THE USE OF SIMULATION-BASED EDUCATION IN CARDIO-RESPIRATORY PHYSIOTHERAPY

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Failure is instructive. The person who really thinks learns quite as much from his failures as from his successes.

(Dewey, 1910)

Abstract

This thesis is situated in the context of simulation-based education (SBE) within cardio-respiratory physiotherapy in the UK. A pragmatic mixed methods study has provided a comprehensive examination of the use of SBE from two perspectives: 1) physiotherapy education and 2) pre-registration physiotherapy students' experiences of managing a deteriorating patient in a simulation context. Two national surveys in Phase 1 provided the first insight into the spectrum of SBE utilised in pre-registration and postgraduate physiotherapy education in the UK between 2009 and 2010. National inconsistencies in simulation provision and accessibility were identified. Financial costs, time and access to simulation centres/laboratories reportedly influenced the use of SBE within cardio-respiratory physiotherapy education. Phase 2 combined SBE and video-reflexive ethnography (VRE) methods to elicit a unique and comprehensive exploration of performance, behaviours, errors and personal experiences of 21 final year (pre-registration) physiotherapy students from one higher education institution in the UK. This study has identified the multi-layered impact of personal experiences and behaviours on practices, clinical decisions, dynamics and the complexities and interconnectivity of participants to the simulation environment. The range of errors identified by this study also highlights the complexity of managing an acutely deteriorating patient in a simulation context. The combination of SBE and VRE allowed the participants to explore errors and defences erected within the scenario and their impact on patient safety. The findings of this thesis emphasise the importance of scenario design, considering the learner's level of experience, prior knowledge and sequencing of abstract skills before requiring contextualisation within a complex scenario. Carefully planned and executed SBE and VRE methods can provide a safe learning environment to allow participants to explore routine, evolving and complex situations whilst allowing them to learn to be become comfortable with making and exploring errors. Thus, the findings provide valuable insights to inform future research regarding physiotherapy practice and integration of educational methods to augment patient safety awareness and enhance safe healthcare practice. The key message of this thesis is that SBE is a valuable learning modality to explore the complexities of healthcare education and practice.

Dedication

This thesis is dedicated to Andrew, Aaron, Azaria and my parents who have supported me throughout my doctoral study.

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I have been fortunate to receive funding for my doctoral fees and study leave from the Faculty of Health, Psychology and Social Care at Manchester Metropolitan University (MMU). I am extremely grateful for the monetary support provided by the faculty to enable me to travel to America and Australia numerous times to present different aspects of my doctoral study. I have learnt so much from these opportunities and as a result of presenting innovative work, have been fortunate to develop international collaborative research partnerships.

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Operational definitions

Debrief is referred to as a group discussion following a simulation-based learning experience, which encourages reflective thinking regarding the participant's performance. This is typically led by a facilitator and driven by the scenario learning objectives.

Emergency on-call physiotherapy is defined as the provision of respiratory/cardio-respiratory/cardiothoracic physiotherapy or combinations of respiratory and orthopaedic physiotherapy out of normal working hours (Gough and Doherty, 2007:37).4

Fidelity is used to describe the believability, or the degree to which a simulation-based learning experience approaches reality.

Human factors is a scientific discipline, which encompasses environmental and organisational factors and individuals' characteristics that affect day-to-day working and health and safety.

Reflective practice is a process of pausing, thinking about one's own practice, consciously analysing decisions and evaluating or modifying changes for future practice.

Reflexivity refers to seeking self-reference, in which individuals (practitioners/participants/learners/researchers) review themselves and their cultural practices (e.g. beliefs, ethics, norms, behaviours).

Simulation is a technique used to provide guided experiences that are designed to evoke knowledge, skills and behaviours that replicate real world experiences.

Video-reflexivity refers to the practice of video-recoding environments and later sharing the video footage with participants to facilitate a reflexive discussion of their practice.

Abbreviations and glossary

ABCDE	Airway, Breathing, Circulation, Disability, Exposure/Extremity (acronym used to describe a systematic assessment approach in healthcare)
ACBT	Active Cycle of Breathing Technique
ACPRC	Association of Chartered Physiotherapists in Respiratory Care
ASPiH	Association of Simulated Practice in Healthcare
AIM	Acute Illness Management, an acronym for a national course developed by the Greater Manchester Critical Care Skills Institute
ANTS	Anaesthetists Non-technical Skills
ANTS-AP	Anaesthetists Non-technical Skills for Anaesthetic Practitioners
AR	Acute respiratory (care)
Auscultation	The process of listening to the internal sounds of the body, usually using a stethoscope, e.g. to examine the circulatory, respiratory gastrointestinal systems
BEME	Best Evidence Medical Education
Bird	A trade name for an Intermittent Positive Pressure Breathing (IPPB) device, used to assist secretions clearance from a patient's lungs
BP	Blood pressure
Breathing exercise	Exercises specifically taught to increase lung volume, to reduce the work of breathing or clear secretions from the lungs
CPD	Continuous professional development
Crackles	Used to describe the crackle sounds heard on auscultation of the lungs, which can indicate lung collapse and/or sputum retention
Crepitations	An older term used to describe crackles heard on auscultation (the term is now more commonly used to describe audible joint sounds in the knee)
CSP	Chartered Society of Physiotherapy
CXR	Chest x-ray, a radiograph of the lungs

Desaturation	A reduction in oxygen saturation level in the blood. The normal range is 94–98% in a healthy adult without pathology
DH	Department of Health
DVD	Digital versatile disc
DH/DHx	Drug history
ECG	Electrocardiography is the recording of electrical activity in the heart using electrodes attached to the skin on the patient's chest. This can be transmitted to the patient's monitor when continual monitoring is required or an ECG machine for assessment purposes
EOC	Emergency on-call
Faculty	The term faculty is used as a collective term to describe the academic staff involved within simulation-based education
FH	Family history, recorded during the subjective assessment of the patient
HCA	Healthcare assistant
HCO	High concentration oxygen mask, a face mask used to deliver high flow oxygen therapy over 65%, using a flow rate of 15 litres per minute
HCPC	Health and Care Professions Council
HDD	Hard disk drive
HEA	Higher education academy
HEI	Higher education institution
HFPS	High-fidelity patient simulator
HPC	History of present complaint, recorded during the subjective assessment of a patient
HPS	Human patient simulator
HR	Heart rate, measured in beats per minute
Huff	A chest clearance technique used to clear secretions from the lungs
iCSP	Interactive Chartered Society of Physiotherapy, an online discussion forum
ICU	Intensive care unit

INACSL	International Nursing Association for Clinical Simulation and Learning
IPE	Interprofessional education
IPPB	Intermittent positive pressure breathing
ISPE	Interprofessional simulation-based education
LAN	Local area network
METiman	A computerised human patient simulator
MDT	Multi-disciplinary team
MMU	Manchester Metropolitan University
MPSCG	Multi-professional Patient Safety Curriculum Guide
Nebuliser	A device used to deliver sterilise water or drugs using compressed air, which causes the liquid to form very small droplets, enabling inhalation into the lungs and optimal delivery
NHS	National Health Service
NHS KSF	National Health Service Knowledge and Skills Framework
NPS	Nasopharyngeal suction, a method of clearing secretions from the lungs using a catheter inserted via the nose
NOTSS	Non-technical Skills for Surgeons
NTS	Non-technical skills
NWSEN	North West Simulation Education Network
OSCAR	Observational Skill-based Clinical Assessment tool for Resuscitation
OTAS	Observational Team Assessment for Surgery
PARS	Patient at risk score
PGC-AP	Postgraduate Certificate in Academic Practice
PSCG	Patient Safety Curriculum Guide
PMH	Past medical history. This is established during the subjective assessment of the patient
RCT	Randomised controlled trial
RR	Respiratory rate, measured in beats per minute (bpm). A normal rate is between 12 and 20 bpm

SaO_2	The measurement of arterial oxygen saturations levels in the blood, established using arterial blood gas analysis (using a non-invasive portable machine and finger probe)
SBE	Simulation-based education
SH	Social history, established during the subjective assessment of the patient
SLE	Simulated learning environment
SLP	Simulated learning programme
SP	Simulated patient
SPLINTS	Scrub Practitioners' List of Intra-operative Non-technical Skills
TAR	Think aloud review
TEL	Technology enhanced learning
Temperature	Body temperature, normal range 36.5–37.5^{0}C
UK	United Kingdom
UO	Urine Output, normal value 0.5mls/Kg/Hr (millilitre per kilogram of body weight per hour)
VHB	Virtual haptic back

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Chapter 1: Introduction

This thesis provides a novel exploration of the use of simulation-based education in cardio-respiratory physiotherapy, error recognition abilities of pre-registration physiotherapy students and presents a new integrated simulation and technology enhanced learning framework. In this chapter, I discuss the drivers behind this thesis including the background of physiotherapy education, concerns raised regarding graduate physiotherapists' cardio-respiratory skills and a disparity in patient outcomes resulting from intervention provided by non-respiratory physiotherapists undertaking emergency on-call duties in the UK. The chapter also presents my backstory followed by an overview of the structure of this thesis and research questions.

1.1 Drivers behind this thesis

In 2009, the Chief Medical Officer's report to the Department of Health (Donaldson, 2009) stated that simulation-based education (SBE) offers an important route to safer care for patients and needs to be more fully integrated into healthcare education. Simulation also provides a safe environment for learning clinical, psychomotor, communication, teamwork and clinical decision-making skills (Gaba, 2004; Lasater, 2007; Donaldson, 2009; Dreifuerst, 2009; Motola et al., 2013). Simulation has the potential to improve not only the quality of health and social care but also to have an impact on patient outcomes, patient safety and experience (DH, 2011).

Evidence now suggests that SBE can enable the healthcare workforce to develop required skills more efficiently when compared to skill development in clinical practice (Haycock et al., 2010). Over the last two decades, evidence has demonstrated the benefits of SBE in healthcare (Cant and Cooper, 2009; Neill and Wooton, 2011; Patient Safety Education Group, 2009; Ricketts, 2011; Cook et al., 2012). There is strong evidence that SBE improves learning outcomes (McGaghie et al., 2011; Shearer, 2012), clinical practice (Siassakos et al., 2011; Zahara-Such, 2012; Cook et al., 2010), confidence, competency and clinical decision making (Cook et al., 2012). The integration of SBE within training and education has been shown to be cost-effective and associated with significant health-related cost savings (Cohen et al., 2010). More recently the drive to improve patient safety has drawn upon SBE to support the quality of organisational priorities and address healthcare system failures (LaVelle and McLaughlin, 2008), reduce adverse events (Patterson, 2013) and reduce in-hospital infection rates (Gerolemou et al., 2014). It is also recognised that optimal advantages of SBE are realised when the interventions are appropriately designed and evaluated (Issenberg et al., 2005; Jeffries, 2005; DH, 2011; Jeffries and Rogers, 2012).

Negative SBE learning experiences may arise due to ill-designed scenarios (Jeffries and Rogers, 2012), particularly when inappropriate levels of fidelity and realism are embedded leading to cognitive overload (Sweller, 1998; Haji et al., 2015; Reedy, 2015), when simulation faculty members are inadequately trained, ineffective facilitation techniques are utilised or there is a lack of or ineffective feedback (Issenberg et al., 2005; Inventures, 2011; Jeffries and Rogers, 2012; Motola et al., 2013). The barriers to implementing effective SBE include: scheduling (in situ or within academic courses); financial and time costs associated with the need for high staff to learner ratios; and a lack of available equipment to ensure equity of provision, technical support and funding for simulation resources (Baker et al., 2008; Jull et al., 2010; Luctkar-Fludee et al., 2010; Wagner et al., 2011; Reeves et al., 2012; Gough et al., 2012a).

Simulation is not a new teaching modality within the physiotherapy profession. Clinical skill development (experienced during practice placements) on ‘real’ patients is deemed an essential component in the development of professional skills and has been used within physiotherapy educational examples since the inception of the profession in 1895 (Wicksteed, 1948; Thornton, 1994; Doody and McAteer, 2002; Marrow et al., 2001; Jull et al., 2010). SBE has been predominantly used in cardio-respiratory and musculoskeletal physiotherapy (da Silva Bezzera Fitipaldi and da Caetano Azeredo, 2005; Shoemaker et al., 2009; Stephens, 2010; Jull et al., 2010; Jones and Sheppard, 2011; Shoemaker et al., 2011; Jull et al., 2011; Watson et al., 2012) and patient safety education (Parry, 2005; Gough et al., 2013a). Respiratory, musculoskeletal and neurological physiotherapy are integral aspects of pre-registration physiotherapy education (CSP, 2002a; 2012a; 2012b). Physiotherapy programmes are required to demonstrate compliance with all nine of the Chartered Society of Physiotherapy's (CSP) learning and development principles (CSP, 2015), to prepare learners for the continually changing healthcare environment. In addition, programmes are required to incorporate the CSP's Physiotherapy Framework: putting physiotherapy behaviours, values, knowledge and skills into practice (CSP, 2013).

Globally, physiotherapy students are required to complete 1,000 hours of placement-based education to prepare them for immediate practice on graduation (CSP, 2002b; Jull et al., 2010). The CSP advocates that newly qualified physiotherapists should be competent in respiratory care but will require further educational opportunities before becoming competent within the cardio-respiratory on-call context (CSP, 2002a). Concerns have been repeatedly raised regarding some physiotherapists' abilities to deliver on-call respiratory physiotherapy in the UK (Nicholls, 1996; Thomas, 1999; Byrne, 2002; CSP, 2002a; Gough and Doherty, 2007; Shannon, 2010; Shannon et al., 2013). In 2002, the CSP published 'Emergency Respiratory On-call Working: Guidance for Physiotherapists' (CSP, 2002a) in response to the concerns regarding the delivery of physiotherapy care to patients who are at risk of deterioration (compromised respiratory function) outside of normal working hours (traditionally 8.30am–4.30pm). Discrepancies in training within respiratory physiotherapy services have been identified by numerous UK surveys pertaining to respiratory care and on-call physiotherapy (Dixon and Reeve, 2003; Thomas et al., 2003; Cross et al., 2003; Harden et al., 2005; Gough and Doherty, 2007). Significant disparities in treatment outcomes have since been reported when paediatric patients are treated by non-respiratory on-call physiotherapists compared to specialist respiratory physiotherapists (Shannon et al. 2015).

In 2001, 'The National On-call Project' was established in collaboration with the Association for Chartered Physiotherapists in Respiratory Care (ACPRC) (Harden et al., 2007). The purpose of the project was to facilitate a consistent (national) approach to on-call training and assessment throughout the UK, whilst supporting physiotherapists to develop and maintain their competence and confidence in on-call physiotherapy practices (Harden et al., 2007). The national on-call project team developed a series of resources including the 'On course for on-call' (Quint et al.,

2005) learning and teaching resources (paper vignettes and workshop content, which were predominantly discussion focused). They also published two editions of a respiratory textbook: 'Emergency Physiotherapy: On-call survival guide' (Harden, 2004) and 'Respiratory Physiotherapy – An on-call survival guide', a pocket guide to on-call physiotherapy (Harden et al., 2009). The 'On course for on-call' learning and teaching resources were designed for physiotherapy students and novice physiotherapists to develop problem solving and clinical reasoning skills around the management of the acutely unwell adult respiratory patient (ACPRC, 2006)[1].

Despite the development of these resources, the course was never translated to include SBE scenarios, nor guidance issued on how to adapt the resources for SBE. To my knowledge, no studies have been published relating to the impact of the national on-call project resources on learning, knowledge, skills, behaviours, confidence, competence or impact on patient outcomes. The on-call project team also developed the ACPRC 'Acute Respiratory/On Call Physiotherapy Self-evaluation of Competence Questionnaire' (ACPRC, 2007), which was later evaluated by Thomas et al. (2008). Whilst this tool was reportedly able to discriminate between physiotherapists with different seniority levels and experience, it had not been used within SBE. Alternative uses were suggested by the authors, which included supporting continuous professional development in respiratory care. In particular, providing evidence of achievement of the National Health Service Knowledge and Skills Framework (NHS KSF) domains (NHS, 2004) or emergency on-call (EOC) or acute respiratory (AR) within personal professional development portfolios (Thomas et al., 2008).

1.2 Backstory

My own career in physiotherapy started in 2000, when I graduated with First Class Honours in Physiotherapy. Immediately after graduation, I was fortunate enough to gain employment as a rotational basic grade physiotherapist. As both a basic grade and senior II physiotherapist, I undertook acute medicine, surgery and intensive

[1] The 'On course for on-call' project resources were previously available for organisations to purchase via the Association of Chartered Physiotherapists in Respiratory Care.

care, paediatrics, outpatients and orthopaedic inpatient rotations. These rotations provided me with a firm grounding in both inpatient and outpatient care. In 2002, I was promoted to a senior I in surgery and critical care. With this role came the responsibility for developing the EOC service, and AR training for new graduates and existing staff. I gained further experience as a clinician and novice educator, training on-call physiotherapists and multi-disciplinary team (MDT) staff on the Acute Illness Management (AIM) courses, which were run in-house (internally within the Trust). This was the start of a series of transitions that inevitably shaped my thoughts, beliefs, knowledge, skills and behaviours, which I bring to this study and its respective analysis.

Through my experience in providing EOC and AIM within one NHS trust, I developed new teaching skills featuring part-task simulators and later full-body human patient manikins. In December 2004, I made a further transition from expert clinician to novice academic within a physiotherapy programme at one higher education institution (HEI) in the UK. I completed my Masters in Education and a Postgraduate Certificate in Academic Practice (PGC-AP). These qualifications enhanced my personal and professional development and shaped my thoughts around the use of SBE and its use within physiotherapy education. Whilst finishing my PGC-AP in 2006/7, the nursing and physiotherapy departments received capital funding to enable the expansion of SBE resources. The improvements to the simulated learning environment (SLE) and provision of additional human patient simulators coincided with the launch of the North West Simulation Education Network (NWSEN). I also began exploring other courses and conferences to enable me to expand my knowledge in simulation scenario design, programming and use of technology to enhance the delivery of teaching and learning within physiotherapy curricula.

At the first simulation conference I attended, I also presented my early work on the use of simulation within AIM (Gough, 2009a; 2009b). I attended various beginner SBE workshops, which greatly enhanced my knowledge and skills of scenario design, whilst highlighting the importance of using a simulation education framework to underpin scenario design, development, evaluation and research. Completion of various NWSEN faculty development courses and an advanced human factors training course shaped my thoughts on patient safety and its inclusion (albeit relatively hidden) within physiotherapy curricula. These later developments have therefore impacted on my knowledge and skills in this field. These external courses and development of my simulation teaching experiences also led to a series of technology enhanced learning (TEL) research studies (Gough and Hamshire, 2010; Gough et al., 2012a; Gough et al., 2012b; Gough et al., 2013a; Hellaby et al., 2012), which I have undertaken alongside my PhD. My knowledge and skills in relation to simulation and patient safety were further enhanced and tested when I adopted the role of Principal Investigator for the World Health Organization (WHO) Complementary Pilot Site for the 'Multi-professional Patient Safety Curriculum Guide' in 2011. My role and subsequent research findings relating to the WHO study have been published within various research outputs (Gough et al., 2012a, 2012b, 2013a; Hellaby et al., 2012; WHO, 2013; Gough et al., 2014).

