that the PCE role would be implemented where radiographers lacked formal training in MIIR and Snaith and Hardy’s (2008) observation that PCE systems are often voluntary, when this intervention was implemented all radiographers, irrespective of training and experience, were involved. Initially, trainee and inexperienced radiographers were anxious about the responsibility but as a group the radiographers had a mix of knowledge and skill and on a day-to-day basis more experienced colleagues and those with formal MIIR training collaborated with junior peers to present a ‘collective’ radiographic opinion to the radiologist. Responsibility was thus also shared across the intra-professional radiographer team, collaboration and collective decision making being facilitated by occupation of a shared (radiographer) workspace. Participation in PCE enhanced radiographer job satisfaction because they felt more involved in patient care.

In addition to potentially improving cancer detection as demonstrated by Mucci et al. (1997), this study identified that the intervention might also streamline the patient's journey through clinic because radiographers initiated and performed additional imaging (mammographic extra views and / or ultrasound) on the basis of their PCE; avoiding repeat transits through clinic might be offset the time needed by radiographers to generate a provisional report. PCE also had the potential to improve mammographic image quality because radiographers became more aware of the technical requirements for accurate image interpretation, this might lead to increased cancer detection (Rauscher et al., 2013; Taplin et al., 2002).

The final programme theory about PCE is illustrated in Figure 7.1.

Figure 7.1 Final programme theory - commenting



7.3 Double reading

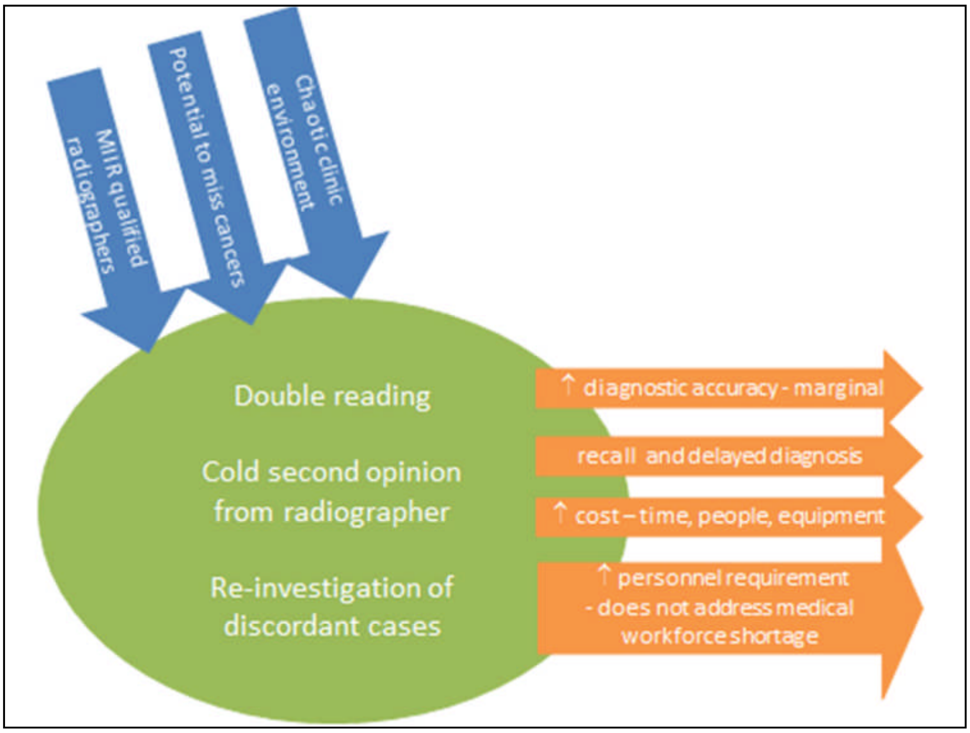
There have been many studies demonstrating that double reading in mammography screening programmes improves cancer detection (Liston and Dall, 2003; Blanks et al., 1998; Anderson et al., 1994; Thurfjell et al., 1994; Anttinen et al., 1993) and the case for involving radiographers in double reporting in the UK NHSBSP instead of a second radiologist is well established (Bennett et al., 2012; Wivell et al., 2003). The one-stop nature of the diagnostic clinic, with the need for MIIR whilst the patient was present in the clinic, was identified as a barrier to involving radiographers in a formal double reporting interventions similar to the ‘cold’ (delayed) double reading that occurs in screening programmes. In addition to PCE described above, and excluding preceptorship where the cases of trainees and novices are reviewed by a mentor, this study identified and explored two other double reading interventions: delayed radiographer second reading and instant second reading.

Formal delayed radiographer second reading of cases first-read by radiologists in the one-stop clinic did not reduce radiologist workload, arguably the over-riding intended consequence of the programme of interventions being evaluated in this study. Nor, on the balance of evidence collected and analysed did it seem to offer any improvement in quality of care for patients attending symptomatic clinics. The intervention was reported to occasionally detect small, subtle incidental cancers that had been overlooked by the radiologist, arguably such errors occurred because the one-stop clinic was a pressured and distracting environment that impaired concentration, but the detection of cancers, and other ’false positive’ abnormalities, after patients had been given their ‘results’ and left the clinic was undesirable.

Berlin (2010) highlighted that small, ill-defined incidental abnormalities missed by practitioners issuing instant reports can result in clinically significant delayed diagnosis and Waldmann et al. (2012) demonstrated that ‘cold’ second consideration of mammograms increased cancer detection in a German breast imaging service. However, Britton et al. (2009) demonstrated that the number of cancers missed by a single reading radiologist in a UK symptomatic ‘triple assessment’ service might be as low as three per annum. Double reporting is an addition to the current standard of symptomatic care and as Britton et al. (2009) argue is likely to produce very little gain for a large increase in workload - Waldmann et al. (2012) demonstrated a 90% increase in further investigation rates (from 3% to 5.7%) for a 12.3% increase in CDR (from 14.6/1000 to 16.4/1000).

The findings in this thesis are concordant with the arguments against cold double reporting of symptomatic cases. The participants recalled detecting only a small number of ‘missed’ cancer cases and the intervention required additional human resource, MIIR qualified AdvP and CP radiographers and additional service resource - second reading and recalled patient follow-up sessions. The cost and clinical consequences of the cold second radiographer reporting intervention encountered in this project, increased patient anxiety (false positive) and diagnostic delay (true positive) for recalled cases, remain unknown. The final programme theory for delayed double reporting is illustrated Figure 7.2.

Figure 7.2 Final programme theory – delayed double reporting



By contrast, the study data identified a new 'double reading' intervention – informal second reading at the time of patient attendance. This intervention worked where ultrasound practitioners, either radiographers or radiologists, were multiskilled in both MIIR and ultrasound and the two examinations were performed by different practitioners. Double reading occurred because the second practitioner (sonographer) always looked at the mammographic images and reviewed the report before performing the ultrasound examination. This intervention yielded an instant second opinion, required no additional operational human or service resource, had the potential to identify additional small, subtle or incidental abnormalities that might have been overlooked, which could be investigated further without delay. The intervention would require some capital investment to ensure practitioners were multiskilled, however it would make the staff resource more flexible and responsive to operational (clinic) and strategic (vacancies, sickness and holidays) fluctuations in service demand.