Throughout the duration of this PhD study, I have held the position of senior lecturer, with a focus on physiotherapy, management of acute and critically ill patients, and simulation practitioner. In section 3.2.1 I reflect on how my key transition and clinical experiences as a cardio-respiratory physiotherapist, educator and simulation practitioner has positioned me as an 'insider' researcher. I openly acknowledge that my insider-researcher position may have enabled me to present a greater understanding of the physiotherapy practices being studied. It has also allowed me to understand the natural social interaction of the physiotherapy participants involved in the study and afforded me the ability to promote telling and judging the truth during the analysis (Carrol, 2009a, 2009b; Burns et al., 2012; Unluer, 2012). Conversely, I acknowledge that being an insider-researcher also brings some disadvantages, including the potential loss of objectivity due to relative familiarity of physiotherapy practice and introduction of bias through incorrect assumptions based on my own prior knowledge (Burns et al., 2012; Unluer, 2012). Throughout the development of the research study, I was required to balance the dual roles of the 'insider' (academic, physiotherapist, simulation facilitator) and 'researcher'. Managing the duality of the insider-research roles is also addressed later in section 3.2 (introducing the researcher) and in relation to the research design, data collection and analysis in Chapter 4.

During the research journey, I have undertaken various external courses, additional facilitator training and participated in conference workshops relating to scenario development, design, debriefing and research methods. I recognise that these key personal transitions, experiences and quests for new knowledge will have undoubtedly influenced my choice of area of research, formulation of research objectives and method of inquiry (Cohen et al., 2000; Carroll, 2009a; Unluer, 2012). Therefore, the primary development of the study presented in this thesis is embedded within my personal journey as an academic and post-graduate student researcher.

1.3 Structure of the thesis and research questions

My thesis begins in Chapter 2 by exploring the literature pertaining to the use of SBE in healthcare and then focusing on physiotherapy. A narrative literature review of existing SBE within physiotherapy is presented alongside the theoretical frameworks that underpin the use of simulation in healthcare. The chapter concludes with gaps highlighted by the literature review relating to the use of SBE within physiotherapy education and practice, and outlines my research questions. The research gaps are later mapped to the questions and respective phases of the study (see section 2.4). The six research questions (RQs) that are addressed in this thesis are:

1) How is SBE utilised within emergency on-call physiotherapy services in the UK?
2) How is SBE utilised within cardio-respiratory physiotherapy programmes in the UK?
3) To what extent are final year pre-registration physiotherapy students able to independently manage an acutely deteriorating cardio-respiratory patient in a simulation context?
4) To what extent are final year physiotherapy students able to independently recognise errors within a simulation-based learning experience?
5) Which elements of prior learning do pre-registration physiotherapy students perceive may influence their performance within a simulation-based learning experience?
6) What value do pre-registration physiotherapy students attribute to the cardio-respiratory simulation-based learning experience?

7) What is the cost of undertaking a cardio-respiratory simulation-based scenario and video-reflexive ethnography review?

Chapter 3 begins by introducing my position as the researcher, followed by a discussion relating to my choice to adopt a pragmatic philosophy and a technical pragmatic approach to address all six research questions. The ontological and epistemological assumptions underpinning the methodological approaches used in this study are discussed. Phase 1 comprised two national surveys pertaining to the use of SBE within cardio-respiratory education in the UK. Phase 2 utilised video-reflexive ethnography (VRE) to explore the experiences of pre-registration physiotherapy students from one HEI undertaking a high-fidelity cardio-respiratory physiotherapy simulation scenario. This chapter concludes with the ethical considerations, which were applied to both phases of the research.

Chapter 4 presents the research methods employed within Phase 1, followed by those used in Phase 2.

Chapter 5 presents the findings of the two national surveys, with respect to RQs 1 and 2. The findings of the surveys have been integrated to facilitate comparative analysis of common questions within the two surveys. In Chapter 6, I discuss the findings of Phase 1 in relation to existing literature. This is followed by a discussion of the methodological strengths and limitations of the study, the implications for educational practice and suggestions for future research.

Chapter 7 presents the results for Phase 2, which addressed RQs 3-6. In Chapter 8, I discuss the findings from Phase 2 in relation to the existing literature. The development of the Integrated Simulation and Technology Enhanced Learning (ISTEL) Framework is introduced, which arose from the literature review, methodological design and findings of Phase 2. This is followed by a discussion of the methodological strengths and limitations of the study. Finally, the educational implications of the research are explored before discussing areas of future research.

Chapter 9 provides an overview of the achievements of this study. The overall methodological strengths and limitations and novel aspects of the thesis are discussed. Finally, the local, national and international impacts of my doctoral study to date are discussed.

1.4 Dissemination

I have presented various aspects of this thesis at both national and international conferences, published two articles in peer reviewed journals and two forthcoming book chapters.

Chapters 4 to 6

Gough, S., Yohannes, A.M., Thomas, C. and Sixsmith, J. (2013) 'Simulation-based education (SBE) within postgraduate emergency on-call physiotherapy in the United Kingdom.' *Nurse Education Today*, 33(8) pp. 778-784.

Gough, S. (2011) 'What lies in the cupboard? – Physiotherapy simulation-based education (SBE) in the United Kingdom.' Paper presented at: *World Confederation of Physical Therapy, Royal Dutch Society of Physical Therapy*. Amsterdam, Netherlands, 20–23rd June.

Gough, S. and Yohannes, A.M. (2010a) 'Current provision, level of fidelity and application of simulation-based education (SBE) within pre- and post-registration cardio-respiratory physiotherapy.' Paper presented at: *Chartered Society of Physiotherapy Congress*. BT Convention Centre, Liverpool, 16th October.

Gough, S. and Yohannes, A. (2010b) 'Simulation-based education (SBE) within acute respiratory and emergency on-call physiotherapy: Current use and future implications.' Paper presented at: *Chartered Society of Physiotherapy Congress*. BT Convention Centre, Liverpool, 17th October.

Chapters 7 to 9

Gough, S., Yohannes, A.M. and Murray, J. (2016) 'Using video-reflexive ethnography and simulation-based education to explore patient management and error recognition in pre-registration physiotherapy'. *Advances in Simulation,* 1(9) pp. 1-16. doi: 10.1186/s41077-016-0010-5.

Gough, S. (2016) Optimising learning in simulation-based education using video-reflexivity. *In* Nestel, D., Kelly, M., Jolly, B. and Watson, M. (eds.) *Healthcare Simulation Education: Evidence, Theory and Practice*. John Wiley and Sons: West Sussex. (Forthcoming).

Nestel, D. and **Gough**, S. (2016) Designing simulation-based learning activities: A systematic approach. *In* Nestel, D., Kelly, M., Jolly, B. and Watson, M. (eds.) *Healthcare simulation education: Evidence, theory and practice*. John Wiley and Sons: West Sussex. (Forthcoming).

Gough, S., Yohannes, A.M. and Murray, J. (2016) 'The Integrated Simulation and Technology Enhanced Learning (ISETL) Framework: Facilitating robust design, implementation, evaluation and research in healthcare.' Paper submitted for presentation at: *European Region of the World Confederation for Physical Therapy*, ACC Liverpool, 11–12th November 2016 (Forthcoming).

Gough, S. (2015) 'The development of a new integrated simulation-based education framework.' *BMJ Simulation and Technology Enhanced Learning*, 1(Suppl.2) pp. A14-A15.

Gough, S., Yohannes, A., Roberts, P., Murray, J. and Sixsmith J. (2015) 'Facilitating error recognition and patient safety awareness in final year pre-registration physiotherapy students using video-reflexive ethnography and simulation.' Paper submitted for presentation at: *World Confederation of Physical Therapy,* Suntec Singapore Convention and Exhibition Centre, Singapore, 1–4th May.

Gough, S. and Greene, L. (2014) 'Simulation scenario design'. Master class presented at: *North West Simulation Education Network,* The Centre, Birchwood Park, Warrington, 6th May.

Gough, S., Hellaby, M. and Jones, N. (2014) 'Spreading the word: Developing and repurposing resources to create sustainable simulation learning-scapes.' Paper

presented at: *International Association of Higher Education Teaching and Learning HETL Conference*. Anchorage, Alaska, 2nd May.

Gough, S. (2012a) 'Exploring learning, reflection and professional development through the use of simulation and video debriefing.' Paper presented at: *Higher Education Academy Seminar Series: Assessment for learning: Understanding the process of learning for more effective feedback*. University of Leeds, UK, 18th June.

Gough, S. (2011) 'High-fidelity simulation and video-performance analysis: Supporting cardio-respiratory physiotherapy clinical skills.' *4th International Clinical Skills Conference, Showcasing Innovation and Education Based Clinical Skills Education and Practice*, Prato, Tuscany, 22–25th May.

Award for Overall Best Abstract

Gough, S., Yohannes, A., Sixsmith, J. and Roberts, P. (2014a) 'SimHealth 2013 Research. Are final year physiotherapy students able to independently recognise errors encountered in their own simulated practice?' *Journal of the Society for Simulation in Healthcare*, 9(1) pp. 73.

Chapter 2: Literature Review

This chapter presents the findings of a narrative literature review regarding the use of SBE in physiotherapy and the theoretical frameworks used to underpin SBE in healthcare. A narrative literature review is presented and the search strategy is provided for transparency. The underpinning epistemological grounding of this thesis (presented in Chapter 3) does not align with a systematic review, thus it is not presented in this way. Key SBE frameworks act as a lens through which to view the exploration of the use of SBE within cardio-respiratory physiotherapy in the UK (Creswell, 2014). Finally, the gaps from the literature review and resultant research questions are presented.

2.1 Literature review

An initial literature search was conducted using CINAHL, MEDLINE, and PsycINFO and EBSCO databases from inception to March 2009 (and continually updated until January 2015). The search terms were grouped with truncation (*) into three categories: physiotherapy (physiotherap*, physical therap*); respiratory care (cardio-respiratory*, acute respiratory*, on-call*, emergency duty*); and instructional design (educat*, train*, simul*, skill*, teach*, practic*, feedback*). Terms within each category were searched in each database using the Boolean operator ‘OR’, and then across categories using ‘AND’. Articles were included in the review if they met specific criteria: empirical studies reporting quantitative and/or qualitative data or literature reviews evaluating the effect of SBE within pre- or post-registration or physiotherapy education or practice. Papers published in English in a peer-reviewed journal and available in full text were included in the review. Papers were excluded if data and content specific to physiotherapy was not clearly reported. Hand searches (including searching references from relevant articles and website searches of simulation, healthcare related professional/regulatory bodies) were also undertaken. The titles and abstracts were screened to discard all irrelevant articles. I then reviewed the full texts to determine eligibility for inclusion. The initial screening of titles and abstracts revealed literature pertaining to simulation medium (educational delivery format); modalities (including role play involving simulated patients, paper vignettes, use of part-task trainers, haptic simulators, virtual reality simulators and computerised human patient manikins); and teaching methods.

Following immersion in the literature pertaining to SBE in physiotherapy, additional focused searches were undertaken to explore the theoretical concepts and educational practices underpinning SBE. The search terms were grouped with truncation into two categories: physiotherapy (physiotherap*, physical therap*) and frameworks (simul*, technology enhanced learn*, instruct*, design, theor*, educ*, prac*). Terms within each category were also searched in each database using the Boolean operator ‘OR’, and then across categories using ‘AND’. Articles were included in the review if they met specific criteria: published in English in a peer-reviewed journal and full text was available for review. Papers were initially excluded if the content was not specific to physiotherapy. However, despite the adoption of SBE in physiotherapy education and practice internationally, the literature review failed to identify a specific framework to facilitate the design of SBE in physiotherapy. The literature review was then extended to include health*, nurs* and medic* in the search terms. Hand searches (including searching references from relevant articles and website searches of simulation and healthcare related professional/regulatory bodies) were also undertaken.

This chapter is divided into two sections: section 2.2 presents the findings from the literature review pertaining to SBE in physiotherapy education and then section 2.3 presents the theories and educational practices underpinning SBE.

2.2 SBE in physiotherapy education

The literature pertaining to the existing use of SBE in physiotherapy is presented under the following instructional design headings: medium, modality and method (Chiniara et al., 2013). The *medium* refers to the format of delivery (e.g. lectures or online learning). *Modality* refers to the description of the simulation activity e.g. involvement of simulated patients, part-task trainers or more immersive learning environments like simulated clinical training wards that are designed to replicate a clinical environment. *Method* refers to the specific techniques used e.g. self-directed or facilitator-led learning. The New World Kirkpatrick Model (Kirkpatrick and Kirkpatrick, 2010) of training evaluation has been used throughout section 2.2

to facilitate a comparative review of the literature pertaining to SBE in physiotherapy. The new model builds on the original four levels of evaluating training programmes devised by Donald Kirkpatrick in 1959 that he later revised in 1994. The New World Model includes: level 4: results (the degree to which targeted outcomes occur as a result of learning events and subsequent reinforcement); level 3: behaviour (degree to which participants apply behaviours gained during the training); level 2: learning (degree to which participants acquire the intended knowledge, skills and attitudes based on their participation in the learning event); and level 1: reaction (degree of favourable reaction to the learning event). Whilst the New World Kirkpatrick Model integrates the existing four levels, it does not focus on the economic costs associated with training evaluation. Salas (2009) proposed the addition of a fifth level (return on investment) to Kirkpatrick's (1959) original Learning Evaluation Model.

2.2.1 Simulation medium used in physiotherapy education

Despite a review of the provision and use of simulation being commissioned by the UK Department of Health in 2009-2010 (Inventures, 2011), specific details relating to the format of delivering SBE within physiotherapy remained unknown. The national review was conducted by Inventures on behalf of the Department of Health, which featured a series of questionnaires (a short qualitative questionnaire to strategic stakeholders and an in-depth qualitative and quantitative questionnaire to those providing training to NHS staff in England). In addition, findings from a strategic stakeholder workshop, case studies and a literature review were also included. Caution is applied when interpreting the findings of the survey, owing to the relatively low response rates achieved in both surveys (79/184 strategic organisations and 76/544 NHS training providers) and the potential for respondent bias. The study reported varied provision and use across the UK in medical, nursing and midwifery, allied health professional and clinical psychology education and training. The review by Inventures (2011) only acknowledged the use of simulation in one HEI providing physiotherapy education. No reference was made to the use of simulation within physiotherapy training provided by NHS trusts. It is possible that reports of physiotherapy use and provision were integrated in the allied health professions' responses, but this is not clarified in the report itself. Thus, despite this national study, the application and extent of simulation use within cardio-respiratory physiotherapy pre-registration or postgraduate education and both respiratory physiotherapy and EOC services in the UK remained unknown. The absence of details relating to the use and provision of simulation in physiotherapy education in the UK may have been due to the Chartered Society of Physiotherapy (CSP) not being included as an original stakeholder and limited dissemination to those providing training to NHS physiotherapy staff.

Previous regional and national postal surveys have focused on EOC physiotherapy service provision and frequency of training in the UK (Brown et al., 1997; Dixon and Reeve, 2003; Harden et al., 2005) and New Zealand (Reeve, 2003). However, none of these explored the use or provision of SBE in AR or EOC training. Similarly, the literature review highlighted that no surveys have been undertaken to explore the use or provision of SBE within pre-registration and/or postgraduate physiotherapy cardio-respiratory physiotherapy programmes in the UK. One Australian survey, Jull et al. (2010), did outline the use and provision of simulation in physiotherapy and reported findings from 16 of the 17 HEIs that provided physiotherapy curricula, including Bachelor, Masters and doctoral programmes. The report highlighted varied pedagogies across all HEIs. HEIs reportedly used problem-based learning or case-based learning approaches, which featured the use of lectures, tutorials, practical sessions, clinical education (placement experiences) and simulated learning experiences. However, no further details of the use and application of each simulation medium (delivery method) were reported. Respondents identified three formal pedagogies that underpinned Australian physiotherapy curricula: constructivist approach, computer-assisted learning approach and Blooms Taxonomy (n=3, 1 and 1 HEIs respectively). A review of the theories, educational practices and frameworks that underpin SBE in physiotherapy and healthcare will be provided later in section 2.3.

In summary, whilst the use of simulation as a medium of physiotherapy education in Australia has been reported, the extent of the use of SBE (including application, equipment fidelity and range of scenarios) within pre-registration and postgraduate physiotherapy curricula and postgraduate physiotherapy training in the UK is unknown.

2.2.2 Simulation modalities used in physiotherapy education

French (1989) provided an overview of teaching methods to encourage student centred learning in physiotherapy to fulfil learning objectives in physiotherapy. Blending modalities of teaching including seminars, tutorial, discussion groups, case studies and role play within a physiotherapy curriculum was advocated (French, 1989). Additionally, other simulation modalities have been reported in the physiotherapy literature such as practising with and on peers (peer-on-peer learning or peer physical examinations); scenarios involving simulated patients (people trained to portray the role of a patient, relative or carer); paper or video vignettes; computer-based simulation; part-task trainers; human patient simulators; and clinical training wards. The literature pertaining to each of these modalities will be explored in the forthcoming sections, 2.2.2.1 to 2.2.2.8.

2.2.2.1 Role play

Role play has been documented as a core teaching modality within physiotherapy education since the inception of the profession in 1895 (Wicksteed, 1948). An opinion article by Dickinson et al. (1991) suggested that role play is highly applicable to physiotherapy education with examples of practising physiotherapy therapeutic interventions such as electrotherapy, manual therapy, massage and respiratory care, as well as enabling students to illicit reasoning and skills related to professional dilemmas and communication skills. The purpose of role play within physiotherapy education has been comprehensively outlined by Dickinson et al. (1991) and includes stimulating thought processes, demonstrating and developing practical skills, consolidating learning, promoting retention through skill conceptualisation, enhancing interprofessional development, heightening self-awareness, challenging attitudes, developing an appreciation of patient case complexity, increasing student (self-) confidence and heightening sensitivity to the needs of others (peer/patient/carers). Examples of physiotherapy role play are detailed in other educational guidance articles (French, 1989; Dickinson et al., 1991; Thornton, 1994; Quitter et al., 1996; Parry and Brown, 2009). However, their scope is limited to research studies comparing the effects of a combination of simulated patients and human patient simulator scenarios to clinical placement exposure with traditional placement learning opportunities (Jull et al 2010; Smith et al., 2012; Jones and Sheppard, 2011; Jull et al., 2011; Watson et al., 2012; Blackstock et al., 2013; Watson et al., 2012). Literature pertaining to SP and human patient simulators will be explored in more detail in sections 2.2.2.3 and 2.2.2.7, respectively.

2.2.2.2 Peer learning

Peer learning or peer physical examinations are commonplace in physiotherapy education (Wicksteed, 1948; French, 1989; Dickinson et al., 1991; Thornton, 1994; Quitter et al., 1998; Parry and Brown, 2009; Jull et al., 2010; Smith et al., 2012) and provide opportunities for learners to develop and evaluate competency in basic physiotherapy assessment and management skills. Peer physical examinations have been integrated within teaching of clinical skills, whereby learners are repeatedly required to practice assessment skills or specific treatment techniques previously demonstrated by the teacher (also referred to as a facilitator in SBE, Meakim et al., 2013). Literature pertaining to peer physical examination describes its use and application in physiotherapy education (Wicksteed, 1948; French, 1989; Dickinson et al., 1991; Thornton, 1994; Quitter et al., 1996; Parry and Brown, 2009; Jull et al., 2010; Smith et al., 2012). However, research has not investigated the value or impact of peer learning on physiotherapy skills development, proficiency, competency or retention (Kirkpatrick level 2), behaviour change (Kirkpatrick level 3) or degree of achievement of targeted outcomes (Kirkpatrick level 4).

2.2.2.3 Simulated patients

Sixteen research studies featuring simulated patients[2] (SP) in physiotherapy were identified and have involved participants from different levels of physiotherapy education, ranging from first to third year pre-registration Bachelor or Masters degree programmes, to fifth year doctorate of physical therapy programmes in the USA (Ladyshewesky and Gotjamanos, 1997; LaPier, 1997; Black and Marcoux, 2002; Jensen and Richert, 2005; Hale et al., 2006; Lewis et al., 2008; Hayward et al., 2006; Hayward and Blackmer, 2010; Cahalin et al., 2011; Hensman and Conduit, 2012; Smith et al., 2012; Wamsley et al., 2012; Ohtake et al., 2013). Comparison of findings is difficult owing to the vast differences of participant experience, country of origin, purpose of the intervention, study design and

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[2] Alternative terms used to describe SPs include role player, clinical teaching associate, trained patient, patient instructor, incognito or unannounced patient, volunteer patient, hybrid patient, actor patient or confederate (Nestel and Bearman, 2015).

outcomes measures used. Three research articles featuring SPs in physiotherapy education included randomised controlled trials, two of which were undertaken in Australia (Watson et al., 2012; Blackstock et al., 2013) and the other in the USA (Black and Marcoux, 2002). The educational intervention varied amongst the studies and included clinical reasoning, communication and interpersonal skills, professionalism, multi-disciplinary working, therapeutic techniques and ethical issues relating to healthcare. Only two studies provided details of programme design and integration of SPs, scenario development and training provisions for SPs (Watson et al., 2012; Blackstock et al., 2013). However, little attention has been paid to the development of the scenarios featuring SPs, and none has been provided in the aforementioned literature, reducing the possibility of replicating the studies.

Jull et al. (2010) reported that SPs (students, educators or actors, trained to portray the role of a patient) were involved to some degree in physiotherapy education prior to clinical practice exposure (placement learning). The actual detail pertaining to specific aspects of physiotherapy education, the use of scenarios and their location within the curricula was not outlined in the funding report by Jull et al. (2010). Eight of the 16 Australian HEIs reported challenges related to involving SPs in physiotherapy education; these included recruitment of SPs, training provided for SPs prior to involvement in simulation and funding to develop scenarios. Smith et al. (2012) compared the effects of two simulation modalities (human patient simulation and simulated patients) on teaching electrocardiographic rhythms to physical therapy students in the USA, using a randomised crossover design. Whilst some detail is provided by Smith et al. (2012) with respect to the SPs' experience and standardised script, no further detail of training, scenario or teaching resources were reported.

Two research studies reported the cost of embedding SPs within a physiotherapy educational intervention (Black and Marcoux, 2002; Shoemaker et al., 2011). Black and Marcoux (2011) reported a cost of US$1760.60 for the 19 physiotherapy students undertaking a 90-minute SP learning activity. Whereas, Shoemaker et al. (2011) reported the cost of US$500 for providing a four-hour interprofessional simulation exercise for 64 physiotherapy and occupational therapy students, featuring six SPs portraying three complex case scenarios (including management of patients with burns due to mishandling fireworks, attempted suicide and a smoking accident). However, the true cost of designing, implementing and evaluating the four-hour intervention was underreported, as the authors acknowledged their figure did not account for actual staff time for the design and implementation. Also, Black and Marcoux (2011) reported that inefficient integration of student scheduling, camera set-up recording, streaming and post-event processing contributed to higher staffing costs (eight hours of staff time to run a four-hour intervention). To date the cost of integrating SPs within learning, teaching or assessment across an entire physiotherapy curriculum has not been published. Additionally, no other studies have reported the design or delivery costs for individual simulation modalities; therefore, further comparisons cannot be made.

2.2.2.4 Videos

The use of instructional videos (video vignettes) have been reported in physiotherapy practice and education (Cross et al., 2001; Parry and Brown, 2009; Weeks and Horan, 2013). The current literature provides insufficiently detailed information relating to the development of instructional videos or video-based viva preparation learning examples, scenarios and instructional delivery methods to facilitate replication beyond the studies. Whilst, the positive impact of instructional videos have been reported (Cross et al., 2001; Parry and Brown, 2009; Weeks and Horan, 2013), the impact across multiple areas of physiotherapy, depth of learning and resultant knowledge or skill retention has not been established. Cross et al. (2001) explored the gap between evidence-based judgements of clinical educators using six video vignettes of undergraduate physiotherapists in placements in the UK. In this experimental study, the video resources were extracted from actual placement experiences and used to compare the validity and reliability of two assessment forms used as educational tools for monitoring clinical educators' judgement of undergraduate students' performance on placement. Parry and Brown (2009) used a mixed methods questionnaire to explore teaching and learning of communication skills across physiotherapy programmes in the UK. A respectable response rate of 69% (25/36 HEIs) was achieved. Participants reported the use of videos of simulated scenarios (8/18) and actual patient videos (4/18) in communication-specific modules, but no further detail is provided as to how they were developed or integrated within undergraduate teaching and learning provisions. The perceived value of demonstration videos for examination preparation and demonstration of greater (but not statistically different) student performance outcomes is reported in single-cohort studies (Cross et al., 2001; Weeks and Horan, 2013). Findings reported by Weeks and Horan (2013), were based on a single, two-hour workshop featuring two 20-minute video (cardio-respiratory and neurology) case studies. The generalisation of findings remains difficult based on such small samples and range of scenarios.

Parry (2005) reported the use of video technology in physiotherapy, exploring how qualified physiotherapists communicate errors of performance to patients. Parry (2005) used conversational analysis of 74 video-recorded interactions between 21 stroke patients and 10 senior physiotherapists in one inpatient rehabilitation setting in the UK. In this study, video technology was as an analytical tool, rather than a means to facilitate change during the rehabilitation intervention or as a learning tool.

To the best of my knowledge, the use of video technology has not been used to explore learning, patient safety or the provision of feedback (debriefing) in physiotherapy education or within patient interactions. Feedback (in particular debriefing) is reportedly the most important aspect of SBE (Issenberg et al., 2005; Dufresne, 2006; Fanning and Gaba, 2007; Shinnick et al., 2011; Decker et al., 2013; Motola et al., 2013; Cheng et al., 2014), yet has not featured within any of the physiotherapy research studies identified in this literature review. Whereas, evidence of the effectiveness of debriefing in other aspects of healthcare has been reported (Issenberg et al., 2005; Rudolph, 2006; Fanning and Gaba, 2007; Shinnick et al., 2011; Decker et al., 2013; Motola et al., 2013; Cheng et al., 2014).

Debriefing commonly occurs immediately after the simulation learning experience, which is referred to as a warm debrief as opposed to a delayed or cold debrief (MacKinnon and Gough, 2014). Formats range from being relatively unstructured to highly structured and may feature the use of specific debriefing tools (Imperial College London, 2011; Jaye et al., 2015). To date, literature pertaining to SBE lacks reference to debriefing practices, formats and use of supportive tools. Guidelines for video-assisted debriefing in SBE have been published (Grant et al., 2010; Grant and Marriage, 2012; Levett-Jones and Lapkin, 2013; Krogh et al., 2015) but the most effective method of integrating video footage within a debrief has not been established. Debriefing practices vary widely and there is currently a lack of consensus on the most appropriate time post-event, duration, format and tool to optimise learning from SBE. Overlap between the debrief and further post-event reflection phases is also recognised in the literature (The NHET-Sim Monash Team, 2012) and learners may reflect before the debriefing. Several reflective models have been adopted within debriefing (Kolb 1984; Schon, 1987) to facilitate learning transfer from SBE (Husebo et al., 2015). Gough and Hamshire (2012) reported successfully blending digital technologies (podcasts, video excerpts from SBE and e-portfolio) to support the learning experience, facilitate repetitive reflection and to demonstrate continuous professional development (CPD). Twenty-three pre-registration physiotherapy students voluntarily participated in this single-cohort study to evaluate their experience of blending digital technologies to their support learning during an educational cardio-respiratory module. They reported that digital technologies could be successfully blended to enhance the students' educational experience, and facilitate repetitive, post-event reflection. However, the limited sample size, response rate (16/23, 70%) and recruitment from a single cohort reduces the generalisability of the findings.

Both paper and video vignettes have reportedly been used to enhance learning of key physiotherapy skills and to explore cardio-respiratory on-call practice. Research studies have reported varied effects of using vignettes, from enhancing patient education to enhanced examination preparation (Cross et al., 2001; Marrow et al., 2001; Parry, 2005; Kolt et al., 2007; Gough and Hamshire, 2012; Weeks and Horan, 2013). However, Dunford et al. (2011) highlighted the limited ability of paper vignettes to explore clinical reasoning or decision making of on-call physiotherapists when integrated within a questionnaire. Existing literature pertaining to vignettes has featured the use of survey methods or single-cohort, single-site studies, with relatively small-sample sizes, which limits the generalisability of their findings.

Unlike other areas of healthcare, including medicine and nursing (Carroll et al., 2009a, 2009b; Henneman et al., 2009; Iedema, 2009; Iedema et al., 2013a-d), no studies have engaged physiotherapists or pre-registration physiotherapy students to reflexively review their own practice or simulation-based learning experience in relation to patient safety or error recognition. Error recognition (Reason, 1990, 1997, 2000; Coombes et al., 2008; Vincent 2011, 2012) and the impact of non-technical skills (NTS) on practice and patient safety (Patey et al., 2007; Yule et al., 2006, 2008a, 2008b; Flin et al., 2008; Henneman et al., 2009; Mitchell et al., 2013), have been explored within healthcare practice but have not been specifically related to physiotherapy. Research has already demonstrated that behavioural marker systems can provide value for training, understanding of performance in high-risk environments, SBE and research into safety and human factors in healthcare (Klampfer et al., 2001). Several NTS behavioural observational tools have been developed for healthcare staff involved in surgery and anaesthesia (Fletcher et al., 2003; Healey et al., 2004, 2006; Yule et al., 2006, 2008a, 2008b; Flin et al., 2010; CPSSQ, 2011; Walker et al., 2011; Rutherford et al., 2013). The aforementioned NTS tools provide clinical facilitators, educators and researchers with a means to observe and rate behaviours (e.g. situational awareness, communication, teamwork, decision making, task management and leadership), which may be integrated within debriefing or feedback. Although these NTS scales have been used with other professions e.g. nursing (Hull et al., 2011), anaesthetic practitioners (Rutherford et al., 2013) and scrub practitioners (Mitchell et al., 2013), and in the simulated environment (Flin et al., 2010), no specifically designed NTS scales have been identified with respect to exploring behaviours of professions allied to healthcare or physiotherapy (Kirkpatrick level 3).

2.2.2.5 Computer-based simulation

Computer-based simulation modalities include haptic devices and virtual reality technology. Haptic simulators, including a walking simulator (Schmidt, 2004) and a finger rehabilitation simulator (Ferre et al., 2011), have been developed with applicability to physiotherapy rehabilitation education. Schmidt (2004) presented the first walking simulator (Haptic Walker®) that can be used to investigate gait and different walking trajectories. Whereas, Ferre et al. (2011) developed a two-finger haptic device for hand rehabilitation manipulations, which can be used to teach physiotherapy students how finger movements should be performed (including forces required to apply the movement). However, the use of haptic simulators within physiotherapy curricula has not yet been reported on.

There is a growing body of evidence to support the use of low-cost commercially available virtual reality (gaming) technology in physiotherapy rehabilitation (Groen and Goldstein, 2008; Jull et al., 2010; dos Santos Mendes et al., 2012; Fung et al., 2012; O'Donovan and Hussey, 2012; O'Donovan et al., 2012; Pompeu et al., 2012; Salem et al., 2012; Pompeu et al., 2014). To date, existing small-scale, quasi-experimental studies and randomised-controlled trials have focused their investigations on the use of the low-cost, commercially available gaming platforms such as the Nintendo Wii™ and Microsoft Kinect Adventures™ games as a form of physiotherapy rehabilitation. Studies have investigated the impact of using virtual reality technology in healthy participants and on improving patient outcomes (e.g. balance and gait, quality of life and cardio-pulmonary function) in pre-school children with developmental delay and adults with neurological impairments (dos Santos Mendes et al., 2012; Fung et al., 2012; O'Donovan and Hussey, 2012; O'Donovan et al., 2012; Pompeu et al., 2012; Salem et al., 2012; Pompeu et al., 2014). Despite the use of virtual reality technology in physiotherapy practice, there is a paucity of evidence in its use in physiotherapy education.

Jull et al. (2010) reported limited evidence of the use of virtual reality simulation within physiotherapy education in Australia. The only other educational reference to virtual reality was by Seefeldt et al. (2012), who conducted a pilot study featuring an hour-long interprofessional case discussion in Second Life Virtual World (Linden Labs, http://secondlife.com). Their pilot study recruited 47 pre-registration students (from pharmacy, nursing, physician assistant, physical therapy and occupational therapy programmes). Students participated in one of nine, one-hour interprofessional mock case discussions undertaken in one of four cities in the Virtual World. Limited information is provided by Seefeldt et al. (2012) regarding the recruitment of participants from their respective courses. As the numbers of students per professional group were 10 or less, it is unlikely that they represented to entire cohort population. Technical issues relating to the provision of learning activities in a virtual environment were reported as the biggest challenge (Seefeldt et al., 2012), and the implications of large cohort roll-out is required to ascertain the feasibility and value of this learning modality within physiotherapy curricula.

2.2.2.6 Part-task trainers

Research featuring the use of part-task trainers (simulators that are specifically designed to replicate a single task or skill) has primarily been confined to the laboratory setting (Hassam and Williams, 2003; Gregson et al., 2007; Shannon et al., 2010; Maréchal et al., 2012). Hassam and Williams (2003) investigated the use of a purposely-designed paediatric simulator to teach safe chest percussion for pre-term infants to final year pre-registration physiotherapy students in Australia, using a within-subject, repeated measures design with a follow-up questionnaire. Significantly better educational outcomes were reported when theoretical and practical (simulated) experience was combined (Hassam and Williams, 2003). The authors suggested that the combination of active participation using the simulator, prior knowledge and technical skill combined with new specific theoretical knowledge, resulted in more specific and increased retention than the provision of specific theoretical knowledge alone. However, the suggestions were based on data obtained using a purposely-developed scoring system of skill demonstration following a 20-minute education session. Further testing of this paediatric simulator and the educational method is required to establish the value and impact on student learning, behaviours and targeted outcomes (Kirkpatrick levels 2-4).

Laboratory-based studies have provided positive evidence of abstract skills acquisition (Gregson et al., 2007; Shannon, 2010; Maréchal et al., 2012). Abstract skills acquisition refers to acquiring skills in isolation (e.g. without integration of case studies where knowledge relating to pathophysiology can be linked to the skill being taught). Gregson et al. (2007) reported the development of a method of objectively measuring the direct and indirect effects of vibration and manual lung inflations, as a precursor to developing evidence-based practice. Customised sensory mats and computer software were developed and tested in this laboratory-based study, but to date, there has been no report of the equipment being used within physiotherapy education. Shannon et al. (2010) used a ventilated lung model to investigate the effects of chest wall vibration timing on airflow and pressure. Their findings provide powerful initial insights into the importance of timing chest wall vibrations to ensure both effectiveness and safety of this core respiratory physiotherapy chest clearance intervention on patients. Maréchal et al. (2012) designed and developed a prototype mechanotronic infant torso to simulate a six-

month-old baby, for use within respiratory physiotherapy education. Further developments to the prototype would reportedly include the realistic sensation of infant skin, a loudspeaker to generate infant-specific breath sounds and characteristics of respiratory distress.
Several other small-scale, quasi-experimental studies have been undertaken featuring part-task trainers specifically designed to develop palpatory and diagnostic manual therapy physiotherapy skills (Chester et al., 2003; Holland et al., 2004; Tuttle and Jacuinde, 2011). These small-scale, single-cohort studies report recruitment of students from various levels of pre-registration physiotherapy programmes and have featured the design of bespoke part-task trainer and devices to measure forces. To date, as with cardio-respiratory, part-task trainer studies, none of the manual therapy studies have explored skill retention or compared the effectiveness of learning using part-task trainer or force measurement devices on skills retention or transfer to the practice environment (Chester et al., 2003; Holland et al., 2004; Williams et al., 2004; Tuttle and Jacuinde, 2011). Two small, single-centre experimental studies have reported commonalities in relation to observed differences in skill reproducibility amongst qualified physiotherapists, with respect to displacement and amplitude of manual therapy, graded joint oscillation (Chester et al., 2003) and chest wall vibrations in cardio-respiratory physiotherapy (Shannon et al., 2010). Variance of joint displacement and amplitude of movement varied between physiotherapist and joint mobilisation grade. Shannon et al. (2010) reported that the safety and efficacy of actual respiratory treatments are likely to be influenced by the timing of chest wall vibrations, for example early vibrations in a breath cycle providing dangerous pressures compared to later vibrations generating more effective interventions. Similarly, both studies reported that individual physiotherapists applied consistent forces and techniques within and between test conditions (Chester et al., 2003; Shannon et al., 2010).

Williams et al. (2004) outlined the development of a virtual haptic back simulator to facilitate palpatory training for osteopathy, medicine, physical therapy, massage therapy and other health professions. To date, only a preliminary study involving six physiotherapy students and 30 novices (non-health related students from the same university) has been undertaken. Limited details of the educational methods, study design and group allocation were provided by Williams et al. (2004), with only brief initial evaluation data based on 36 students using the virtual haptic back simulator every three months for a total of 12 months (except during the summer vacation period). Whilst the authors reported limited data on the comparison of time to identify various levels of vertebral stiffness and incorrect responses, there was little information as to the educational intervention on which these findings are based and no comparative breakdown of data with respect to the learner group (physical therapist and non-health related students). Although originally described as being applicable to physical therapy palpatory diagnostic skills (Williams et al., 2004), research evidence of the effectiveness of the virtual haptic back as a learning and teaching modality is yet to emerge. However, Tuttle and Jacuinde (2011) and Snodgrass et al. (2010) have investigated the use of computer-generated feedback from part-task trainers to teach manual therapy (joint mobilisation) techniques to pre-registration physiotherapy students in Australia.