The findings of this study are a useful addition to the current knowledge base about double reading of symptomatic mammograms. The two double reading interventions which involved radiographers in 'instant' (hot) double reading, PCE and informal (sonographer) image review for example, could realise the principal intended consequence of double reading, detection of cancers missed by a single reader, with fewer unintended consequences than radiographer performed delayed (cold) second reading.

7.4 Expertise in MIIR and task substitution

Following formal task-specific training and an extended period of practical experience radiographers were able to undertake symptomatic MIIR instead of a radiologist. Although this study did not evaluate quantitative ‘outcome’ measures the qualitative data included evidence suggesting that the diagnostic accuracy of trained and experienced radiographers was similar, if not greater than that of radiologists. This was in keeping with the findings of other studies which assessed radiographers undertaking image interpretation in screening mammography (Wivell et al., 2003), skeletal radiography (Robinson et al., 1999), chest radiography (Woznitza et al., 2014), intravenous urography (Bradley et al., 2005) and barium enema reporting (Murphy et al., 2002). The qualitative data also suggested that performance outcome indicators such as decision speed (a proxy for workload capacity), additional resource use, report content and reporting style were not significantly different between the professions. Further corroboration of the task substitution outcome measures identified in this study using quantitative methods would be a useful extension of the project.

In keeping with substantive theories about the development of expertise ‘deliberate practice’, that is instruction, repetition and feedback on performance (Ericsson, 2004a), was confirmed as a ‘mechanism’ which could alter the reasoning processes of radiographers as they progressed from trainee, through ‘novice’ towards ‘expert’ practice. Deliberate practice seemed to develop intuitive pattern recognition and heuristic reasoning for an increasing range of mammographic appearances - expertise in symptomatic MIIR being defined as the ability to recognise small, subtle and incidental cancers and interpret and report difficult and unusual cases. This was consistent with Berlin’s (2010) small series of radiological errors which included small, ill-defined, equivocal and incidental abnormalities missed by non-expert practitioners.

Although not equipping radiographers with all the knowledge and skills to interpret and report symptomatic cases, involvement in NHSBSP screen-reading was identified as an important ‘mechanism’ for development of mammography image interpretation expertise. Screen reading experience was considered to improve specificity over symptomatic cases because intuitive recognition of a wide range of normal and uncomplicated benign mammographic appearances reduced the number of additional investigations performed. Involvement in NHSBSP PERFORMS and interval cancer review was seen as a tool for improving sensitivity for small and subtle abnormalities, those often overlooked by single readers, and thereby reducing the risk of missing clinically occult incidental, often contra-lateral, cancers in symptomatic patients presenting with focal symptoms. Participation in NHSBSP screen reading occurred where services were co-located on the same site but access for practitioners working at symptomatic-only sites was limited to consultant (radiologist and radiographer) practitioners or limited to accessing the PERFORMS resource.

In contrast to the two-stage model of mammography interpretation proposed by Pauli (1993), interpretation and reporting of symptomatic mammograms was discovered to be a four-stage process, see Table 7.1.

Table 7.1 Four stage symptomatic MIIR process

Fast reasoning ⟶	**Slow reasoning ⟶**	**Slow reasoning⟶**	**Action**
Intuitive global impression Automatic detection Recognition of obvious and expected abnormalities	Analytic deliberate considered Search to find Sequential systematic check Whole / all images – current and prior	Analytic Holistic review Compare, synthesise and correlate clinical and radiological information	Decide what to do next Collect more information Stop Accept consequences of decision

In an extension of Kahneman's (2011) dual processing theory – in addition to intuitive ('thinking fast'), and analytic ('thinking slow') visual processing, symptomatic MIIR involved a third analytic clinical decision making phase which considered how decisions about image appearances explained a patient's presentation and answered the clinical question followed by an 'action' decision.

Knowing when to 'stop' and 'accepting the consequences of decision' were additional characteristic of expertise identified in this study. Kim and Mansfield (2014) identified that most image interpretation errors were due to under-reading (42%), defined as 'simply missed', or 'satisfaction of search' (22%), defined as missing additional clinically significant abnormalities after detecting initial less significant findings. They suggested that these errors might be reduced using a 'checklist' approach - the slow systematic evaluation of mammographic images discovered in this study appeared to operate as a 'virtual' checklist.

In addition to cognitive competence, the ability to recognise and categorise abnormalities, this study identified 'confidence' as an important mechanism which triggered 'stopping'.

The existing literature about ‘confidence’ in radiographers functioning in ‘expert’ roles focusses on a personality trait synonymous with assertiveness. Price and Edwards (2008) proposed that competence and confidence were interlinked qualities in expert practitioners but their suggestion of ‘combined strategies’ for development was based on a combination of separate strategies in parallel. They defined confidence as a ‘soft’ skill and suggested boosting it with assertiveness training to build tenacity and resilience. In contrast they suggested cognitive approaches for developing competence - feedback and performance analysis. When Henwood and Booth (2016) illustrated ‘confidence’ in their study of pioneer radiographers establishing new roles they used data about being ‘pro-active’ and ‘unafraid to challenge others’. Further examples given in Henwood et al. (2016) inferred that self-belief and inner confidence were synonymous traits manifest in behaviours such as ‘projecting yourself’ and ‘being prepared to challenge’.

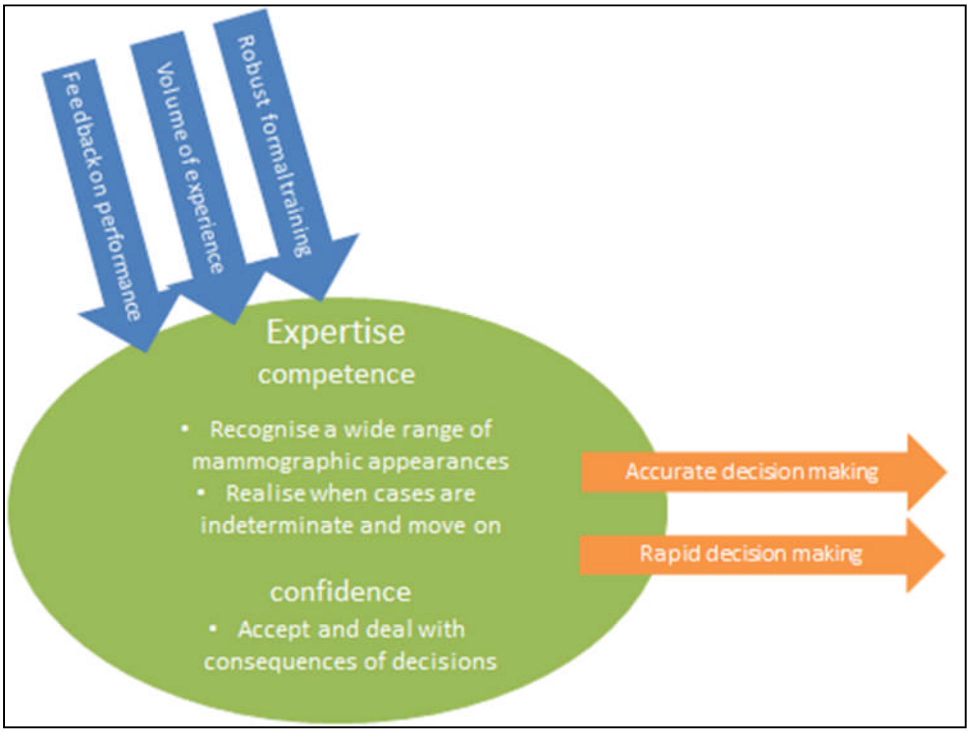
The ‘confidence’ identified in this thesis was a different attribute. Wittenbaum et al. (1998, cited by Thomas-Hunt and Phillips, 2004) argued that expertise increased confidence - in this thesis it is argued that confidence is inextricably linked to competence and that both are mechanisms, resources of expertise.