Tuttle and Jacuinde (2011) proposed that their low-cost sensor device (featuring sensors, resistors and a bespoke computer software programme) may provide other applications for teaching manual therapy to physiotherapy students. Snodgrass et al. (2010) investigated the effect of feedback on the accuracy of manual therapy mobilisation techniques using an instrumented table and real-time computer software (Snodgrass et al., 2010). Their well-designed, single centre randomised controlled trials (RCTs) demonstrated that real-time feedback did improve the accuracy of manual therapy mobilisation techniques and as a result the device has since been integrated within the curricula at the University of Newcastle, Australia (Snodgrass, 2013).

In summary, existing experimental studies have provided valuable insights into skill acquisition (Kirkpatrick level 2), but to date none of the studies has investigated the retention of skills or longitudinal reproducibility. Owing to the diversity of part-task trainers, skills focus and different outcome metrics used, direct comparison between studies was not possible. There is a paucity of research relating to the application of part-task trainers in relation to physiotherapy assessment, interventions, clinical reasoning, learner behaviours (Kirkpatrick level 3) and the targeted impact on educational learning outcome or translation to physiotherapy practice (Kirkpatrick level 4).

2.2.2.7 Computerised human patient simulation

Small-scale, single cohort studies featuring postgraduate physiotherapy students have also reported positive findings using high-fidelity simulation scenarios featuring computerised human patient simulators (HPS) in the intensive care environment (da Silva Bezerra Fitipaldi and da Caetano Azeredo, 2005; Shoemaker et al., 2009). Whilst the two aforementioned studies demonstrated the positive benefits of using human patient simulators during training, the lack of robust outcome measures and small sample sizes limited the generalisability of their findings. Da Silva Bezerra Fitipaldi and Azeredo (2005) proposed that human patient simulators offer valuable learning opportunities to develop skills and cognitive aspects required in the management of intensive care unit (ICU) patients in Brazil. Caution is noted as the findings are only based on eight physiotherapy participants (five postgraduates and three physiotherapy students) recruited from a single ICU and the analysis lacked a valid metric. A similar small-scale, single-site study was undertaken in the USA (Shoemaker, 2009). Similarly, this study omitted the use of a valid outcome measurement tool when rating student performance. Instead, it reported generalised (ungraded) observational recordings of skill performance such as managing lines, leads and tubes when mobilising the simulated patient. Whilst Shoemaker (2009) proposed that high-fidelity simulation prior to acute care clinical experience may positively influence individual decision making, psychomotor performance and self-confidence, this is yet to be established.

More recently Silberman et al.'s (2013) findings from a small-scale, mixed methods study featuring a RCT (n=16 entry-level Doctor of Physical Therapy students), indicated that students demonstrated significant differences of self-efficacy (of confidence using a validated Acute Care Confidence Survey, ACCS, tool) when exposed to six additional HPS experiences, compared to a control group of routine academic experiences. Post hoc analysis also revealed significant differences in self-efficacy (ACCS) between the baseline and at six subsequent (undefined) timeframes. Themes identified from the focus group (n=8 participants) related to the ability of SBE to provide a safe non-judgemental learning environment, gaining increased confidence for acute care experience, fostering clinical reasoning skills and facilitating multi-tasking in a complex setting. Limitations of a small sample size, single cohort and single HEI were acknowledged by the authors, who also suggested future multi-site, multi-centre studies are required.

A number of external factors such as senior staff shortages, training costs, patient availability and increasing student enrolments in physiotherapy programmes have contributed to clinical placement deficiencies in various countries (Hall, 2006; Hutchings et al., 2005; Lekkas et al., 2007; Jull et al., 2010; Jones and Sheppard, 2011; Jull et al., 2011; CSP, 2014b). These factors have thus stimulated research to explore whether SBE can be used to supplement and/or replace clinical placement experience (Jull et al., 2010; Gough et al., 2012a). A literature review by Jones and Sheppard (2007) indicated that it was not possible to conclude whether the use of human patient simulation (featuring human patient simulators or SPs) could be used to improve physiotherapy patient management. Since this review, a series of funded, well designed RCTs have used the same primary outcome measure (Australian Physiotherapy Practice Standards, APC, 2006) to investigate changes in student learning objective achievement when undertaking a combination of SLE and placement experience versus 100% traditional placement immersion (Jones and Sheppard, 2011; Jull et al., 2011; Watson et al., 2012; Blackstock et al., 2013). All of the RCTs recruited Australian pre-registration physiotherapy students to investigate changes in clinical ability (measured by the Assessment of Physiotherapy Practice, AAP tool) using the SLE versus traditional clinical practice placement immersion (Jones and Sheppard, 2011; Jull et al., 2011; Watson et al., 2012: Blackstock et al., 2013). Although this reliable and valid APP measure of student competence (Dalton et al., 2011; Dalton et al., 2012) is used by Australian and New Zealand physiotherapy programmes (Watson et al., 2013), it has never been compared to any of the UK-based or international physiotherapy placement assessment metrics. Three of the four RCTs were adequately powered, reporting over 90 students being allocated to each group (Jull et al., 2011; Watson et al., 2012: Blackstock et al., 2013).

Jull et al. (2011) compared SLE education with traditional clinical immersion featuring 720 pre-registration physiotherapy students, across seven Australian universities (during 2009/10). Results indicated that there were no differences in students' clinical competency (APP) scores in either cardio-respiratory or musculoskeletal physiotherapy, but suggested that high-fidelity SLEs could substitute for some placement time (Jull et al., 2011). Jones and Sheppard (2011) reported findings from a RCT featuring 50 third-year physiotherapy students from one university in Australia. Findings indicated that two, four-hour cardio-respiratory or acute care human patient simulation educational sessions did not generate significant changes in clinical ability (also measured by the AAP tool), compared to undertaking traditional placement learning opportunities.

Watson et al. (2012) reported findings from two parallel-group, single-blind, multi-centre RCTs to investigate the effect of replacing one week of musculoskeletal physiotherapy practice placement time with nine patient cases portrayed by trained SPs. RCT1 featured SP interactions in the first week of the four-week placement, whereas in RCT2, the SP interactions were interspersed within the first two weeks of the four-week placement. Students' achieved comparable clinical (APP) competencies from the traditional placements and both RCT1 and RCT2 placement variations. The authors acknowledged potential variability in SP interactions due to the limitations in physical presentations that they can portray despite role training. They proposed that hybrid simulation (combination of an SP and part-task trainer) may help to overcome the deficits in physical presentation that may not be achievable when a SP is required to portray a specific case. The authors suggested that medium to high fidelity, part-task trainers would enrich the hybrid experience but lower fidelity (static), part-task trainers offer no benefit in musculoskeletal physiotherapy hybrid simulation.

Similarly, Blackstock et al. (2013) assessed 349 pre-registration physiotherapy students' competency to practice during two placements to establish whether SLEs can be used to replace time in the clinical environment for cardio-respiratory physiotherapy. Two independent, parallel, single-blind, multi-centre RCTs were conducted across seven Australian HEIs featuring 2009-2010 physiotherapy cohorts. No significant differences were observed in student competency (measured by the APP tool) between the control (clinical placement) and SLE groups (one week of SLE during the first week of placement). The third group, who experienced two weeks of interspersed SLE and clinical placement (equating to one full week) achieved higher scores in five out of seven assessments areas of the APP tool, with

$p < 0.05$. Since the competency requirements of placement were achieved by all of the students, the authors concluded that the SLE can replace some of the cardio-respiratory placement time in Australia.

Four research studies have reported the recruitment of physiotherapy students within interprofessional education featuring simulation (Leaviss, 2000; Reeves et al., 2002; Ponzer et al., 2004; Alinier et al., 2008). These interprofessional research studies all utilised different simulation-based learning mediums and durations. All of these studies featured the recruitment of physiotherapy students from a single HEI in the UK (Leaviss, 2000; Reeves et al., 2002; Alinier et al., 2008) or Sweden (Ponzer et al., 2004). These four studies explored participants' perceptions of interprofessional education (IPE) featuring simulation, using semi-structured interviews (Leaviss, 2000; Reeves et al., 2002) or purposely-designed questionnaires (Alinier et al., 2008; Ponzer et al., 2004). The duration of IPE interventions varied from three hours (Alinier et al., 2008), a two-day course (Leaviss, 2000) to a two-week placement on a clinical training ward (Ponzer et al., 2004; Reeves et al., 2002). Collectively, the interprofessional interventions featuring simulation were viewed positively by participants. Significant differences in knowledge tests results ($p = 0.02$) and perceived view of multi-disciplinary training ($p=0,011$). Reliable differences in perceived confidence in their ability to work as part of a team ($p = 0.073$) and perceived knowledge of other professions' roles ($p = 0.066$) were reported between the experimental group and control, following a three-hour IPE session (Alinier et al., 2008).

Leaviss (2000) recruited 15 UK undergraduate students (medical, radiography, occupational therapy, physiotherapy and orthoptics) onto a two-day, interprofessional course. This small-scale study highlighted positive changes in relation to students gaining a greater understanding of other professions, increased awareness of profession-specific skills and an improved understanding of professional pressures and holistic care. The two studies featuring IPE clinical training ward exposure for pre-registration healthcare students in the UK (Reeves et al., 2002) and Sweden (Ponzer et al., 2004) are discussed in section 2.2.2.8 in more detail. Despite these IPE interventions featuring simulation being positively received by participants, the educational impact of IPE interventions featuring simulation and translation of resultant skills into healthcare practice have yet to be investigated. In contrast, Ponzer et al. (2004) reported positive outcomes in relation to the achievement of the specific goals of the IPE programme, attitudes to IPE and satisfaction with the two-week supervised experience on a Swedish clinical training ward, involving 1233 students from medicine (n=210), nursing (n=470), occupational therapy (n=98) and physiotherapy (n=184) programmes. Only Reeves et al. (2002) explored the impact of the intervention (one-year) post intervention. Findings indicated that the two-week ward exposure provided valuable insights into the other professions' roles and interprofessional working for the 36 students. Further multi-centre studies are also warranted.

In summary, one major factor limiting the replication of the studies featuring human patient simulators is the relatively limited details provided pertaining to the level of fidelity (equipment, environment or psychological), realism, development and implementation costs required to generate the reported findings (da Silva Bezerra Fitipaldi and da Caetano Azeredo, 2005; Shoemaker et al., 2009; Jull et al., 2010; Jones and Sheppard, 2011; Jull et al., 2011; Watson et al., 2012; Blackstock et al., 2013). Whilst existing studies have explored students' academic competency achievement (Kirkpatrick's level 2), they have not yet explored the students' perceptions of academic or clinical placement factors that may influence their performance within the SLE. Unlike existing medical and nursing SBE literature, none of the studies identified in this review has explored the value (in terms of outcomes related to learning or patient safety) of intervention featuring computerised human patient simulators (Kirkpatrick's level 4).

2.2.2.8 Clinical training wards

Research featuring clinical training wards has produced positive results in relation to learner satisfaction, achievement of interprofessional learning objectives and insights into the lasting effects of insights into other healthcare professionals' roles in patient management (Reeves et al., 2002; Ponzer et al., 2004). Whereas, Gough et al. (2013a) explored the impact of a four-day pilot interprofessional simulation-based education (IPSE) course on students' perceptions of interprofessional learning and patient safety. The IPSE course participants were exposed to a fully operational simulated clinical training ward featuring 10 standardised patient scenarios (5 male and 5 female) and one computerised manikin scenario (Laerdal, SimMan 3G located within a simulated hospital side room). These clinical training ward initiatives have highlighted improvements in key non-technical skills (communication and team working skills), which may impact on safe and effective care (Reeves et al., 2002; Ponzer et al., 2004; Gough et al., 2013a).

Reeves et al. (2002) undertook a multi-method evaluation of an interprofessional training ward placement experience. Thirty-six undergraduate UK medical, nursing, occupational therapy and physiotherapy students were supervised in teams of six on a clinical training ward during a two-week pilot. No validated observational metrics were reportedly used in the observational aspect of this study, which focused on the students' practice, handovers and reflective sessions. The authors deemed that the two-week clinical training ward intervention was too short to provide lasting interprofessional effects. However, their one-year follow-up did provide valuable insights into the students' awareness of other professional roles and interprofessional working. Whilst the study reported positive findings in relation to practice observations and student satisfaction, concerns were raised regarding staff 'burn-out'. In contrast, Ponzer et al., (2004) reported positive outcomes in relation to the achievement of the specific goals of the IPE programme, attitudes to IPE and satisfaction with the two-week supervised experience on a Swedish clinical training ward, involving 1233 students from medicine (n=210), nursing (n=470), occupational therapy (n=98) and physiotherapy (n=184) programmes.

Gough et al., (2013a) recruited 15 pre-registration medicine, nursing, physiotherapy and pharmacy students to pilot a four-day IPSE patient safety course. This was developed in response to and undertaken as part of the World Health Organizations' (WHO) complementary pilot site evaluation of the 'Multi-professional Patient Safety Curriculum Guide' (MPSCG) (WHO, 2011). The single-centre pilot study featured an approach to embed patient safety education within practice placement provision in the UK (Gough et al. 2013a). The pilot study integrated an eclectic mix of simulation modalities to embed the WHO MPSCG (WHO, 2011) within pre-registration healthcare (including physiotherapy) education in the UK (Gough et al., 2013a). Key findings concur with previous studies (Reeves et al., 2002; Ponzer et al., 2004) as the IPSE course enabled the pre-registration students to develop an appreciation of each other's professional roles, in particular individual and collaborative practice that may have a positive impact on patient safety in the clinical environment.

Reeves et al. (2002) and Gough et al. (2013a) both explored the impact of their interventions beyond the immediate post-intervention period. Reeves et al. (2002) reported that the two-week ward exposure provided valuable insights into the other professions' roles and interprofessional working, one-year post intervention. Whereas, Gough et al. (2013a) reported that participants provided reflexive accounts of their practice three months post-course, during subsequent placements or as qualified staff. These reflective accounts related to medication safety, human factors, teamwork, error prevention and infection prevention and control. Despite these positive findings, they are based on single-centre studies, featuring a small number of students. The clinical training ward studies (Reeves et al., 2002; Ponzer et al., 2004) lacked depth of information pertaining to the design of the intervention, staff training/orientation and range of patient scenarios to facilitate replication. However, Gough et al. (2013a) provided detail of the development of the 11 scenarios, learning objectives, training and facilitation and standardised patient checklist to facilitate feedback during the debrief, thus aiding study replication.

In summary, there is limited research exploring the application of clinical training wards as a learning modality in physiotherapy. Studies have utilised semi-structured interviews and purposely-designed questionnaires to explore learner satisfaction (Kirkpatrick's level 1) and applied skills and knowledge (Kirkpatrick's level 2). The extent to which behaviours (Kirkpatrick's level 3) have been applied following IPE/IPSE or targeted outcomes have been achieved as a direct result of the intervention (Kirkpatrick's level 4) has yet to be established. The purpose, research design, SBE intervention duration and data collection methods used within the aforementioned clinical training ward studies varied (Reeves et al., 2002; Ponzer et al., 2004; Gough et al., 2013a), limiting overall comparison.

2.2.3 Simulation methods used in physiotherapy education

Simulation methods refers to whether the SBE intervention has either student-led or facilitator-led instruction (Chiniara et al., 2013). All of the studies included in the literature review provided in this chapter have featured facilitator-led SBE intervention within pre-registration and postgraduate physiotherapy education. No studies were identified that have involved student-led SBE in physiotherapy. Despite the publication of literature pertaining to features and educational practices in SBE that led to effective learning in medical education (Issenberg et al., 2005), there is an absence of studies investigating the SBE methods that lead to effective learning in physiotherapy. In summary, despite the publication of literature pertaining to features and educational practices in SBE that led to effective learning in medical education, there is an absence of research to demonstrate which simulation methods lead to effective learning in physiotherapy. Box 2.1 provides a summative critique of the existing use of SBE in physiotherapy.

Box 2.1: Critical summary of the existing use of SBE in physiotherapy

- Existing studies have predominantly evaluated learning-related characteristics including reactions to simulation intervention (Kirkpatrick level 1) and knowledge relating to skills and interprofessional working (Kirkpatrick level 2)
- A wide range of simulation modalities have been reported in the physiotherapy literature, but differences in methodological design and metrics limit the comparison of research findings. Additionally, relatively limited details have been provided in the literature pertaining to the level of fidelity (equipment, environment or psychological) or realism created to generate the reported findings
- Four high-quality RCTs were identified, which have indicated that up to 25% of physiotherapy placement experience can be replaced with clinical education in a simulated learning environment (featuring SP and/or HPS), without compromising student learning objectives (Kirkpatrick level 2)
- Unlike in other healthcare disciplines, video technology has not been used to explore learning, patient safety, the provision of feedback (debriefing) in physiotherapy or to critically engaged learners to review reflexively their own experience or practice in relation to patient safety, knowledge, skills or behaviours
- There is a paucity of studies detailing the theoretical frameworks underpinning the simulation intervention outlined in the research
- Influential factors affecting performance within SBE have yet to be explored.
- There is a paucity of research exploring the behaviours of physiotherapists in a simulated environment. Additionally, there is a paucity of research featuring simulation modalities to improve the awareness of, or evaluating the effect of interventions on patient safety, recognition of factors that contribute to safe and effective patient care, and recognising and responding to errors in practice. (Kirkpatrick level 3)
- There is a paucity of studies demonstrating the impact of simulation modalities on the achievement of targeted outcomes occurring as a direct result of SBE (Kirkpatrick level 4)
- There is limited research outlining the monetary value (cost) of simulation interventions within research studies (Return on investment, Roberts, 1990; Salas 2009)

2.3 Theories and frameworks underpinning physiotherapy SBE

This section presents the findings of the literature review pertaining to theories and frameworks that have been applied to simulation-based education. This was deemed appropriate due to the absence of a framework to facilitate the design, implementation and evaluation or research of SBE in physiotherapy. Literature pertaining to theories and frameworks applied to SBE in healthcare will be discussed.

2.3.1 Theories applied to SBE in healthcare

The literature review identified four different theoretical perspectives that have been applied to SBE in healthcare including behaviourism, cognitivism, humanism and socio-materialism. Theories and educational principles will influence both the design of the intervention (learning design characteristics, pre-briefing and debriefing, linked learning activities) and evaluation or research considerations. Knowles (1990) described adult learners as self-directed, motivated and orientated towards real-life issues. Theories commonly associated with adult learning include behaviourism, cognitivism, constructivism and humanism (Gould, 2009). Socio-material theories (e.g. complexity, cultural historical activity theory and actor network theory) provide conceptual resources to explore patterns of conformity and unpredictability in educational activities and lifelong learning (Fenwick and Edwards, 2013). In particular, socio-material theories are attractive to educationalists designing and delivering SBE interventions, those evaluating course or curricula and researchers alike, to explore struggles, negotiations and accommodations affecting learners, facilitators, educational resources and learning itself (Fenwick and Edwards, 2013). Each of these theoretical perspectives offer benefits in their own right and should be considered in the context of the learning activity to be designed (short course or embedded within a curricula), learning objectives (performance goals) and the learners (uni/multi/interprofessional groups).

Appendix 1 (on page 264) summarises the four theoretical perspectives, views of learning and considerations for integration within the planning, design, assessment and evaluation of SBE in healthcare. References to how the different theoretical perspectives and respective educational practices have been applied within healthcare education and practice are also illustrated. Nestel and Bearman (2015) propose that the selection and utilisation of multiple theories offers the opportunities to provide multiple perspectives of learning. Similarly, Drescher (2004) proposes that the complexities of learning can be explored by employing and triangulating qualitative and quantitative approaches to provide meaningful evaluation of education.

Healthcare programmes in HEIs awarding qualifications for successful completion are examples of formal learning, which characteristically involve the development of specific curricula, designated specialist teaching faculty and results in assessment or certification. (The term 'programme' in this instance refers to curricula that are credit bearing, for example pre-registration physiotherapy). Educationalists are required to draw on theories and educational practices to support the development of holistic curricula, which are driven by current practice, and regulatory and statutory requirements (DH, 2011; Ravert, 2014; CSP, 2013, 2015). Key drivers in curriculum development also include statutory and professional bodies' requirements. Examples for UK pre-registration physiotherapy curriculum development include the Chartered Society of Physiotherapy's Physiotherapy Framework: Putting physiotherapy behaviours, values, knowledge and skills into practice (CSP, 2013); Learning and development principles (CSP 2015); The Health and Care Professions Council standards (HCPC, 2012a, 2012b); The National Health Service Knowledge and Skills Framework at band five (DH, 2004); and The Quality Assurance Agency Framework for Higher Education Qualification in England, Wales and Northern Ireland (QAA, 2008).

In the UK, The CSP allows individual HEIs the flexibility to design and deliver the physiotherapy curricula according to their organisation's strengths and resources (CSP, 2002b, 2013a, 2013b, 2015). The principle tenant of the CSP (2002b) curriculum framework relates to the provision of a student-focused learning environment that equally and fully integrates learning within the university and practice placements. Practice placements provide the opportunity to learn new skills and ideas, and to integrate existing university-acquired learning into real-world practice with patients under the supervision of qualified physiotherapists. Placements are currently organised by individual HEIs and typically take place within healthcare practices in close geographical proximity to the HEI.

In contrast to formal learning within a physiotherapy curriculum, informal learning is defined as lacking at least one of the aforementioned formal learning characteristics; it occurs more opportunistically and is part of an ongoing process (Hager and Halliday, 2006). Contemporary SBE activities provide informal learning opportunities for uni/interprofessional groups to develop knowledge and extend understanding of and connections with practice through the facilitation of participation, peer and vicarious learning (DH, 2011; Kelly and Hager, 2015). Informal learning principles can also be applied to in-situ (occurring in the clinical practice setting), ad hoc or impromptu SBE activities in healthcare environments to enrich learning, such as EOC training. However, no literature was identified that related to the theories or education practices underpinning the development and delivery of EOC training programmes in the UK.

In 2010, a critical review of simulation-based medical education research (2003-2009) was published, which summarised the 12 best features and educational practices of SBE. These included curriculum integration, outcome measures, simulation fidelity, skill acquisition and maintenance, team training, feedback, deliberate practice, mastery learning, transfer to practice, high-stakes testing, instructor training and educational and professional context (McGaghie et al., 2010). Additional educational practices, which align with the aforementioned theories presented in Appendix 1 (on page 264), include blended learning (DH, 2011), flipped classroom (Roehl et al., 2013) and scaffolding (Gould, 2009; Jeffries and Rodgers, 2012). It is proposed that by utilising these educational practices, educators/facilitators can optimise learning time spent with the facilitator during SBE activities (DH, 2011; Lioce et al., 2013; Franklin et al., 2013).

A blended learning approach, which may include SBE, e-learning and other new learning technologies could be used to facilitate achievement of the desired learning objectives across a particular course or curriculum or clinical need within both formal and informal learning (DH, 2011; Chiniara et al., 2013; Lioce et al., 2013). Flipped classroom resources can be designed to support the development of prerequisite knowledge and/or skills required within the forthcoming SBE activities, outside of the formal classroom (Roehl et al., 2013). The flipped classroom approach may help prepare learners for the simulated experience, highlighting key topics and achieving baseline knowledge and skills (technical and non-technical).

Scaffolding is an educational concept traditionally aligned to constructivism (Bruner, 1967) that has been applied to the design of the simulation intervention. Learning activities can be scaffolded to introduce incrementally more complex concepts, skills and procedures (DH, 2011; Chiniara et al., 2013; Lioce et al., 2013). Incremental (scaffolded) learning activities enable learner progression to independent achievement of a task or activity (Motola et al., 2012) and mastery (Vygotsky, 1986). The overall complexity of the learning activities and respective learning objectives can therefore be increased and support from the facilitator reduced, as the learner progressively moves towards achievement of the intended level of development, expectations or progression from novice to expert (Dreyfus and Dreyfus, 1980; Benner, 1984; Fenwick and Abrandt Dahlgren, 2015) or towards mastery (Bloom, 1956). Deliberate practice, featuring various levels of simulation equipment fidelity coupled with feedback, has been linked to development of mastery learning (Motola et al., 2012) and improved skill levels (Clapper and Kardong-Edgren, 2012).

Situated and contextualised learning usually refers to learning that takes place in environments similar to those in which it will be practiced. In physiotherapy, situated and contextualised learning occurs during practice placements, with guidance from a qualified physiotherapist who adopts the role of the clinical educator. Similarly, during EOC informal training sessions/mentoring opportunities with a senior or specialty respiratory physiotherapist, may be used to situate and contextualise skills required for EOC practice. However, the comparative impact of integrating the specific aforementioned educational practices within physiotherapy SBE on learner reaction, knowledge, skill and attitudes, behaviours and targeted outcomes (Kirkpatrick levels 1-4) is currently unknown.

2.3.2 Frameworks that underpin the design and development of SBE

With the increasing use of SBE within healthcare training (medical, nursing and allied health professions), simulation frameworks have been developed to support the processes from conceptualisation through to evaluation (Jeffries, 2005; Eldabi and Young, 2007; DH, 1011; Chiniara et al., 2013). No specific framework was identified to facilitate the design of SBE or simulation and technology enhanced learning (STEL) in physiotherapy.

Eldabi and Young (2007) describe the drivers shaping healthcare educational frameworks (which are commonly seen in industrial processes), whereby organisations are pressured to deliver more for less with refined processes. Such drivers include changes in healthcare delivery methods, service developments, performance and quality evaluations, and pressure to reduce operating costs. Eldabi and Young (2007) describe the move towards developing a framework to examine healthcare practices, which utilises modelling and simulation as system-level techniques to support healthcare delivery and implementation at an organisational level. The focus of blending 'modelling' and 'simulation' together in this context is to align healthcare improvement methods with actual grassroots practice. The literature review identified reference to six frameworks specifically developed for SBE in healthcare (Jeffries, 2005; Anderson et al., 2008; Dieckmann, 2009; DH, 2011; the NHET-Sim Monash Team, 2012; Chiniara et al., 2013). In 2005, Jeffries (2005) published a simulation framework for application to nursing education. The simulation framework consists of five constructs (educational practices, teacher, student, simulation design characteristics and outcomes), each containing several essential sub-components (Jeffries, 2005, 2007a). Jeffries (2005) proposed that the outcomes presented in the framework (learning knowledge, skill performance, learner satisfaction, critical thinking and self-confidence) are influenced by the degree to which best educational practices are incorporated in the design and implementation of the simulation interventions (Jeffries and Rogers, 2007a).

Jeffries' simulation framework (2005) was developed to promote the simulation team (those involved in SBE, curriculum review and development) to strategically consider and align variables for optimal learning from the design, to implementation and then evaluation stages (Jeffries and Rogers, 2007a). A significant attribute of the model is flexibility for use in a variety of international educational settings. The nursing simulation framework acknowledges the interaction between four constructs (teacher, students, educational practices and design characteristics), which lead to the fifth construct, the simulation 'outcomes'.

However, this framework fails to indicate how the outcomes drive change in future simulation design or implementation. A key disadvantage of the model is the lack of recognition of opportunities to transfer learning to the healthcare practice environment, and transfer of learning beyond the simulation environment and debrief. Reviews of individual constructs in the nursing simulation education framework (Jeffries, 2005) have since been published (Groom et al., 2014; Fentress Hallmark et al., 2014; Jones et al., 2014) and incorporated into the most recent version of the framework (Jeffries, 2016). Whilst Jeffries' (2005) simulation framework did not differentiate between the types of simulation modalities, Dieckmann (2009) developed a simulation framework based on interprofessional manikin-based simulation. Dieckmann's (2009) framework is presented as an oval, segmented vertically into seven sections. An arrow indicates linear movement from left to right, starting with setting instruction and moving through simulator briefing, theory inputs, scenario briefing, simulation scenario and debriefing to the final element of course ending. This linear model reflects the seven stages of SBE rather than a framework for its design, implementation and evaluation. No research studies were identified that have implemented this model.

In 2012, the NHET-Sim Monash Team developed a simulation framework to promote a systematic approach to adopting SBE in healthcare. This framework was specifically developed for a national simulation educator programme in Australia. The framework is presented as a cyclical figure, featuring the six component titles (as words encased in a text box) including preparation, briefing, simulation activity, debriefing/feedback, reflection and evaluation. Similarly, no research studies were identified that have implemented this model. Unlike Jeffries (2005), both Dieckmann (2009) and the NHET-Sim Monash Team's (2012) frameworks omit specific reference to theories or educational practices that underpin SBE. Whilst their frameworks refer to an evaluation phase, this is visually omitted from Dieckmann's framework (2009).

In 2011, The Department of Health published ‘A framework for technology enhanced learning’ (TEL[3]), to establish a vision to underpin world-class education to enhance patient care (DH, 2011). TEL encompasses a variety of technologies including mobile (or m-learning), e-learning, simulation and virtual and augmented reality (DH, 2011). Whilst the aforementioned frameworks have focused on the components involved in the design and implementation of SBE (Jeffries, 2005; Dieckmann, 2009; the NHET-Sim Monash Team, 2011), the TEL Framework presents six guiding principles that should underpin the use of TEL in healthcare (DH, 2011). The guiding principles state that healthcare education should be patient centred and service driven; ensure equity of access and quality of provision; deliver value for money and high quality educational outcomes; and be innovative, evidence based and educationally coherent (DH, 2011). However, the TEL Framework (DH, 2011) provides a very basic outline of how such key technologies can be used to enhance patient safety, outcomes and experiences and in its current format the report lacks a comprehensive range of examples of evidence-based research studies that underpin these six principles. References to theoretical frameworks and educational practices and methods to facilitate the design, implementation and evaluation of TEL in healthcare are also omitted. A more diverse range of case studies featuring a broader range of professional groups (e.g. medicine, nursing, allied health professions and social care), alongside evidence-based research findings and details of theoretical principles supporting each of the six principles, would have further enhanced this report. Health Education England has since established the TEL programme in 2013 to underpin world-class education and training through innovation and the use of existing and emergent technologies and techniques.

Although the aforementioned simulation frameworks were developed from different professional practices and based on different simulation modalities, they share commonalities that reflect effective educational design and include pre-briefing,

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[3] The DH (2011:6) defines TEL as ‘innovative educational technologies, such as e-learning, smart phones, which provide unprecedented opportunities for health and social care students, trainees and staff to acquire, develop and maintain the essential knowledge, skill, values and behaviours needed for safe and effective patient care’. Further information is available from: https://www.hee.nhs.uk/our-work/research-learning-innovation/technology-enhanced-learning

debriefing/feedback, reflection and evaluation (Issenberg et al., 2005; Motola et al., 2012). However, less attention is paid to the justification of the theories and educational practices that underpin the design, development and evaluation of SBE in healthcare. In addition, none of the frameworks (Jeffries, 2005; Dieckmann, 2009; DH, 2011; the NHET-Sim Monash Team, 2012) propose linked learning activities (simulation, academic or practice-based) beyond the debrief to facilitate consolidation or transfer to practice.

Two instructional design frameworks for SBE in healthcare were identified (Anderson et al., 2008; Chiniara et al., 2013). These instructional design frameworks provide a different perspective to the design of SBE intervention. Anderson et al. (2008) proposed an instructional design framework to embed simulation within the context of a neonatal resuscitation training curriculum, and explored multiple theories from educational psychology and evidence-based strategies. The authors describe a four-step process without a diagrammatical model. The four steps include step 1: problem identification, learning needs and targeted learners; step 2: overarching educational goals and specific measurable learning objectives; step 3: select curriculum content and the educational strategies; and step 4: assessment of learning outcomes, curriculum evaluation and revision. Whilst Anderson et al. (2008) briefly reference the educational psychology and evidence-based strategies, these are not clearly articulated in relation to the four-step process. Relevant theories, including educational psychology, concerned with manipulating the instructional environment and learner characteristics to promote growth, facilitating experimental learning, reflection, deliberate practice and modelling are described with reference to the neonatal curriculum, rather than the four-step model. Simulation is defined as an educational strategy but the selection of the instructional medium, method and modality of simulation are not discussed.

In contrast to the previous five frameworks, Chiniara et al. (2013) developed a comprehensive taxonomy and conceptual framework for instructional design and media selection for SBE in healthcare. The authors provide a progressive four-tiered approach to aid the instructional design of educational experiences featuring SBE in healthcare: Level one: instructional medium refers to the principal instruction mode (teaching) e.g. lectures, computer-based, digital media or simulation. Level two: simulation modality refers to the simulation activity used for teaching and learning (e.g. computer-based simulation, procedural simulation, simulated patients or hybrid simulation). Level three: instructional method refers to determining whether a self-directed or facilitator-led learning approach is to be adopted (with the latter being the most common). Level four: presentation features feedback, fidelity, type of simulator, scenario and team composition.

In conjunction with the four levels, the zone of simulation matrix model is used, which is based on the characteristics of clinical situations including acuity (severity) and opportunity (frequency). It is proposed that the matrix is used to assess whether simulation may be advantageous or complementary to other educational strategies. Further media and simulation modality selection charts (decision trees) are provided, which highlight key questions to consider when designing simulated learning experiences. Priority is given to the desired objectives of the learning activity, which can be based on professional competencies, local practices or competency frameworks. Overall, this conceptual framework at first may appear complex and disparate, but holistically it assists the reader to reason and justify the use of simulation medium, methods and modality prior to use. Whilst it is recognised that SBE in healthcare can help to bridge the gap between theory and practice (Weller, 2004), no reference is made as to how to optimise the transfer of learning to the clinical practice environment (Issenberg et al., 2005; Gough et al., 2012a). Similarly, theories and educational practices are not overtly presented within the framework, and guidance on educational practices beyond the provision of feedback and reflection are not proposed.

In summary, whilst the literature review did not identify a specific framework to facilitate the design of SBE in physiotherapy, existing nursing, healthcare, TEL and instructional design frameworks share some commonalities that reflect effective educational design including pre-briefing, debriefing, reflection and evaluation. However, none of the frameworks explicitly link educational theories or practices to underpin the design of SBE or propose linked learning activities (simulation, academic or practice-based) beyond the debrief. Literature pertaining to the application of the aforementioned frameworks is limited beyond Jeffries' simulation framework, which has featured within a series of literature reviews

(Groom et al., 2014; Fentress Hallmark et al., 2014; Jones et al., 2014) promoting the use of the framework in research and practice. Whilst Groom et al. (2014), Fentress Hallmark (2014) and Jones et al. (2014) all indicated that many elements of the Jeffries' (2005) simulation framework have been reported in healthcare literature (predominantly in nursing), inconsistency in terminology and lack of specific details pertaining to the simulation design mean development and implementation is still required to facilitate reproducibility of studies and intervention.

2.4 Gaps in the literature and research questions

This literature review has outlined the existing use of SBE within physiotherapy. Table 2.1 summarises (i) the gaps in the literature, (ii) maps them to the associated research questions and aligns them to (iii) the respective phase of study where these questions are addressed, with the chapter location.

2.5 Conclusion

This chapter has presented a critical synthesis of the available literature review pertaining to the current use of SBE within physiotherapy research and curricula internationally. It identified existing research and gaps with respect to the specific medium, modalities and methods of simulation that have been applied to physiotherapy.

Table 2.1: Literature gaps, research questions phase and chapter location

Gap in the literature	Research question	Phase	Chapter location
The extent of use of SBE (including application, equipment fidelity and range of scenarios) within cardio-respiratory pre-registration and postgraduate physiotherapy curricula, and postgraduate EOC/AR physiotherapy training in the UK is unknown	1) How is SBE utilised within emergency on-call physiotherapy services in the UK? 2) How is SBE utilised within cardio-respiratory physiotherapy programmes in the UK?	1	3-5 & 9
The ability of pre-registration physiotherapy students to independently manage a deteriorating cardio-respiratory patient in a simulation context is unknown	3) To what extent are final year pre-registration physiotherapy students able to independently manage an acutely deteriorating cardio-respiratory patient within a simulation context?	2	3, 6-9
The ability of physiotherapy students to identify errors in their practice is unknown	4) To what extent are final year physiotherapy students able to independently recognise errors within a simulation-based learning experience?	2	3, 6-9
The influential factors affecting performance within SBE are yet to be explored	5) Which elements of prior learning do pre-registration physiotherapy students perceive may influence their performance within a simulation-based learning experience?	2	3, 6-9
The perceived value of SBE in physiotherapy education has not been explored	6) What value do pre-registration physiotherapy students attribute to the cardio-respiratory simulation-based learning experience?	2	3, 6-9
The cost of providing a cardio-respiratory simulation-based scenario and video-reflexive ethnography review has not been explored in physiotherapy	7) What is the cost of undertaking a cardio-respiratory simulation-based scenario and video-reflexive ethnography review?	2	3, 6-9

Chapter 3: Methodology

3.1 Introduction

This chapter begins by introducing my position as the researcher, including the insider-researcher perspective and the blurring of boundaries within this study. Secondly, I discuss the adoption of a pragmatic philosophy and a technical pragmatic approach used to address all six research questions. The ontological and epistemological assumptions underpinning the methodological approaches used in this study are presented. Finally, the ethical considerations and requirements of this study are discussed.

3.2 Introducing the researcher

I have already presented in section 1.2 the key transitional periods in my professional career that have influenced my experiences and ultimately impacted on the design, development and presentation of this research study. In this section, I examine my position as an insider-researcher (Simmons, 2007; Roberts, 2007; Carrol, 2009a; Unluer, 2012) during this study. It is important when using reflexive methods to acknowledge the position of the researcher, the effects that the person has on the knowledge that is produced and the relation between the researcher and the participants/environment/material that is bound within the context of the study (Rose, 2012). The role of 'self' in qualitative, and specifically ethnographic research, is similarly explained by Smith (1998b), who proposes that the reflexive researcher (an observer) is positioned as an integral part of the setting, context and culture that the research is designed to explore.