Sonnentag and Volmer (2009) linked expertise and self-efficacy - the confidence to be able to perform a specific course of action (Bandura, 1977). Yeung and Summerfield (2012) call this ‘first order confidence’ making a choice, a decision. In terms of symptomatic MIIR this is diagnosis - deciding that an abnormality is present and allocating a level of suspicion (the M1- M5 scale) based on the information available at the time, image appearances and clinical history for example. ‘Second order confidence’ Yeung and Summerfield (2012) suggest, is an estimate of the likelihood that the outcome of the decision is favourable (correct) or unfavourable (incorrect). Errey (2015) proposes that confidence is not about trusting that an outcome will be favourable, but is about being able to deal with the consequences of the decision whatever the outcome. This appears to be the ‘confidence’ that study participants described – experts retained some fear and anxiety about making mistakes, consequences that Errey (2015) described as things ‘not going according to plan’ or ‘having adverse consequences for you’, but they could make difficult choices because they trusted their own judgement. McMurray (1992) suggested a similar phenomenon – that experts might be the type of people who can maintain a sense of perspective about themselves.

McMurray (1992) suggested further research was needed to investigate confidence as both a pre-disposing factor, in realist terms a ‘contextual’ triggering characteristic, and an outcome, of expertise. In this thesis competence and confidence were demonstrated to be co-dependent features of 'expertise' and characteristics that were developed simultaneously. Price and Edwards (2008) suggested that 'feedback' could improve competence – arguably because apprising radiographers of their own cognitive strengths and weaknesses prompts them to engage in reflective practice to improve their performance. Performance appraisal such as this also developed both competence and confidence in this thesis. Positive feedback reassured radiographers that they were 'getting it right most of the time' as their competence developed, seeking feedback from radiologists also reassured them that 'doctors don't know either' and 'doctors miss things too'. Feedback was also sometimes expressed as a show of 'respect', demonstrated in actions such as 'doctors come to you for help' and 'surgeons trust your opinion'. McMurray (1992) reported a similar development of confidence in expert community health nurses as they built up a history of successful judgements.

The programme theory which explains the task substitution intervention - that deliberate practice (context) develops competence and confidence (mechanisms) which enable radiographers to interpret and report mammograms to the same performance standards as radiologists (outcome) is illustrated in Figure 7.3.

Figure 7.3 The task substitution intervention

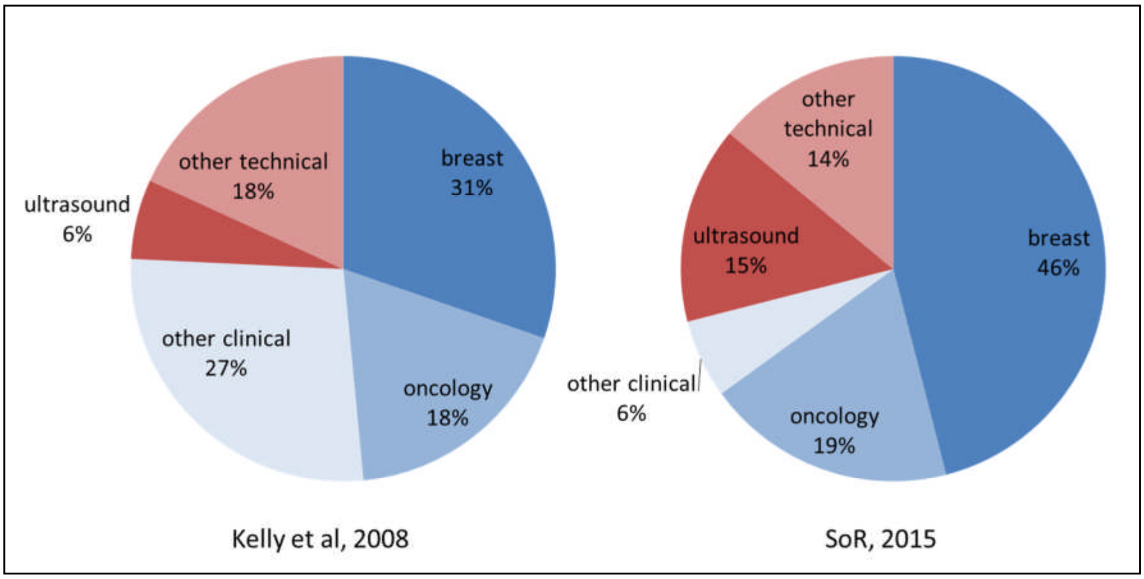


7.5 Clinical specialisation and role substitution

Role substitution had greater potential to realise the intended consequences of the ‘substitution’ intervention than task substitution. Role substitution could only be implemented where radiographers had expertise across the full range of routine diagnostic tests traditionally performed by a radiologist - in the symptomatic clinic this included ultrasound examinations and tissue sampling procedures. Some radiographers had also extended their professional boundaries to encompass clinical breast examinations, breast MRI and breast localising RNI procedures.

Specialisation, the development of expertise in a specific clinical area (Nancarrow and Borthwick, 2005) is a relatively new paradigm for radiographer professional development. In their paper outlining the requirements for ‘consultant’ radiographer practice Hardy and Snaith (2007) suggested that their expertise would have an anatomy, or pathological ‘condition’ focus. Data presented by Kelly et al. (2008b) from the Society of Radiographers consultant group corroborated that the majority (25/33, 76%) of consultant practitioners had an anatomy or pathology focussed domain of expertise – the blue sectors of the left pie chart shown in Figure 7.4.

Figure 7.4 Consultant radiographer focus of expertise



Comparison of this with current data (SoR, 2015), shown in the right pie chart in Figure 7.4, demonstrates a similar situation: 71/100 (71%) current consultant radiographers are clinical specialists (blue sectors). These data illustrate that clinical specialisation in breast imaging is the largest sub-speciality group and appears to be on the increase. Adding to current literature describing the scope of consultant radiographer practice, the findings presented in this thesis provided a theory-based explanation of the conditional relationship between clinical specialisation and the development of expertise.

This thesis explained how the acquisition of skills across a range of diagnostic techniques in a single clinical domain gave the expert practitioner a holistic overview of the patient's entire diagnostic journey. A similar holistic client-centred perspective was documented by McMurray (1992) in her comparison of novice and expert community health nurses.

Multiskilling was a mechanism (resource) which enabled a single radiographer to perform all examinations for an individual patient – this provided direct continuity of care and allowed the synthesis of information into a coherent overall diagnostic opinion. A new finding in this study was 'virtual' continuity of care, synthesis of knowledge in a holistic approach to diagnostic reasoning even when working in an isolated MIIR 'task' substitution capacity. Multiskilled radiographers considered their interpretation of the mammographic appearances in the context of all other additional and potential information that had been, or might be available, from clinical examination, ultrasound and tissue sampling for example. Although they might perform only one of the tests in an operational scheme of work, multiskilled clinical specialisation was a resource that aligned radiographer reasoning more closely to that of radiologists who had a similar 'whole diagnostic journey' overview.

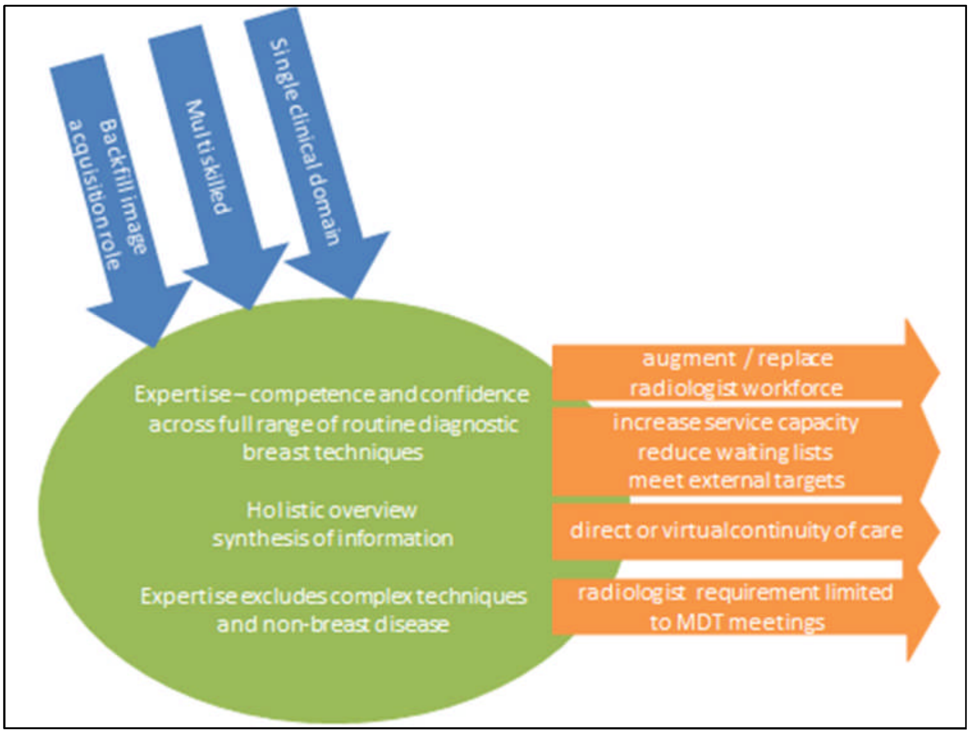
Invariably as radiographers specialised in breast imaging – developed expertise and across a wide range of technical disciplines, they gave up tasks they were trained for initially - general radiography, and they gave up other non-breast imaging. This was enabled by backfilling these roles with radiographer practitioners at lower grades in the 4-tier workforce structure. This gave them enough time to undertake the training and repetition (volume of cases) needed to develop expertise across the range of breast diagnosis techniques. The findings presented also demonstrated that as clinical specialist breast radiographers took on more and more of the breast radiologist's role they also gave up their mammography image acquisition role – with similar backfilling as before.

Hardy and Snaith (2007) contrasted the anatomy focussed 'expert' consultant radiographer's practice with that of practitioner and advanced practitioner grade radiographers which, they claimed, were typically technique based. Contradicting this view, the findings presented in this thesis demonstrated anatomy focussed practice across the whole 4-tier workforce structure.

This thesis explained how lack of expertise in technically complex cross-sectional imaging techniques (CT and RNI) and non-breast imaging was a barrier to radiographers substituting for radiologists in MDT clinical decision making meetings which covered cancer staging and cases with co-existent non-breast disease. In this thesis a radiographer only led the symptomatic MDT in the planned or unexpected absence of a radiologist. Booth et al. (2016) report the data of a consultant radiographer who is a ‘clinical lead for breast imaging’ and ‘leads the radiology side of the breast MDT’ – it is suspected that this practitioner was targeted for recruitment to this study but was unable to participate within the limits of the data collection period available.

The programme theory for role substitution is similar to that for task substitution, with the extension of expertise, that is competence and confidence, across the full range of routine diagnostic breast examinations as illustrated in Figure 7.5.

Figure 7.5 Final programme theory - role substitution



Lack of expertise in complex and non-breast imaging prevented full substitution for radiologists, for the radiographers in this study. It was therefore argued that the consultant radiographers substituting for radiologist in this study had created a new innovative technical-clinical hybrid practitioner role that was more than a radiographer, but not quite a radiologist.

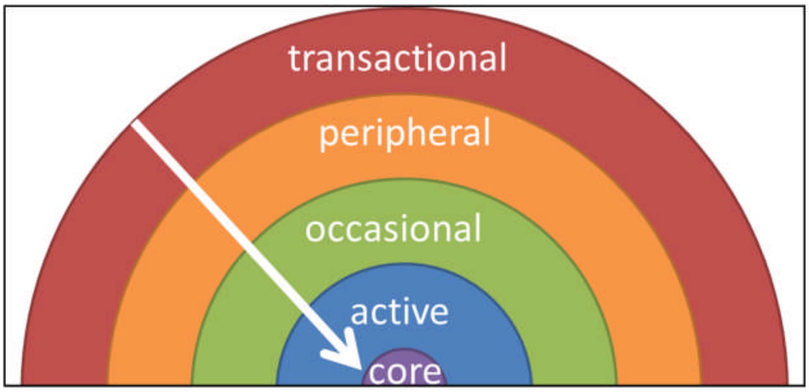
7.6 Social learning - a mechanism for developing expertise

This study highlighted the influence of the ‘situated’ real-life practice environment on radiographer diagnostic decision making. In particular it revealed the influence of team working on the development and application of symptomatic MIIR expertise. The data analysis presented in the thesis demonstrated how symptomatic MIIR was embedded in the wider diagnostic process of triple assessment and required radiographers to interact with nursing and surgical colleagues who performed clinical examinations and pathologists who interpreted histology of tissue samples obtained under image-guidance. In the one-stop clinic environment and in multidisciplinary clinical decision making meetings radiographers involved in symptomatic MIIR had to interact with an even greater range of medical and nurse colleagues. These interactions were discovered to be important situated ‘peer-to-peer’ learning opportunities. Team working was an important resource for radiographers to acquire the skills needed to substitute for a radiologist and was also a forum where their expertise and autonomy could be displayed.