3.2.1 Insider-researcher perspective

I acknowledge the potential influences an insider-researcher perspective may have on this study. Whilst, insider-researchers have the potential to facilitate a greater understanding of the participants' (physiotherapy) practices and social interaction, I also acknowledge the potential effect of acquiescence, owing to my role as a physiotherapist and as an educator on the physiotherapy programme (Carrol, 2009a; Unluer, 2012). The challenges of maintaining an 'insider' perspective whilst striving to observe with an 'outsider' lens are acknowledged, including role confusion, over-identification with the participants and loss of analytical perspective through over-familiarity of the community/culture (Simmons, 2007; Burns et al., 2012; Unluer, 2012).

In particular, I acknowledge my position as an 'insider' within this study. Throughout this research, I have been employed as a senior lecturer in physiotherapy, with leadership responsibilities for several cardio-respiratory units of the pre-registration (BSc and MSc) physiotherapy programmes. I acknowledge that my role as an educator may have had a potential impact on recruitment of respondents to the national surveys in Phase 1 and students from my own organisation in Phase 2. As a qualified physiotherapist and academic, I was an 'insider' in both phases of the study. My knowledge of physiotherapy practice and professional status provided ease of access to participants in this study. Being named as a senior lecturer in physiotherapy in the study documentation, highlights to participants the commonality of cultural identity between potential participants and myself as the researcher, and implies a level of trustworthiness (Burns et al., 2012). In both phases, the cover letters (Appendices 3 and 4) and participant information sheets (Appendices 5 and 6) provided contact details, which included my role and contact address at the University. This indicated my position as senior lecturer in physiotherapy and postgraduate researcher. I acknowledge that participants in both phases of this study may have felt that their organisation/emergency on-call physiotherapy service/physiotherapy programme or themselves as students were being assessed. To address this prior to the study, the participant information sheets were developed to outline the purpose of the study and reason for their invitation to participate. Conversely, I acknowledge that invited participants may have perceived my position with intrigue, being suspicious that either their organisation/service or they were being measured, rather than contributing to a shared body of understanding and desire to improve clinical practice (Burns et al., 2012; Rose, 2012).

3.2.2 Blurring of boundaries

I acknowledge the possibility of what Burns et al. (2012) refers to as 'blurring of boundaries' during the data collection. In particular, this refers to my role as the simulation facilitator in Phase 2. Throughout my study, I received funding from my department to cover the academic fees. No further funding was obtained to support the development, delivery or data collection of Phase 2. At the time I was undertaking Phase 2, the University did not have a simulation technician, thus I was required to adopt the role of simulation facilitator and technician. I acknowledged that this decision had the potential to influence greatly the data generated in this study, inherent as a reflective, inductive and qualitative researcher. The practicalities of adopting these multiple roles within the data collection phase had the potential to compromise my role as a researcher.

Whilst undertaking the role of facilitator, participants had a constant reminder of the various roles I was adopting (researcher, participant and observer). During the scenario, I was a participant researcher, due to my role as the simulation facilitator providing the pre-brief, the technical role of running the computerised human patient simulator and later providing a debrief to the participants. The adoption of multiple roles had the potential to influence the data collection and later analysis (Pink, 2007; Burns et al., 2012; Rose, 2012). The advanced programming of the computerised human patient simulator (METIman) and video recording of the scenario provided a degree of distance from the scenario. However, the one-way mirror situated between the control room and simulation room also provided a vehicle to ensure that I was aware of the participants' every move. Coupled with the visibility of the recording equipment, my presence was essentially permanent (Pink, 2007; Rose, 2012). Additionally, as an academic in the programme that the participants were recruited from, I felt a level of responsibility and protectiveness towards the participants. The post-data collection debrief (later discussed in section 3.4.2) afforded the opportunity to regain distance from and provide reassurance and protection to the participants, and potentially shield future patients from harm.

A debate in the literature exists as to whether research is best conducted by 'outsiders' (Simmons, 2007; Roberts, 2007; Burns et al., 2012), owing to the potential loss of objectivity due to relative familiarity with the culture/community or participants. Unluer (2012) similarly acknowledges the introduction of bias through incorrect assumptions based on the researcher's prior knowledge (Unluer, 2012). However, Roberts (2007) argues that educators and students are inextricably linked throughout the journey of becoming a health professional; thus, studying students known to the researcher is part of everyday practice; it is not just a matter of convenience. Therefore, the detail of the design, and the clarity and transparency of the methods of data collection and analysis undertaken during both phases of this study are presented in the following methods chapter.

3.3 The pragmatic approach

From the 1950s to the mid-1970s, research was dominated by the positivist paradigm, which is linked with quantitative methodologies. Then from the mid-1970s to the 1990s the constructivist research paradigm, linked to qualitative methodologies, became established (Morgan, 2008; Denscombe, 2008). During the late 1980s, the debate or paradigm war reportedly raged in social and behavioural sciences regarding which paradigm had superiority, positivism/realism or constructivism/interpretivism (Guba and Lincoln, 1994; Creswell, 2014; Morgan, 2014). Mixed methods research originated in the late 1980s to early 1990s (Morgan, 2007; Denscombe, 2008; Creswell, 2014). Earlier reference to mixed methods in psychology research using multi-trait/multi-methods typologies was identified by Campbell and Fiske (1959, cited in Creswell, 2009). The birth of the mixed methods approach has been described as evolving from the paradigm war (Tashakkori and Teddlie, 2008). Many authors now acknowledge the co-existence of three philosophical worldviews or paradigms: (i) postpositivism, (ii) constructivism and (iii) pragmatism. These are aligned with three respective methodological research approaches: quantitative, qualitative and mixed methods research (Johnson et al., 2007; Tashakkori and Teddlie, 2003, 2008; Creswell, 2014). However, Morgan (2007) acknowledges the choice to avoid referring to the word ‘paradigm’ with regard to pragmatism, and suggests the alternative ‘pragmatic approach’ is used, owing to the movement away from the Kuhnian view of paradigms, which previously focused attention on the metaphysical level (ontology and epistemology) of practice and research culture.

For the remainder of this study, I have chosen to adopt a ‘technical approach’ (Bryman 1998), which refers to a pragmatic position that considers the adequacy of given methods to answer the research question(s), as opposed to a paradigmatic pragmatic position. The technical approach requires distinction between the process and the data generated and judged within the confines of the relative methodological framework to which it belongs (Bryman, 1998). Whilst I have adopted a technical approach, I acknowledge that I also share some pragmatic and social constructivism paradigmatic philosophical characteristics throughout this thesis (Bryman, 1998; Haas and Haas, 2002; Creswell, 2014; Morgan, 2014).

3.3.1 Ontology and epistemology

Pragmatism is referred to as a practical and applied philosophy that recognises the existence and importance of the natural or physical, social and psychological world including language, culture, human institutions and subjective thought (Denscombe, 2008; Morgan, 2008; Tashakkori and Teddlie, 2010). The pragmatic philosophical position provides a set of assumptions about knowledge and enquiry that underpins the mixed methods approach, which is distinguished from the realism that provides the assumptions associated with quantitative research and constructivism assumptions for qualitative research (Denscombe, 2008; Morgan, 2008; Creswell, 2009; Tashakkori and Teddlie, 2010; Morgan, 2014). Morgan (2007) refers to pragmatism rejecting the top-down privileging of ontological assumptions over epistemology, methodology and methods (Morgan, 2007). Morgan's later work (2014) refers to pragmatism side stepping issues of ontology and epistemology and assigns precedence to emphasising action as the basis of whether knowledge is useful in guiding behaviour to produce anticipated outcomes. Pragmatism is considered the middle ground between realism and the constructivism metaphysical paradigms (Morgan, 2014).

Some pragmatic researchers who follow the metaphysical definition of paradigms argue that the pragmatist ontology relates to the belief of an external world that is independent of the mind as well as located in the mind (Creswell, 2014). Morgan agrees that a pragmatist views reality as existing apart from human experience but it can only be encountered through human experience (Morgan, 2007, 2014).

The pragmatist epistemology argues that knowledge is both constructed from and based on the reality of the world we experience and live in:

> Knowledge of the world is socially constructed, but some versions of that construction are more likely to match individual's experiences. You are free to believe anything you want, but some beliefs are more likely than others to meet your goals and needs…all knowledge is based on experience… Pragmatists acknowledge that each individual's knowledge is unique because it is based on individual experience, while ascertain that much of this knowledge is socially shared because it comes from shared experiences (Morgan, 2014:39).

From a philosophical perspective, human action and past experience cannot be separated and beliefs arise from experiences (Morgan, 2007, 2014). As no two people share the same lived experiences, no two worldviews will be identical, thus the study aims to explore the shared beliefs of those participating in SBE within physiotherapy. The pragmatic approach offers a reflexive outlook towards what is to be studied, placing the research questions at the centre of all considerations with equal attention drawn to the selection of the methodology and most appropriate methods available to address the research questions (Bryman, 2007; Morgan, 2007; Denscombe, 2008; Creswell, 2009; Tashakkori and Teddlie, 2010; Morgan, 2014). The combination of methodological approaches in this thesis is based on the assumption that mutual relevance and 'what works' can address the research questions (Bryman, 2007; Morgan, 2007; Denscombe, 2008; Creswell, 2009; Tashakkori and Teddlie, 2010).

In Phase 2, I acknowledge that I also drew on the social constructivism philosophical perspective. Constructivism is commonly referred to as the theoretical paradigm that best aligns with education and SBE (Pritchard and Wollard, 2010; Whittmann-Price, 2014). Social constructivism is a sub-theory of constructivism, which places emphasis on the importance of the social interaction in the process of developing knowledge and understanding (Crotty, 1998; Pritchard and Wollard, 2010). Crotty (1998) differentiates between constructivism and constructionism, which are sometimes incorrectly used interchangeably. Crotty (1998:58) refers to reserving the term:

> …constructivism for epistemological considerations focusing exclusively on the "meaning-making activity of the individual mind" and to use constructionism where the focus includes "the collective generation [and transmission] of meaning.

This distinction relates to the constructivist's consideration of how each individual makes sense of the world by interaction with objects in the world. A social constructivist ontology refers to reality being constructed through shared human and social activity. Each individual will construct their own reality, which may not necessarily be shared by others (Pritchard and Wollard, 2010). Thus, multiple versions of reality exist, which is referred to as multiplicity. Within physiotherapy practice and learning featuring SBE, individual realities may be very similar but in some cases very different based on experiences and interactions.

I also draw on complexity theory to explain the uncertainty and multiple approaches to and understandings that are inherent in both everyday practice within healthcare and learning (Fraser and Greenhalgh, 2001; Plsek and Greenhalgh, 2001; Wilson and Holt, 2001; Dekker, 2011). There is a growing emphasis on the importance of understanding 'complexity theory' to appreciate interactions and incidents in healthcare (Fraser and Greenhalgh, 2001; Plsek and Greenhalgh, 2001; Wilson and Holt, 2001; Dekker, 2011). Dekker (2011) proposed the rejection of the 'Cartesian-Newtonian' thinking that disregards the dynamic, multifactorial nature of healthcare practice, in favour of complexity theory. Complexity theory holds the belief that it is not possible to observe a phenomenon truly objectively, since our choices are affected by personal background, preferences, experiences, biases, beliefs and purposes (Dekker, 2011).

There is currently no commonly accepted definition of complexity theory, but it has been characterised in broadly similar ways when describing complex systems such as mathematics, computer science, business and healthcare (Johnson, 2007). Kernick (2006) reports the identification of 45 different definitions of complexity theory. I refer to Cilliers (1998) definition of complexity, whereby complexity is the pattern of behaviour emerging from interaction of elements, which respond to the limited information (stimuli) they are presented with. To date, no universal consensus has been reached as to how complexity theory should best be utilised or applied to research and practice (Kernick, 2006; Dekker, 2011). This may prevent some researchers from adopting complexity theory as a theoretical lens. Alternatively, this can be seen as an advantage as the theory is not currently limited in its application. Complexity research has focused on complex physical systems and complex adaptive systems (Fraser and Greenhalgh, 2001; Plsek and Greenhalgh, 2001; Wilson and Holt, 2001; Holland, 2014).

Healthcare is referred to as a complex adaptive system, which is a collection of individual agents that have the freedom to act in unpredictable and non-linear ways (Wilson and Holt, 2001). Behaviour is partly determined by rules, past experiences and responses to environmental stimuli (Fraser and Greenhalgh, 2001; Plsek and Greenhalgh, 2001; Wilson and Holt, 2001). Wilson and Holt (2001) apply complexity to clinical care in that the health of an individual and healthcare organisations themselves can only be maintained (or re-established) through a holistic approach that embraces unpredictability and builds on the emergent forces acting within the overall complex adaptive system. The interaction of individuals leads to continually emerging and novel behaviours that are influenced by relatively simple rules (Plsek and Greenhalgh, 2001). Stacey's (1999) degree of certainty diagram situates complexity (or zone of complexity) between simplicity and chaos. Plsek and Greenhalgh (2001) refer to clinical guidelines, multi-faceted health and social needs of a patient, departmental initiatives and educational requirements existing in the zone of complexity in healthcare practice.

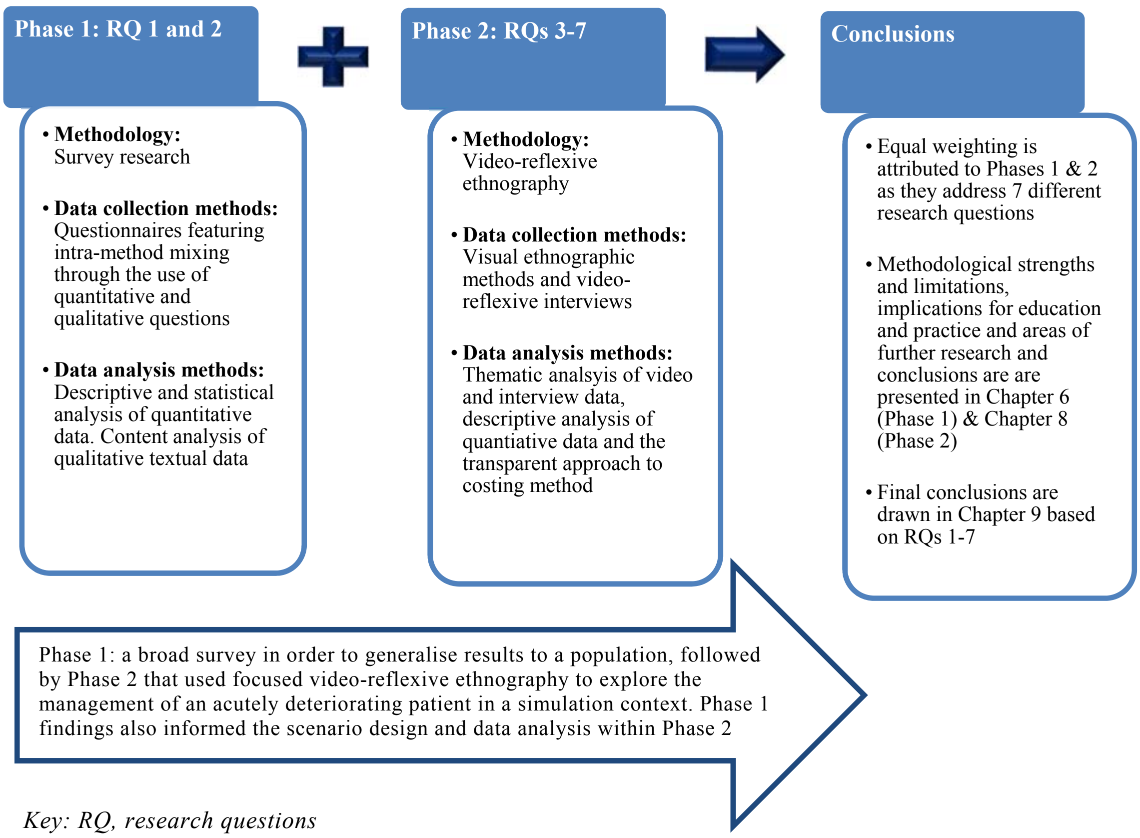
A social constructivist's epistemological belief refers to knowledge as a human creation, constructed by social and cultural interactions and their interaction with the environment (Creswell, 2014; Morgan, 2014). In this thesis, knowledge is deemed to be created through social and cultural interactions of the participants within SBE. Wollard and Pritchard (2010) refer to the exact knowledge during the interaction as varying from completeness to misconstruction, which is based on the participant's interpretation of the experiences and interaction within the SLE and interaction with the participant's pre-existing knowledge. SBE provides opportunities to generate effective and lasting learning through the engagement of participants (learners) in a social activity with others, with new or repetitive stimuli (e.g. sensory cues) are related to pre-existing knowledge and understanding.

3.3.2 Phase 1 and 2 methodologies

In this section, I discuss the mixed methodologies I selected for Phases 1 and 2. Within the literature pertaining to the pragmatic approach, there are variations and inconsistency concerning the purpose of mixed methods research and the relationship between the qualitative and quantitative components. Some authors acknowledge that quantitative and qualitative approaches both have their own strengths and weaknesses but the combination of the two approaches may be more fruitful (Denzin, 2008; Denscombe, 2008; Morgan, 2008; Creswell et al., 2014). Others argue the existence of various rationales and different purposes of mixed methods in the literature (Denscombe, 2008; Tashakkori and Teddlie, 2010; van Griensven et al., 2014). The four broad rationales for mixed methods include: 1) improving accuracy of data; 2) producing a complete picture of the phenomena by combining information from complementary data sources; 3) avoiding biases intrinsic to adopting a single-method approach; and 4) developing the analysis through the use of contrasting methods (Denscombe, 2008; Tashakkori and Teddlie, 2010; van Griensven et al., 2014; Creswell, 2014; Morgan, 2014). I also acknowledge that despite mixed methods research purportedly offering the best of both worlds (van Griensven et al., 2014), practical difficulties may arise at various stages in any study (Morgan, 2014). Such practical issues may relate to time and resource management across multiple phases (also referred to as strands), which may favour or prohibit selection of some methods. The combination of the quantitative and qualitative research methods within this study is based on the assumption of the mutual relevance and complementarity of the knowledge they produce relating to the use of SBE in cardio-respiratory physiotherapy.

Figure 3.1 provides an overview of the study, which was undertaken sequentially, in two phases. It presents the associated methodology and methods of both data collection and analysis for the two-phased research study. The methods of data collection and analysis are later comprehensively outlined in Chapter 4.