In their realist synthesis evaluating inter-professional teamwork Sims et al. (2014) tested the hypothesis that working in teams provided individuals with learning opportunities and relationships that enhanced their confidence. The investigators found a substantial amount of evidence showing team working facilitated learning because members pooled their knowledge had opportunities to observe each other and ask questions. They suggested that the ‘mechanisms’ for learning included on-going communication, regular meetings and respect for the skills and knowledge of others. However, there was little evidence that learning within a team enhanced confidence. The evidence presented in this thesis addresses this gap because it demonstrated how learning within the MDT was integral to the development of expertise – a combination of competence and confidence.

This thesis introduced the substantive ‘community of practice’ social learning theory of Lave and Wenger (1991) as an original contribution to the image interpretation discipline and suggested that the path to expertise involved both a cognitive and a social learning journey. The community of practice social learning theory explained how radiographers gained the trust and respect of MDT colleagues and became ‘legitimate members' of the team as they moved in a centripetal journey from the periphery to the core of the community. In the model described by O'Brien et al. (2015), illustrated in Figure 7.6, image acquisition radiographers who observe MDT meetings are 'transactional' members, new MIIR radiographers are 'peripheral' participants, 'occasional' members include CT or RNI radiologists who contribute specific expertise, radiographers performing MIIR, ultrasound and tissue sampling are 'active' members and consultant radiographers substituting for radiologists are 'core' members.

Figure 7.6 Membership of a community of practice



Radiographer and radiologist roles in the MDT were officially defined by their organisational roles, their responsibilities determined by their cognitive 'task-work' knowledge and skill, derived from formal qualifications and experience. The functional success of their roles however was dependent on legitimacy of the 'social' (team) status. Trainee and newly qualified MIIR radiographers (and radiologists) were legitimate peripheral participants and their journey to legitimate active membership of the team involved learning to perform their role 'better' and gaining recognition of their skills and knowledge from other team members. It was by displaying high level skills and knowledge during sustained interaction with other members of the MDT (teamwork knowledge and skill) that 'expert' radiographers gained acceptance as valued active team members and were acknowledged as contributors to clinical decision making as radiologist substitutes. Consultant radiographers became legitimate core MDT members because they 'proved' they could do the job of a radiologist.

This study adds to current evidence base by highlighting the importance of social learning processes, in addition to traditional cognitive learning, in the development and application of radiographer expertise of symptomatic MIIR. Sonnentag and Volmer (2009) suggested that expertise and self-efficacy (confidence) were predictors of contribution to teamwork processes. The data in this study support the theory that expertise, in this study defined as both competence and confidence, and team contribution are interrelated; the social learning theory employed in this study led to the conclusion that expertise and confidence were outcomes of team participation.

In addition to contributing formally to ‘team’ decision making in MDT meetings as above, this thesis identified multiple ways in which radiographers involved in symptomatic MIIR reached decisions in collaboration with colleagues. It also identified that radiographers believed responsibility for cancer diagnosis and accountability for errors was invested at team level in the symptomatic service. The concepts of MIIR as a collective endeavour and team accountability are novel in radiographic practice and are a consequence of their changing role in practice (Goodwin, 2014).

Bell et al. (2011) pointed out that the traditional situation of accountability being assigned to individual practitioners is changing as groups of health-care practitioners increasingly provide team-based care. Hewitt et al. (2014a) sought evidence to support the hypothesis that team members influencing team decisions shared responsibility for those decisions and their outcomes. They discovered that shared influence had been studied more often that shared responsibility. They found that some practitioners feel collectively accountable and less individually responsible where decisions were team based and that this made them less likely to blame individuals when errors occurred.

Bell et al. (2011) noted that although errors in team-based care are more likely to occur due to ‘systems’ failure, blame is still often attributed at individual level by patients, practitioners and the law. In Wilson et al.’s (2005) study of Canadian GPs, opinions about where responsibility lies differed – some GPs felt that a team based model of care improved their working lives because they could ‘share the load’ which reduced stress; others felt that the GP was always ultimately responsible for the overall patient outcome.

Bell et al. (2011) discuss the construct of ‘collective accountability’ as a way of reconciling an individual practitioner’s specific responsibilities with team delivery of care. The authors suggest that the concept requires practitioners to learn new skills that improve team performance and participate in initiatives for evaluating and minimising errors. Although this is not a new concept, Bell et al. (2011) acknowledged that bringing the concept to life was complex. This thesis has demonstrated the concept as an ‘informal’ paradigm for professional radiographic practice, and as Bell et al (2011) suggest – a concept that requires further exploration.

7.7 Conclusion

The research project presented in this thesis explored the involvement of radiographers in symptomatic mammography image interpretation in UK NHS diagnostic breast services – a task traditionally in the professional domain of medically qualified practitioners. The study identified and tested theories that explained how radiographers undertake this task, why they are able to do it and what the consequences of changing the professional boundaries are.

Involving radiographers in symptomatic MIIR was a multifaceted ‘intervention and it was difficult to unpick the influences of all its different aspects (Cheyne et al., 2013). Applying RE in an novel setting was intellectually challenging and required the researcher to engage in sustained thinking and imagination to identify, track and trace contexts, mechanisms and outcomes in the literature (Pawson et al., 2004 cited by Hewitt et al., 2014b) and in the study’s empirical evidence.

There were no prior exemplar studies of a similar nature making it difficult in particular to identify contexts, mechanisms and outcomes and clarify understanding of their dynamic and plural nature. As discovered by Byng et al. (2005) there were many potential ways of constructing CMO configurations, the same phenomenon could operate as a context in one hypothesis and a mechanism, or an outcome, in another, and outcomes sometimes occurred as a result of multiple contexts and mechanisms.

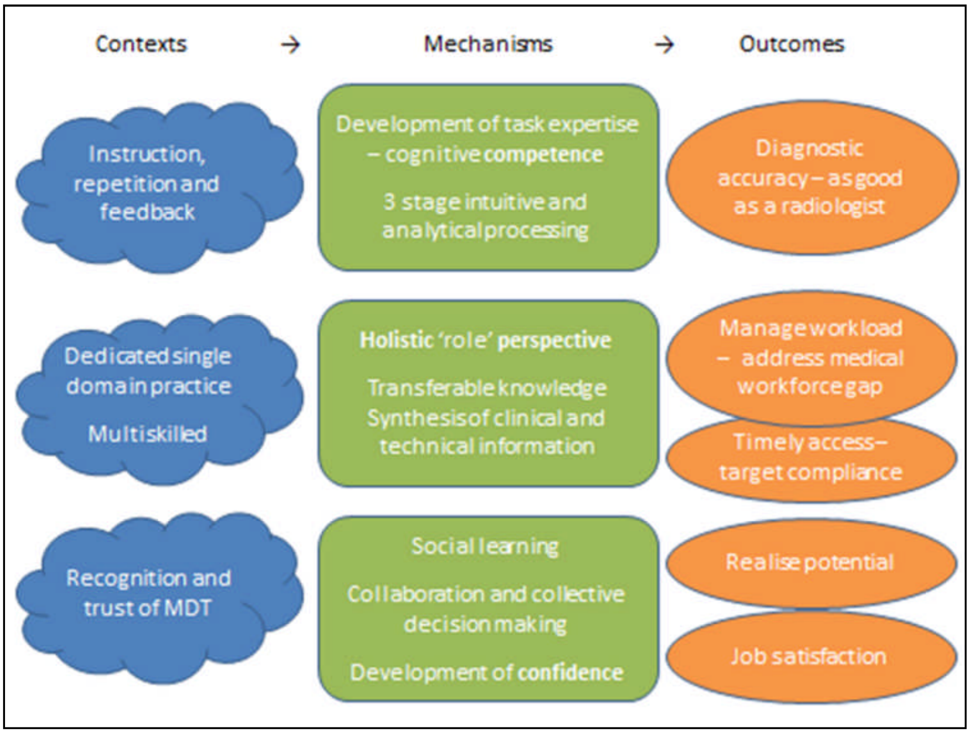
In this study programme theories did not fit the simple single context, single mechanism, single outcome model illustrated by Pawson and Tilley (1997) – the theories identified and developed in this study used Cs, Ms and Os in multiple combinations and described causal relationships at different stages of the implementation chain. Some CMO configurations explained programme theory at individual practitioner (micro) level – what it was about some practitioners that made it work, and why it did not work for others, some explained relationships at local ‘service’ level or at ‘profession’ level (meso) – why it worked differently in different places, and some were configured at macro level to explain how the policies of national bodies influenced professional practice al local and individual level and how this might affect outcomes on a population scale. As Byng et al. (2005) suggested the specific, intermediate and holistic pictures all had value.

In Stage 2 of the study the sample size, 38 participants at 8 sites was large enough to include a range of radiographer practitioner and service contexts but data collection did not include operational manager, strategic policy maker or patient perspectives (Cheyne et al., 2013). In Stage 3 of the study, observation was limited by time constraints to a single clinic observation of each participant and only five MDT meetings but this included data collection of radiographer involvement in approximately 200 patient cases.

The purpose of this RE was not to pass judgement about the different ways in which radiographers might be involved in symptomatic MIIR or identify which processes were more successful and those that had failings (Hewitt et al., 2014b). The purpose of the study was to provide a means of conceptualising and understanding the process of involving radiographers in symptomatic MIIR in a way which carried potential for use in NHS breast imaging service development (Hewitt et al., 2014b) – identify what worked, for whom and in what circumstances.

The model illustrated in Figure 7.7 represents the overarching programme theory at ‘global’ or ‘macro’ level. This explains the main themes identified in the research which explained how individual and organisational conditions (contexts) generated resources which changed the reasoning (mechanisms) of the practitioners who participated in this study and what the consequences (outcomes) were.

Figure 7.7 Final global programme theory



The evidence presented and theories developed in this thesis illuminated what might be going on in the ‘black box’ of the intervention studied (Pawson, 2006). The findings helped develop an understanding of why different radiographers might be involved in symptomatic MIIR in different ways - at different times in their career, under different local circumstances and within different professional cultures - and what the different consequences (outcomes) of this might be. In line with the philosophical principles underpinning realist evaluation, the understandings presented in this thesis are inevitably fallible (Maxwell, 2012; Pawson 2006). Social systems are the product of endless components and forces and the elements of complex problems themselves are inexhaustible (Pawson, 2013, Pawson 2006). Studies of open social systems can never consider every conceivable extraneous influence; as such evaluation research projects are necessarily constrained by pragmatic boundaries (Pawson, 2006).

The final CMO configurations presented in this thesis emerged from the testimonies and observed practices of one particular group of participants as witnessed and interpreted by one particular researcher. As such the final programme theories represent the temporary consensus view that these specific participants and this individual researcher considered to be true at this moment in time (Maxwell, 2012). Beyond the boundaries of this study further evidence, from a larger number and wider range of stakeholders for example, might have generated alternative plausible explanations for the phenomena studied. A different observer (researcher) using different methods might have produced different descriptive accounts of the same observed events.

This evaluation research project sought to gain a wide understanding of the array of potential influences that shaped the involvement of radiographers in symptomatic MIIR; the findings are useful despite being partial, adding to existing knowledge and providing a platform for accrual of further knowledge (Pawson, 2013).

In line with the project's explanatory focus and exploratory nature no attempt was made to 'measure' impact (outcomes) objectively. The 'distal' outcome components of the CMO configurations presented are, in particular, speculative. Assertions about the impact that the intervention might have on service outcomes such as diagnostic accuracy, resource use, patient pathway length and cost effectiveness are based on reportage, data which was not directly observed during the study and thus had only secondary descriptive validity (Maxwell, 2012). These outcomes are observable events that might be tested empirically and measured in further studies using appropriate quantitative methods. It is suggested that data about patient transit time, imaging to diagnostic decision time, radiologist re-reading time, additional investigation frequency, time and cost, and practitioner costs might be useful to individual services wanting to evaluate the potential consequences of involving their own radiographers in symptomatic MIIR in their local setting.

7.8 Recommendations

The findings of this study led to the following key recommendations. Implicit in the RE methodology used for this project, the interventions, and thus the recommended changes suggested here, may not work in the same way for different people in different circumstances. As such these recommendations are made with an over-riding recommendation that changes based on the theories presented in this thesis are introduced prospectively, carefully planned and monitored. Sharing of local initiatives through publication offers the potential to refine the theories further through realist cumulation (Pawson and Tilley, 1997).

Recommendation 1:

- Where there is no radiologist workforce shortage, all radiographers involved in symptomatic mammography image acquisition should be encouraged to participate in preliminary clinical evaluation (commenting) as first reader in a hierarchical double reading system.

  Encouraging radiographers to evaluate the diagnostic information in their images has potential to streamline the patient journey through one-stop clinics, improve the technical quality of mammograms and reduce the risk that abnormalities might be overlooked by radiologists. Diversifying the role of the radiographer in this way requires minimal, if any additional resource but requires radiologists to provide balanced feedback on radiographer opinions to enable them to learn how to interpret mammograms better.