Figure 3.1: Overview of the mixed methods design



Key: RQ, research questions

In Phase 1, I adopted survey research methodology to explore the use of SBE within cardio-respiratory postgraduate education within NHS trusts (RQ1) and HEIs (RQ2). Survey research is a broad and flexible methodology commonly associated with the realist epistemological paradigm (Muijs, 2012), since surveys consist of standardised questions to each respondents. Survey research provides numerous benefits including: a) versatility of design and application to a variety of settings; b) the cost-effectiveness of different survey methods e.g. questionnaires are less costly than face-to-face interviews; c) the possibility to obtain data from a significant number of respondents; and d) the ability to generalise findings to gain a representative picture of the attitudes and characteristics of a given population (Cohen et al., 2000; Fowler, 2009). In Phase 1, I integrated both quantitative and qualitative questions (intra-method mixing) within the survey questionnaires, to gain breadth and depth of understanding of how SBE was used in both environments (NHS trusts and HEIs). Intra-method mixing within questionnaire survey research is associated with a pragmatic epistemology (Muijs, 2012), which aims to overcome the limitations of the rigidity and inflexibility of quantitative surveys featuring standardised questions and closed-response items. Validity is also recognised as an inherent weakness of survey research (Cohen et al., 2000; Fowler, 2009). However, RQs 1 and 2 were related to the exploration of how SBE was embedded in cardio-respiratory education in the UK. They were not designed to test hypotheses or develop a scale for use in SBE. Further details of the survey method and questionnaire design are provided in section 4.1.1 (Phase 1 research design).

A sequential approach was adopted, which firstly allowed me to gather responses to RQs 1 and 2, before moving to Phase 2. The interpretation of Phase 1 data provided insights and hence influenced the methods of data collection (simulation scenario design) within Phase 2 (Hibberts and Johnson, 2012). This is illustrated by the large horizontal arrow in Figure 3.1, projecting from Phase 1 to Phase 2 and the use of the plus signs between phases. Information relating to sequencing decisions is provided in the following section 3.3.3, and further details of the associated methods are provided later in Chapter 4.

In Phase 2, I selected VRE as the most appropriate methodology to answer RQs 3-6. The knowledge and personal experiences shared by participants in a SBE scenario have the potential to introduce multiple perspectives of the same complex experience. The very nature of the participants' interaction in the SLE, their own personal background, preferences, experiences, biases, beliefs and purposes for participation, all contribute to the similarities and differences in their own version of reality and socially constructed knowledge. Thus, I needed to draw on a suitable methodology to enable me to explore the multiplicity and complexity of managing an acutely deteriorating patient within a simulation context. Ethnographic inquiry is concerned with the culture of the participants under exploration, whereby the culture represents anything that combines the participant group together. In physiotherapy, this may relate to the physiotherapy professional code of conduct, shared values and prior learning experiences (Nicholls, 2009a, 2009b). VRE is commonly aligned with the social constructivist ontological belief of multiplicity (multiple versions of reality reflecting the different experiences and beliefs of humans) and the epistemology that all humans possess unique perspectives on reality and hence versions of the truth (Creswell, 2014: Morgan, 2014). Additionally, VRE aligns with the pragmatism otology (reality exists apart from human experience) and epistemology that all knowledge is based on socially constructed experience.

Video-ethnography allows the added dimension of exploring non-verbal and verbal interactions, which are extremely important within the SLE (Heath et al., 2010). Video-ethnography has been increasingly used within healthcare, particularly owing to the complexity of the discipline (Carroll et al., 2008). It has also been widely used to examine social communications and in-situ interactions (Hargie and Morrow, 1986; Hargie and Tourish, 2000; Pink, 2007; Carroll 2009a). Within healthcare, video has also been used as a method of quality assurance (Santora et al., 1996; Michaelson and Levi, 1997) in medical education simulation (Dequeker, 1998; Roter et al., 2004), healthcare video debriefing following simulation (Issenberg et al., 2007; Levett-Jones and Lapkin, 2014) and to explore a wide variety of classroom learning activities (Clarke et al., 2009; Janik and Seidel, 2009).

Video observational methods have also been utilised as part of a large research project, which explored the learning and teaching of patient-centred issues in clinical feedback provided to medical students in one HEI in the UK (Rees and Monrouxe, 2010). Explorations of clinical learning have been published in relation to patients' involvement in hospital bedside teaching encounters (Monrouxe et al., 2009) and pronominal use in bedside teaching encounters (Rees and Monrouxe, 2008). Carroll et al. (2008) argue that video-ethnographic methods have great significance in facilitating the understanding of complex healthcare practices and enabling change or resolution of resultant issues. However, Clarke et al. (2009) acknowledge the potential influence of video recording equipment on participants' behaviour, performance and discussion. VRE was considered an appropriate methodology to enable the participants to fully engage with the scenario and then reflect on the underlying influences that have underpinned their actions within their scenario (Forsyth et al., 2009).

Roskell and Cross (1998) described the complex interactions a respiratory physiotherapist undertakes to function effectively within their clinical environment. Interactions include those of various healthcare professions involved with the patient's management and need of the physiotherapist to maintain situational awareness to function efficiently, whilst optimally managing the patient and filtering unwanted stimuli from the environment (Roskell and Cross, 1998). With this in mind, the research methodology needed to be able to illuminate these occurring phenomena, including the differences between participants in their interactions and abilities. It would not be possible to maintain the essential and embedded features of these phenomena if they were measured in isolation and reduced to the testing of generated hypotheses. Iedema et al. (2013b) also argue that the use of video allows for the unrivalled identification of multi-layered practices/work-flows, dynamics and complexities of interconnectivity of people and the environment, which cannot be achieved by mere linguistic and numerical interpretations. VRE has been shown to be a valuable method to uncover the complexities of care (Carroll, 2009a, 2009b; Iedema et al. 2013b) and explore in-situ healthcare practices (Iedema et al., 2013b). The use of VRE focuses on engaging participants (e.g. practitioners or patients) to discuss incidents and errors within the context of their experience to make sense of the occurrence, highlighting the impact of personal experiences, which may be central to the cause or mitigation of incidents (Iedema et al., 2013b, 2013c).

In particular, Iedema and colleagues (2013d:186) present thought-provoking comments regarding the collective approach to reviewing healthcare practices to provide more holistic insights into patient safety incidents, whereby

> A single person's action constitutes just a single node in a dense web of actions mediating it, contextualising it, reconfiguring it and translating it. This web of interconnectedness, as we have noted it, becomes evident when practice is viewed on the video screen where commonalities and continuities come to the fore. Because of this, to understand errors and failures as issuing from specific actions or origins misses the point. Actions are themselves entangled with other actions, technologies, reactions, spaces and so forth.

Thus, I considered that VRE methodology would enable me to address RQs 3-6, by facilitating a comprehensive exploration of the experiences of pre-registration physiotherapy students' participation in a cardio-respiratory SBE experience.

3.3.3 Mixed methods selection and sequencing decisions

Scholars have developed a variety of typologies including convergent parallel, concurrent, fully integrated, sequential explanatory and sequential exploratory mixed methods (Teddlie and Tashakkori, 2008; Creswell, 2014). These typologies have helped to illustrate the design process by steering the path of study to achieve the research goals; establish common languages through the development of an organisational structure; and legitimise the field of research highlighting distinctions between how the actual design differs from either a purely qualitative or quantitative design (Teddlie and Tashakkori, 2008). I considered a sequential explanatory mixed methods approach to be the most appropriate to facilitate a comprehensive exploration of the use of SBE in cardio-respiratory physiotherapy (Guba and Lincoln, 1994; Cohen et al., 2000; Ivankova et al., 2006; Teddlie and Tashakkori, 2008; Creswell, 2000, 2014).

3.3.3.1 Sequencing decisions

When selecting the design, I considered timing to be a significant factor. No surveys had been undertaken to identify the use of SBE within cardio-respiratory physiotherapy curricula or EOC physiotherapy training in the UK. This was considered a priority area to address RQs 1 and 2 in Phase 1, prior to designing Phase 2, which addressed RQs 3-7.

Sequential timing facilitated the integration of key findings from the national surveys within the design of the scenario to be utilised in Phase 2. Phase 1 national surveys were undertaken in 2009/2010; the findings are presented in Chapter 4. The discussion in Chapter 5 integrates the key findings, similarities and differences between the two areas under investigation (simulated learning within AR/EOC training within NHS trusts and physiotherapy curricula in academia). Integration in mixed methods research refers to the stage or stages within the overall research process when the quantitative and qualitative data are mixed or integrated. An intermediate stage was evident in this study whereby the findings of Phase 1 were used to inform and develop the simulation scenario used in Phase 2 (Teddlie and Tashakkori, 2008). The development of the simulation scenario is provided later in Chapter 4 (Box 4.1, on page 79). Phase 2 was undertaken during the academic year of 2010-2011. This phase featured a qualitative exploration of SBE within cardio-respiratory physiotherapy featuring pre-registration students from one HEI, to address RQs 3-6. Visual ethnographic methods were employed including video recording of the scenario and provision of the un-edited footage to the participants during the VRE interview (Pink, 2007; Forsyth et al., 2009; Iedema et al., 2009; Creswell, 2014). Thematic analysis of the scenario videos and VRE interviews was undertaken, as well as analysis of quantitative physiological data obtained from the simulation manikin (METIman). Comprehensive justification of the individual methods employed within is provided later for Phase 1 (section 4.1) and Phase 2 (section 4.2).

3.3.3.2 Priority

Priority in mixed methods research refers to the weighting or attention that is attributed to the qualitative and quantitative data collection and analysis processes within the study (Creswell, 2014). Equal weighting is attributed to Phases 1 and 2 (Ivankova et al., 2006; Creswell, 2014). Phase 1 explored SBE from an educator's perspective (senior clinicians and academics), whilst Phase 2 explored the use of SBE from the participants' (final year pre-registration physiotherapists) and researcher's perspectives. Triangulation of the qualitative and quantitative data is later discussed in section 4.2.8.2: Phase 2 data analysis. Chapter 9 provides a conclusion to the research study and summarises the implications of the study and further research.

3.4 Ethical approval and considerations

This section presents the combined ethical considerations for both Phases 1 and 2. In Phase 1, NHS research ethics was not required. An application was made to Wrightington, Wigan and Leigh Research Ethics Committee (REC) in July 2009 and approval was deemed not necessary by the chair (Appendix 2) as it did not impact upon the treatment of patients. The University Faculty of Health, Psychology and Social Care Ethics Committee granted ethical approval in September 2009 for both national surveys (Research Ethics Committee Reference Number: 0921, Appendix 2). Ethical review committee approval for Phase 2 was granted by Manchester Metropolitan University (Reference number: 1102, 15 December 2010, Appendix 2). An application for NHS Research Ethics was not indicated for the study, as all participants were final year pre-registration students enrolled on a BSc (Hons) physiotherapy programme. Additionally, the scenario involved a simulated cardio-respiratory patient (human patient manikin) and did not involve treatment to real patients. Key ethical requirements for this study have been identified as follows: respect participants' right to privacy, dignity, confidentiality and anonymity; avoiding harm arising from participation in the surveys and standardised simulation experience; ensuring transparency of the aims of the study, procedure, intention to publish and present the data generated; participating with honesty, professionalism and integrity; and data collection, storage, analysis and presentation (Cohen et al., 2000).

3.4.1 Participants' rights to privacy, dignity, confidentiality and anonymity

Details relating to the intended use of all data obtained were provided in the respective covering letters for Phases 1 and 2 (Appendices 3 and 4 respectively). Participants were fully informed of the nature and purpose of the research (prior to consenting to participation). All aspects of the participants' right to privacy, dignity, confidentiality and anonymity were addressed through the provision of thoroughly detailed covering letters and participant information sheets for Phases 1 and 2 (Appendices 5 and 6 respectively). Information sheets provided a detailed explanation of assurances made to protect both confidentiality and maintain anonymity for all participants in both phases of the study, and the extent of participant involvement was outlined.

Although stated that participation was voluntary, I accept that the participants may have felt obliged to participate. In Phase 2, the information sheet clearly outlined that participation would not bear any impact on their academic assessment grades (Appendix 6). Volunteering to participate in this study may have been perceived by students as an advantageous learning experience for their clinical placements and other units prior to graduation. It was anticipated that by undertaking the simulation scenario, reflexive interview and debrief, the participants would have developed in some way. As Phase 2 participants were able to assess and manage the patient in a simulation context, they would have inevitably engaged in a learning experience (Pritchard and Wollard, 2010).

Consent for use of the survey data was gathered via the consent form issued within the NHS/HEI questionnaire packs and invitation to participate in the pilot studies (Appendix 7). Thus, no reminder letters were issued to the respective NHS trusts/HEIs that returned the consent form indicating they did not wish to participate. The inclusion of a consent form in each survey was at the request of the University's ethics committee based on the initial application. The contact details were provided in the pilot invitation, national survey covering letters and information sheets, from which participants were able to seek further information or to ask questions relating to the study. Survey participants were also informed in the covering letter of their right to withdraw data up until the data analysis stage. However, none of the invited participants requested further information nor withdrew their data in either of the surveys. Prior to participation, all Phase 2 participants completed the consent form (Appendix 8), a simulation confidentiality agreement (Appendix 9), the simulation risk assessment (Appendix 10) and simulation code of conduct (Appendix 11). The latter three forms are standard programme requirements for any students participating in SBE activities at MMU.

3.4.2 Avoiding harm arising from participation

Every effort was taken to minimise participant burden during the pilot and national postal surveys and participation in the Phase 2 simulation scenario and video-reflexive interview (Cohen et al., 2000). It was anticipated that the questionnaire surveys would bring no physical or psychological harm to the participants at the time or bear any reference on the individual's, NHS trust's or HEI's reputation (Fowler, 2009). The questions directly related to the study's aims and had no bearing on current or future employability. The time taken to complete the questionnaires was recorded by the pilot participants and was not deemed excessive. Both pilot studies confirmed that the respective questionnaires would take no longer than 15 minutes to complete (detailed later in section 4.1.4). The covering letter clearly indicated that if participants did not use simulation at the time within their trust/HEI, only the initial two sections needed to be completed.

It was anticipated that participation in the simulation scenario and VRE interview would bring no physical or psychological harm to the participants at the time or bear any reference on their individual reputation. The pilot study (detailed later in section 4.2.5) sought to reduce the burden on students' time away from their academic studies. Thus, the resultant scenario was specifically designed to explore pre-registration physiotherapists' experiences. The purpose of the debrief was to focus on any erroneous events or discussions arising from the scenario or VRE interview. Additionally, the debrief ensured that the learning objectives had been achieved if they had not been met during the scenario. The VRE interview schedule was mapped to the research questions. It had already explored achievement of the learning objectives, strengths and areas for improvement, thus these areas were only discussed if required in the debrief. The debrief ensured that the participants were aware of any skill and rule-based performance errors, unsafe practice or intervention that contravened the professional code of practice (CSP, 2005, 2011) and how they could be mitigated in the future, if these were not already resolved in the VRE interview.

I had planned that if an incident was deemed to highlight unsafe practice without insight into the incident (e.g. not recognised by the participant in the reflexive interview), this was to be brought to the participant's attention during the debrief. As this was a confidential debrief, an agreement for further action would have been generated between both parties (participant and myself), with specific action points recorded in writing. I also planned that if the participant highlighted that the incident was due to lack of knowledge/skill or practice/exposure, this would be discussed in detail by both parties in order to agree a safe outcome. Possible action points anticipated at the outset of this study included additional supervised cardio-respiratory skills sessions, which I would have provided. Since participation in this study was entirely voluntary, it was stressed to the participants that participation would not affect summative assessment marks or the overall outcome of their physiotherapy degree award; thus, no further action was taken to inform the programme leaders of any queries raised in the debrief. This was primarily due to the fact that no patient was harmed and all errors identified by the researcher (myself) were dealt with either in the VRE interview by the participants themselves or in the debrief. Also, the participants had to complete an additional practice placement; for some of the participants, this included a cardio-respiratory element.

3.4.3 Honesty, professionalism and integrity

Contact details were provided in the pilot invitation, main study covering letters and information sheet, giving participants the opportunity to ask questions relating to the study. Although these stated that participation was voluntary, I accept that the participants may have felt obliged to participate in both phases on my study. The information sheets (Appendices 5 and 6) were specifically designed to outline clearly that participation would not bear any impact on their professional status or students' academic assessment grades.

3.4.4 Data collection, storage, analysis and presentation

Details relating to the intended use of all data obtained (including future publication and/or presentations, and as part of my Ph.D. thesis) were provided in the respective covering letters. All confidential waste generated from the study has been cross-shredded and destroyed according to the University's confidential waste procedures. All data relating to both phases of this study were anonymised and stored on a single laptop owned by myself for use during my Ph.D. studies. Anonymised questionnaire data were entered into the Statistical Package for the Social Sciences, Version 17.0 (SPSS Inc., Chicago, IL, USA, SPSS, 2008). All electronic files were password protected and data backed-up on a password protected external hard disk drive (HDD) (that I owned and stored in a locked cabinet when not in use). The laptop and external HDD were stored in my office at the University. All storage complied with the Data Protection Act (OPSI, 1998). Computerised data storage considerations were in line with the University regulation and Medical Research Council recommendations (MRC, 2000). All computerised data were backed-up regularly (after each new data entry session) on the laptop and HDD. All printouts have been retained in a locked filing cabinet and identified by date of collection and questionnaire survey. All modifications/revisions were clearly identified on the front page and dated. All analysed data have been presented in an anonymous manner. All data will be stored for 10 years, in line with the Data Protection Act recommendations (OPSI, 1998) and the University ethical approval requirements.

3.4.5 Specific ethical considerations when generating video data

Specific guidance was used to design the video-recording procedures to ensure compliance with current ethical guidance and requirements (MRC, 2000; Pink, 2007; Heath et al., 2010). When using visual ethnographic research methods, I needed to be mindful that in the attempt to explain the phenomenon under investigation (participants' experiences within the SLE and the potential identification of errors), displaying the outcome of this study visually may amplify ethical, professional and sensitive dilemmas (Schembri and Boyle, 2013). In an audio-recorded interview, participants may talk openly about the phenomenon since they were given the assurances of anonymity and confidentially. However, as VRE methods were central to the data collection, all participants were made aware of the intention to analyse and disseminate the research findings.

Careful consideration of the use of visual representation of the phenomenon was paramount, since exposing the participants' faces and voices/views could be potentially problematic and even harmful. Thus, it was imperative to inform participants that where visual representation within my thesis or subsequent publications/presentations occurred, identifying features (faces) would be anonymised as much as physically possible. This process sought to minimise the risk of potential identification through face recognition. The unique identifying code (specified by the participant on the consent form) was used to code the data file names and subsequent transcription files in case a request to withdraw the data was received from a participant prior to the data analysis. The participants were made aware of the possibility that their data could be withdrawn from the study up until the point of analysis using the video analysis coding templates (outlined in the information sheet, Appendix 6). However, none of the participants requested any of their data to be withdrawn, thus the data set remained complete.

In the future, if complete anonymity of the University is not practicable, agreement from relevant participants and members of the supervisory team will be secured in writing (this may relate to videos/stills from the videos used in subsequent publications in the future). Each video file was password protected and only subsequent DVD files (generated by the simulation) were made available to the supervisory team. Any movies and subsequent analysis files/databases generated within the video-analysis software were also stored within password protected electronic folders. Separate storage of coding and data files was recommended by the Medical Research Council's Good Research Practice guidance (MRC, 2000).