  The Society of Radiographers should consider extending the requirement for PCE as a core competence of general radiographic practice (SoR, 2013) to include mammography practice. Mammography education providers should consider including initial training in PCE in postgraduate mammography programmes.

Recommendation 2:

- Involving radiographers with MIIR expertise in conventional ‘cold’ double reporting of symptomatic mammograms should be discouraged because it is resource intensive and can introduce diagnostic delay for minimal gain.

  Independent (equivalent) double reporting of mammograms by radiologists and radiographers is an addition to the current standard of care in symptomatic services. At present, there is no evidence of clinical gain to justify the resources required for double reporting symptomatic mammograms. The one-stop triple assessment service delivered in UK NHS breast clinics minimises the likelihood that a radiographer second reading after patients have left the clinic will detect clinically significant additional abnormalities missed by a single reading radiologist in clinic. Where a clinically significant level of error is suspected, services should review the one-stop clinic environment and image interpretation process and consider how systems and resources might be improved to enhance the detection of all clinically significant abnormalities at the time of patient attendance.

Recommendation 3:

- Services that need to maintain, increase or expand breast imaging provision in the absence of additional radiologists should consider substituting radiographers in symptomatic MIIR.

    The journey to the level of expertise which allows a radiographer to substitute for a radiologist in symptomatic MIIIR is a long one involving formal training, preceptorship and continued regular practice. Radiographers undertaking this task should be encouraged and incentivised to dedicate their practice full-time to breast imaging. Radiographers with breast ultrasound expertise should be prioritised for MIIR training as they have transferable clinical knowledge and independent reporting skills.

    The duration and cost of training a radiographer for the task is likely to be less than for a radiologist.

Recommendation 4:

- Radiographers involved in symptomatic MIIR should be encouraged to participate in NHSBSP screen reading and attend MDT, error / education / clinical governance meetings. The NHSBSP should make their PERFORMS resource available to all radiographers involved in MIIR.

    Expertise in symptomatic MIIR is characterised by the ability to detect (sensitivity) small, subtle lesions such as those presenting in the asymptomatic population, included in PERFORMS and discussed at interval cancer review; NHSBSP experience should increase symptomatic MIIR specificity.

    Feedback on performance is an integral component of developing expertise – identification of errors can prompt reflective learning, confirmation of success can reinforce accurate reasoning and builds confidence.

Recommendation 5:

- Services which struggle to maintain symptomatic provision with their existing complement of radiologists should consider substituting radiographers in symptomatic clinics.
    - Radiographers undertaking the role of a radiologist need to be motivated, incentivised and supported (investment in training and career progression) to undertake sequential skill development over a protracted period of time to achieve expertise across the full range of routine breast diagnostic examinations (MIIR, ultrasound and tissue sampling). Again the duration and cost of training a radiographer for the role is likely to be less than for a radiologist.

Recommendation 6:

- Services, practitioners and educators should recognise the integrated nature of task-work and team-work knowledge and the blend of cognitive and social learning required for the development of symptomatic breast imaging expertise.
    - Work and meeting spaces should be configured to facilitate informal knowledge and skill sharing, collaborative reasoning and collective decision making.
    - Working practices should be organised to provide opportunities for radiographers to observe and participate in formal team decision making activities (MDT meetings).
    - Services should provide incentives to retain breast radiographers so they can develop a shared history of practice and become trusted and valued MDT members as this improves their competence and confidence.

Recommendation 7:

- Further research should be undertaken to evaluate the impact of involving radiographers in symptomatic MIIR, and in particular to measure quantitative outcomes. The following research questions need to be answered:
    - How many cancers do (single reading) radiologists miss (that radiographers might detect – in double reading and in substitution roles)?
    - Do radiographers initiate more (unnecessary) extra investigations than radiologists?
    - How does radiographer involvement in MIIR affect patient transit time through the symptomatic clinic?
    - What other impact does involvement of radiographers in symptomatic MIIR have on patient experience?

7.9 Dissemination strategy

Throughout the preparation and conduct of this project work-in-progress has been presented at national professional conferences. The findings of the preliminary systematic review 'Can radiographers make accurate decisions about cancer when interpreting mammograms?' (Dixon et al., 2013a) and survey 'Radiographer performed mammography image interpretation: a survey of current UK practice' (Dixon et al., 2013b) were presented at the 2013 United Kingdom Radiological Conference. Findings from Stage 2 of the study, 'Can we use screen reading radiographers to interpret and report symptomatic mammograms?' and 'What happens if we involve radiographers in double reading symptomatic mammograms?' were presented at Symposium mammographicum, 2014.
Work-in-progress has been presented at internal University of Leeds Faculty and School postgraduate conferences and special interest group meetings:

- Involving radiographers in the diagnosis of breast cancer in hospital clinics: what works, for whom and in what circumstances? September 2013;
- Involving radiographers in interpretation and reporting of mammograms in symptomatic breast clinics. A realist evaluation. October 2014;
- Sharing the communal brain – socially distributed reasoning in diagnostic image interpretation. March 2015;
- Radiographer reporting in symptomatic mammography: new professional boundaries in a complex landscape of practice. April 2015.

Drafts papers for submission to international peer-reviewed journals are being prepared. An initial paper presenting the overall study methods and findings will be submitted to Social Science in Medicine; further papers will be targeted at diagnostic imaging, cancer care, professional practice and evaluation research audiences. The scope of this project has been wide and as such it is intended that dissemination will augment the current body of knowledge about radiographer role development and symptomatic mammography image interpretation, progress debate about professional boundary change in diagnostic imaging and extend the reach of qualitative research in radiographer and RE methodology more widely.

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Appendix Stage 3 topic guide and prompt questions

<u>Programme theory 1 – expertise</u>

Development of expertise takes time and practice; expert practitioners reason by dual processing – a combination of heuristic (intuitive) and analytic (hypothetico-deductive) reasoning - this makes their judgements and decisions fast and accurate.

Sub theory 1a: Developing expertise takes time

One of the impressions I got from my initial interviews was that the radiographers involved in symptomatic mammography image interpretation and reporting have been working in breast imaging for a long time. So, I'm thinking that over time, as you see and report more mammograms you get better at it.

Is this your experience?

Does everybody get better with more practice?
If yes / no…. why is that?

What is it about 'doing more' that helps you get better?
Is there anything else involved?

Would you consider yourself an 'expert' in mammography image interpretation?
If yes – how can you tell?
If no – why not?
Would you consider any of your colleagues to be experts?
Can you explain a bit more about that?

Sub Theory 1b: Experts reach a diagnosis through intuitive and analytic reasoning

Another idea is that when people develop expertise in a particular area, they use a combination of intuition (e.g. 'I've seen this before' or 'this is a classic case of…') and also analytic reasoning (i.e. formulating a hypothesis 'this could be ….. or it might be …' and then gather evidence to support or refute each possibility).

Would you say this is true for you, or not?
Can you explain a bit more?

Do you think you use one type of reasoning more than the other?
What influences the sort of reasoning you use?

Can you give me an example of an intuitive / easy / quick decision?
(? refer to example seen during observations)

Can you give me an example of an analytic / more difficult decision?
(? refer to example seen during observations)

Sub theory 1c – expert decision making is fast and accurate

And another idea I got from my interviews was that because radiographers were 'expert' decision makers and combined different strategies for making decisions, this means most of their decisions are accurate and are made quickly.

Do you think that happens in your case or not?
Why yes or no?

Can you give me an example where you made an accurate and quick decision?
(? refer to observed example)
What was it about that case that enabled you to make your mind up quickly?

Can you give me an example where it didn't work out like that?
(? refer to observed example)
What was it about that case that took you longer to make a decision?
What was it about that case that was difficult / misleading?

Can you give me an example of where you / someone else made an error?
Why do you think the mistake was made?

Programme theory 2 - Role innovation

Radiographers do not substitute for radiologists in the symptomatic breast service but undertake an innovative 'hybrid' role within which they undertake and assume responsibility for some components of the radiologist's clinical workload. Introduction of an innovative technical / clinical hybrid role is cost and clinically effective.

Sub theory 2a. Lack of medical / clinical training and experience restricts the ability of radiographers to interpret and report the full range of symptomatic mammograms.

One of the impressions I got from my initial interviews was that radiographers can never fully replace radiologists in the symptomatic service. So, I'm thinking that there are some fundamental differences between radiographers and radiologists which influence the way they interpret and report mammograms.

Is this your experience?

Do you think radiographers and radiologists have a different approach to making decisions (reaching a diagnostic conclusion) about mammogram appearances?
Can you explain a bit more about that?
Why do you think this occurs?
Can you give me an example / refer to an observed case?

Are there any differences between radiographer and radiologist reports?
Why do you think this occurs?
Can you give me an example / refer to an observed case?

Can you give me an example of when you might not be able to interpret and report a case that a radiologist could?

Do you ever consult radiologists about cases?
Yes – what type of cases?
Can you give me an example?

No – why not?
Have you ever done this? / Has this changed over time?
Tell me a bit more about that?

What additional training and / or experience would you need to be able to fully take on the radiologists role?

Is this something you would like to do?
Can you explain a bit more about this?

Sub theory 2b. Radiography training and experience improve the radiographer's ability to interpret and report mammograms.

During the earlier interviews I got the impression that radiographers might sometimes be better at interpreting and reporting mammograms than radiologists because they have more robust training, know about the technical aspects of mammography production and have more direct contact with patients.

Do you agree with this?
Can you explain a bit more about why you say that?

How does a radiographer's training differ from that of a radiologist?
What effect do you think this has on decisions about mammograms?

How does a radiographer's professional experience (practice) differ from that of a radiologist?
What effect do you think this has on your decision making?

Do you think knowledge and experience about acquiring mammography images affects your interpretation and reporting?
Can you explain a bit more about that?
Can you give me an example?

Do you think radiographers and radiologists have different approaches to interpreting and reporting mammograms?
Can you explain a bit more about that?
Can you give me an example?

Sub theory 2c. It is clinically safe and cost-effective to transfer some of the radiologist's work to a radiographer.

In most of the earlier interviews it was clear that radiographers are undertaking some, but not all, of the breast work traditionally done by radiologists. There seemed to be a consensus that radiographers were at least as good as if not better than radiologists at reporting - they had equivalent if not higher diagnostic accuracy, and everyone seemed to think that radiographer reporting was therefore more cost effective than radiologist reporting.

Do you agree with this?
Have you any evidence to back up your opinion?

How do you ensure that your reporting is as 'safe' (as good / as accurate as that of a radiologist?

How do you / can you measure the cost of radiographer reporting?
Is cost important?

What other factors are important when comparing radiographer and radiologist reporting?

How do you feel about taking on some of the radiologist's workload for a lower rate of pay?

<u>Programme theory 3 – Community of practice</u>

Radiographers negotiate a new professional identity through collective learning within a 'community of practice'. Their competence is recognised and their performance and confidence improve as they regularly interact with others members of the community to create and share knowledge across traditional hierarchical and organisational boundaries.

Sub theory 3a. Radiographers are recognised as 'competent' members of a wider 'community of practice' who share a common goal – a correct and timely diagnosis.

I got a strong impression of 'team working' from the first set of interviews. It felt like the radiographer undertaking symptomatic mammography image interpretation was part of a wider team of people, all working towards the same goal, where their expertise was recognised and respected.

Is this how you feel?

Can you explain a bit more about the team, or teams, you feel you belong to?

How do you think you have ‘earned’ your place in this / these teams?

How do you think your colleagues in the team feel about you as a team member?

How do you know this?

Can you give me / refer to an observed example?

What do you think the team’s common goals are?

Do you think some team members have different goals?

Can you give me some examples?

How does this affect the way you work together?

How does working as a team affect the patient’s experience of diagnosis?

Sub theory 3b. Members of the ‘community of practice’ learn from each other by engaging in discussion, helping each other and sharing information in formal and informal ways.

In the earlier interviews I also got a strong feeling that you are all constantly learning as you go along. It seemed that in addition to formal learning opportunities like study days, courses and use of guidance documents, there seemed to be lots of ways that you could learn new things just from other people, your colleagues, as you went about your daily practice.

Is this your experience?

Can you explain a bit more?

What formal systems do you have in place to help people learn from each other?

Can you give an example of something you have learned like this?

Can you give an example of how you have helped someone in this way?

Are there other ways in which people help each other or learn from each other on a day-to-day basis?

Can you give me an example of something you have learned like this?

Are people happy to go to colleagues for help in this department?

Yes – What do you think the benefits of this are?

Does this create any problems?

No – Does this create any problems?

How do you overcome these?

Sub theory 3c. Competence and confidence improve over time as the ‘community’ develops a shared history of practice and a shared repertoire of resources.

I got the impression that radiographers feel a bit more secure about independent reporting because they have a sense of ‘shared’ responsibility with colleagues. It seemed like their confidence stemmed from belonging to a community of practitioners who had shared experiences of success (difficult cases / near misses correctly diagnosed) and failure (wrong diagnosis / clinical errors) which they had all learned from. There seemed to be an acceptance that nobody was perfect, everybody makes mistakes and that no one individual is ever solely responsible for ‘missing a cancer’.

Is this how you feel or not?

Can you explain a bit more?

How did you feel about single reporting when you first came to work here / started to do symptomatic work?

Has this changed over time?

What has helped to boost your confidence?

What tends to undermine your confidence?

Can you give me an example of a local ‘case’ that changed the way you interpret or report symptomatic mammograms?

What role did other colleagues play in this case?

Can you give me an example of something new that has been introduced into your mammography image interpretation or reporting practice from (someone) ‘outside’ (your team)?

How did this happen?

How did other members of your team react to this?

What happens at the MDT meeting when a cancer is diagnosed but you did not report it on the mammogram?

****

END