The written consent form (Appendix 8) requested participants' permission so the information provided in this study may be utilised by the University for educational purposes, future publication, conference presentations and as partial fulfilment of my thesis. The consent form also stipulated the copyright limitations of the personalised simulation DVD to ensure that no further distribution or copies are made and that sharing/uploading of the material to the World Wide Web in any capacity was prohibited by any persons. If images were to be published in peer-reviewed journals, additional video-editing software will be used to remove any traces of the participants' identities. For example, Adobe Photoshop or iMovie packages enable the creation of a 'mask' to cover the face/eyes in order to anonymise the image (Heath et al., 2010). Assurances were also made on the consent form (Appendix 8) as to the nature and intent of the proposed publication purposes:

> The material will not be used out of context – for example, a picture will not be used in an article that is unrelated to the subject of the video/still image.

3.5 Conclusion

This chapter began by introducing my position as the researcher, followed by the ontological and epistemological perspectives that have underpinned both phases of my study. I have outlined the pragmatic approach adopted to address the six research questions. Finally, details pertaining to ethical approval and specific ethical considerations addressed throughout the study have been presented.

Chapter 4: Methods

This chapter firstly presents the research methods employed within Phase 1, followed by those used in Phase 2.

4.1 Phase 1 Methods

This section focuses on the research methods employed within Phase 1 in order to address RQs 1 and 2. Prior to Phase 1, the extent of the use of SBE (including application, equipment fidelity and range of scenarios) within EOC/AR physiotherapy training (RQ 1) and cardio-respiratory pre-registration and postgraduate physiotherapy curricula (RQ 2) in the UK was unknown. The research design, data collection methods, pilot survey procedure and methods of data analysis are also presented. Identical methods were undertaken for both the NHS and HEI surveys; thus, the information has been combined throughout this chapter in relation to the design, participants, instrumentation, pilot, survey procedures and data analysis.

Figure 4.1: Phase 1 research questions

Research question 1

- How is SBE utilised within emergency on-call physiotherapy services in the UK?

Research question 2:

- How is SBE utilised within cardio-respiratory pre-registration physiotherapy programmes within the UK?

Two separate questionnaires were designed to capture existing similarities and/or differences between AR/EOC NHS trust training and within pre-registration and postgraduate physiotherapy curricula (Appendices 12 and 13 respectively). This permitted comparative analysis of the use of SBE across both domains and how the key cardio-respiratory skills identified by the ACPRC (2007) were being taught using SBE. Both surveys featured comparable questions (in relation to cardio-respiratory patient range, assessment and treatment skills, as identified in the ACPRC self-evaluation of acute respiratory/on-call physiotherapy competence questionnaire (ACPRC, 2007).

4.1.1 Phase 1 Research design

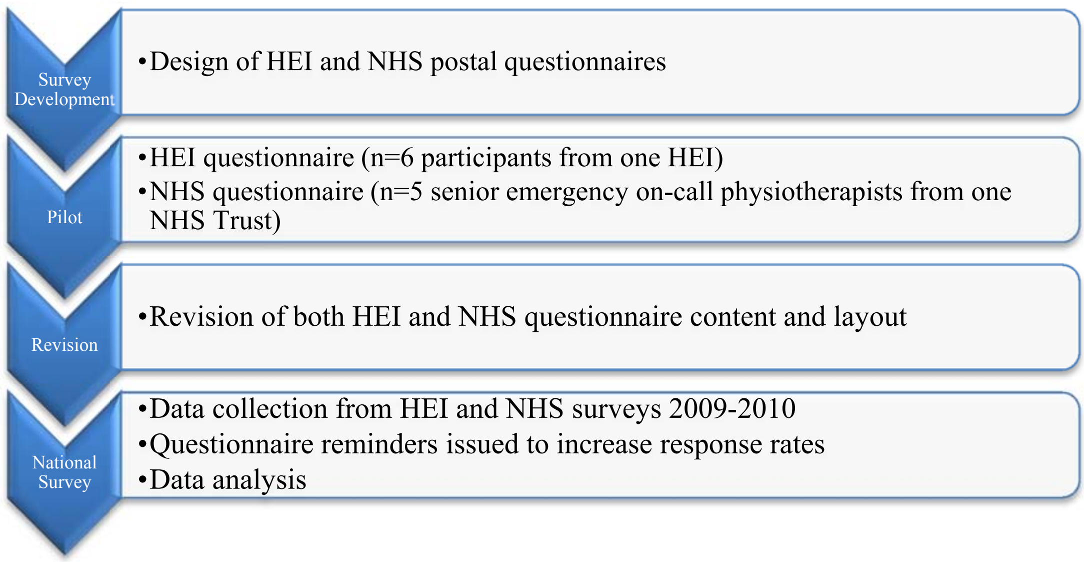
A national postal questionnaire-based survey design was used to explore the extent to which SBE was being used within cardio-respiratory physiotherapy curricula and postgraduate AR/EOC clinical training in the UK. A self-administered questionnaire survey design was selected to enable breadth of data collection, rather than depth. A postal survey permitted the inclusion of all NHS trusts providing EOC physiotherapy services and HEIs in the UK, rather than sampling from within the available populations. I considered the advantages and disadvantages of using a postal questionnaire but deemed this the most suitable and feasible option to address these national populations. Factors influencing the decision to undertake a postal survey included the ability to provide potential participants time for independent thought and potential consultation with peers, which cannot be gained through direct or telephone interviews (Fowler, 2009). Additionally, I acknowledge, as participants have particularly busy schedules, it was deemed that a postal survey may facilitate participant choice with respect to if and when to participate. The flexibility of a postal survey aimed to minimise schedule disruption, allowing completion at a convenient time for the participant. This was an important factor in the decision to undertake a national survey versus a more in-depth analysis of a small sample of the population.

Fowler (2009) suggests that well educated/highly literate populations, such as the professionals within this study, are likely to be interested in research, and procedures such as mail or email become more attractive. A number of factors influenced the decision to use a postal survey instead of an online survey method. In 2009, email addresses of NHS and HEI staff were not available in the public domain. I considered using interactive CSP (the professional networking site) discussion forums to facilitate distribution of an online survey, but this method would potentially generate multiple responses from the same NHS trust/HEI. Whilst this would encapsulate different opinions within organisations, it was considered that the data generated may not provide an accurate reflection of the number of individual NHS trusts/HEIs using SBE throughout the UK.

Strategies detailed by Cohen et al. (2000), Fowler (2009) and Creswell (2014) have been utilised to enhance the validity and reliability of the proposed postal survey.

Firstly, I paid particular attention to specific aspects of the questionnaire itself, relating to time, overall length, ease of completion and question sensitivity and wording (which was addressed through the survey pilot, outlined in section 4.1.4). Secondly, a detailed covering letter accompanied the questionnaire, which emphasised the importance and benefits of the intended research (for both pilot and national surveys). Thirdly, self-addressed envelopes were provided. Finally, a reminder letter and second questionnaire was used to boost response rates (for those identified as non-responders). I had previously employed these aforementioned strategies within a national survey of cardio-respiratory (EOC lead) physiotherapists in UK NHS trusts (Gough and Doherty, 2007). This previous self-administered postal survey generated a response rate of 88% (Gough and Doherty, 2007). A summary of the development and administration procedures undertaken for both HEI and NHS surveys has been presented in Figure 4.2.

Figure 4.2: Survey development and administration procedures



4.1.2 Phase 1 Questionnaire design

Two self-administered postal questionnaires were purposely designed, consisting of four common sections: demographics, on-call training, simulation technology and the current use of simulation within EOC training (Appendix 12, NHS and Appendix 13, HEI questionnaire). Two additional questions in the HEI survey invited pre-registration and post-registration programme specific responses. The questionnaires featured open and closed questions. A five-item Likert Scale (strongly agree to strongly disagree) was used to explore participants' perceptions of SBE in relation to AR/EOC physiotherapy, training, competencies and patient safety (Fowler, 2009).

Closed questions featured multiple responses developed from the acute respiratory on-call physiotherapy self-evaluation of competence questionnaire (ACPRC, 2007) and manufacturer websites (METI, 2009; Gaumard, 2009; Laerdal Medical Ltd, 2009; Simulaids, 2009). Multiple response questions featured an 'other' option to facilitate data from clinical practice and education in addition to the common categories pre-selected from the literature. Intra-method mixing was achieved with open-ended questions to provide specific examples or additional information not captured by the pre-set statements. For each set of closed questions, multiple responses were offered to participants using the current literature where appropriate. These were intended to facilitate ease of completion and have the advantage of allowing question response categories with numerous/complex potential answers (Fowler, 2009). The participant was invited to provide further in-depth explanations to the questions posed, if the set responses did not match current provision. Additionally, two open-ended questions were included at the end of the questionnaires to allow the participant to provide information relating to additional simulation specifications that, in their opinion, would further enhance human-patient simulator use. The final open-ended question invited any further comments regarding cardio-respiratory education or use of simulation that had not been addressed by the questions within the questionnaire. This is in line with published literature (Yohannes, 2012). Questions were coded to allow transfer of data to the SPSS spreadsheet (indicated on the questionnaire as codes for office use only). Where the questions across both questionnaires (HEI and NHS) were identical, the same codes were used. This enabled cross-referencing and later comparison of responses between the two populations in the results and discussion chapters (Chapters 5 and 6 respectively).

4.1.3 Phase 1 Participant recruitment methods

Ethical approval was granted by Manchester Metropolitan University Research Ethics Committee (Reference number: 0921). Identical recruitment methods were undertaken for both surveys, with different target populations. Invitations to participate were sent to all 280 NHS hospitals in the UK providing an EOC service and all 30 remaining HEIs with pre-registration physiotherapy programmes in

2009/2010 in the UK. The inclusion and exclusion criteria for the NHS and HEI surveys have been presented in Table 4.1.

Table 4.1: Inclusion and exclusion criteria

NHS survey inclusion criteria	HEI survey inclusion criteria
• All 280 NHS hospitals in the UK providing an EOC service • One senior I/clinical specialist/superintendent physiotherapist/physiotherapy manager responsible for EOC service provision from each NHS trust	• HEIs that provided undergraduate (BSc Hons or MSc pre-registration) physiotherapy programmes • One senior lecturer/principal lecturer from the physiotherapy programme responsible for cardio-respiratory physiotherapy modules (e.g. unit/module leader) from each HEI within the UK
NHS survey exclusion criteria	**HEI survey exclusion criteria**
• Private hospitals in the UK (as EOC physiotherapy is not routinely provided) • Senior II or newly qualified physiotherapists (these aforementioned staff grades are unlikely to be involved in training provision) • The pilot site	• HEIs within the UK that do not provide physiotherapy programmes • HEIs that provide 'access to physiotherapy' courses, since actual physiotherapy clinical intervention (assessment/treatment) skills would not be taught anywhere other than the 31 physiotherapy pre-qualifying (BSc Honours) three- or four-year programmes currently approved by the CSP and HCPC (CSP, 2009). Thirty-four physiotherapy programmes were listed (CSP, 2009) but not all enable full profession registration; three were pre-qualifying 'access' courses • The pilot site

The NHS survey inclusion and exclusion criteria were adapted from a previous national EOC survey (Gough and Doherty, 2007) to identify respondents who were suitably placed to answer service-specific questions relating to the EOC service that they provide/manage and hence, increase the credibility of the findings of the questionnaire. One service lead from each trust was invited to participate in the NHS survey, as identified in the Medical Data Record (CMA, 2008). One cardio-respiratory lead from each HEI was invited to participate in the HEI survey. The identification of cardio-respiratory physiotherapy module leaders was obtained using hyperlinks from the CSP (2009). Qualifying programmes' webpages were used to locate physiotherapy departmental postal addresses for each HEI. Each envelope was addressed to the cardio-respiratory module leader at the respective HEI.

4.1.4 Phase 1 Pilot surveys

A pilot study was carried out to assess the accuracy and clarity of the questions within both NHS and HEI questionnaires. The pilot procedures followed the same format for both contexts of enquiry. Each was tested within the respective population pilot groups (one randomly sampled NHS trust, and one HEI). This enabled piloting of the questionnaire by a sample pilot population that was the closest match to that of the national questionnaire survey. As more than 6/35 physiotherapy senior lecturers volunteered to participate in the pilot study, the first six respondents (by email or post) were selected for participation. The ethical application detailed that six participants would be selected from each of the pilot sites. In hindsight, I acknowledge that limiting the number of pilot participants had the potential to introduce respondent bias. All senior staff at the pilot NHS trust agreed to participate (n=5).

The pilot questionnaire pack included a pilot covering letter, questionnaire and feedback sheet. The pilot was effective in establishing the average time to complete the questionnaire (15 minutes), clarification of instructions (information sheet, consent form and questionnaire) and clarification of questions (wording, appropriate use of professional language and avoiding jargon/abbreviations). Feedback regarding layout, usability of the questionnaire and appropriateness of the feeder questions was obtained and questionnaires were amended accordingly prior to the national surveys. The pilot data has been excluded from the analysis, presented in Chapter 5.

4.1.5 Phase 1 Data collection

Data collection was undertaken between November 2009 and January 2010. This section describes the identical procedures undertaken in both NHS and HEI surveys. Invitations to participate in the surveys were addressed to the EOC service lead at each of the 280 NHS trusts (CMA, 2008) and the cardio-respiratory physiotherapy module leader from each of the remaining 30/31 HEIs within the UK, identified on the UCAS[4] (2009) website (in accordance with the inclusion criteria outlined in Table 4.1). Questionnaire packs were sent to each participant and included a coloured copy of the questionnaire, an individually addressed covering letter (Appendix 3), information sheet (Appendix 5), consent form

[4] UCAS is the sole organisation responsible for managing applications to HEI physiotherapy courses within the UK

(Appendix 7) and a self-addressed envelope, to increase the response rate (Sim and Wright, 2000). A return date (of 10 days) was specified on both the questionnaire and covering letter to aid response. Participant assurance was provided in the covering letter with a transparent outline of the aims of the study, procedure, intention regarding publication/presentation of the data generated and respect for the participant's right to privacy, dignity, confidentiality and anonymity. Each questionnaire envelope was pre-coded and a register was kept of those numbers returned. To increase the response rate, two reminders were sent; the first, two weeks later and the second, four weeks after the initial mailing date. Once the final date specified on the questionnaire/covering letter had passed, the outstanding numbers (NHS/HEIs) were re-issued with a reminder questionnaire pack. A further seven days was specified on receipt of the reminder covering letter, and this process was repeated twice. The returned envelopes were opened, the relevant data was extracted and then the questionnaires were destroyed.

Questionnaires were anonymised by asking each individual respondent to provide a unique identifying code (outlined in the information sheet). A register was kept so that if any participant wished to withdraw his/her data up until the point of data analysis, they could do so. However, none of the respondents requested their data be withdrawn. New alphanumeric codes were applied to the actual questionnaires according to the order of entry into the SPSS database (with no reference to the responding trust) to ensure confidentiality and preserve the anonymity of respondents. Separate storage of coding and data files was undertaken as recommended by the Medical Research Council's Good Research Practice Guidance (MRC, 2000).

4.1.6 Phase 1 Data analysis

Each question on the questionnaires was pre-coded to facilitate ease of data entry (Appendices 12 and 13). The raw data were entered into the Statistical Package for the Social Sciences, Version 17.0 (SPSS Inc., Chicago, IL, USA, SPSS, 2008) and verified by two members of the team (Fowler, 2009). Descriptive statistical analyses were used to summarise and present quantitative data, including frequency and percentages. Where data was normally distributed the mean, standard deviation and range is presented, otherwise the median and interquartile range is presented. Likert scales were classified into two categories either agree (1 or 2) or disagree (4 or 5), with the neither (3) category data being removed prior to analysis. Associations between responses to different questions were assessed using Chi-square analysis. A $P < 0.05$ was considered significant for the univariate analysis.

The qualitative data from the open-ended questions were analysed using a quantitative form of content analysis (Boyatzis, 1998). Due to a limited amount of qualitative data provided by the respondents in both surveys, content analysis was completed. The units of analysis were short sentences provided as responses to the open-ended questions or in questions where the 'other' category was indicated and participants provided further details not listed in the closed-question response options. Individual headings were generated for each open-ended question, and responses assigned to the categories and sub-categories associated with the data and RQs 1 and 2. The questionnaire responses were analysed until no further insights were identified (Boyatzis, 1998; Bowen, 2008). The frequency of occurrences was recorded. Commonalities and contrasts were examined between NHS and HEI surveys (Silverman, 2001). Two members of the supervisory team reviewed the data for accuracy and consistency (Boyatzis, 1998; Fowler, 2009).

4.1.7 Phase 1 Methods summary

Section 4.1 has detailed the methods used in Phase 1 to operationalise the theoretical perspective and methodologies previously outlined in Chapter 3. This chapter has described the research methods used in Phase 1 of this study. Descriptions of the survey participants, development of the survey instruments, pilot study, survey and data analysis procedures have been provided to permit replication. Chapter 5 will present the combined results of both surveys undertaken in Phase 1.

4.2 Phase 2 Methods

Section 4.2 focuses on the research methods employed within Phase 2 in order to address RQs 3 to 7, as presented in Figure 4.3. The research questions focused on exploring the management of a cardio-respiratory simulated patient, error recognition, perceived value of the simulation experience (scenario and video-reflexivity) and perceived impact of prior learning on performance during simulation. The research design, participant recruitment, scenario development, pilot data, collection methods and data analysis are also presented in this section.

Figure 4.3: Phase 2 research questions

Research question 3	• To what extent are final year pre-registration physiotherapy students able to independently manage an acutely deteriorating cardio-respiratory patient in a simulation context?
Research question 4	• To what extent are final year pre-registration physiotherapy students able to independently recognise errors within a simulation-based learning experience?
Research question 5	• What value do pre-registration physiotherapy students attribute to the cardio-respiratory simulation-based learning experience?
Research question 6	• Which elements of prior learning do pre-registration physiotherapy students perceive may influence their performance within a simulation-based learning experience?
Research question 7	• What is the cost of undertaking a cardio-respiratory simulation-based scenario and video-reflexive ethnography review?

This research was set within the context of a three-year pre-registration physiotherapy programme within one HEI in the UK. In total, 430 hours of teaching briefs across 10 university-based units, within the overall BSc (Hons) physiotherapy curricula were reviewed. Within each unit, SBE was used to scaffold learning (Vygotsky, 1978) through the development of abstract knowledge and abstract skills, before contextualising these within scenarios and progressing to more complex and realistic simulation scenarios. The overall complexity of the case studies, SBE activities and respective learning objectives increased as students progressed from level four to six (pre-registration years 1 to 3). The review of the teaching briefs indicated that knowledge was acquired through the 'flipped classroom' approach (Roehl et al., 2013). This is when prerequisite learning is undertaken outside of the formal classroom. Pre-requisite learning activities required students to access the virtual learning environment (Moodle) where they had access to specialist teaching resources such as podcasts (a series of audio, video and text files streamed online to a computer or mobile device) linked to learning activities relating to essential knowledge, skills, behaviours, core standards, evidence-based practice or case scenarios. This review highlighted the context of SBE within the existing curricula at MMU. Phase 2 was carried out during the final year of the participants' physiotherapy programme of studies, in May 2011. Therefore, the participants had thus completed all of the academic components of the course and over 900 hours of practice placements.

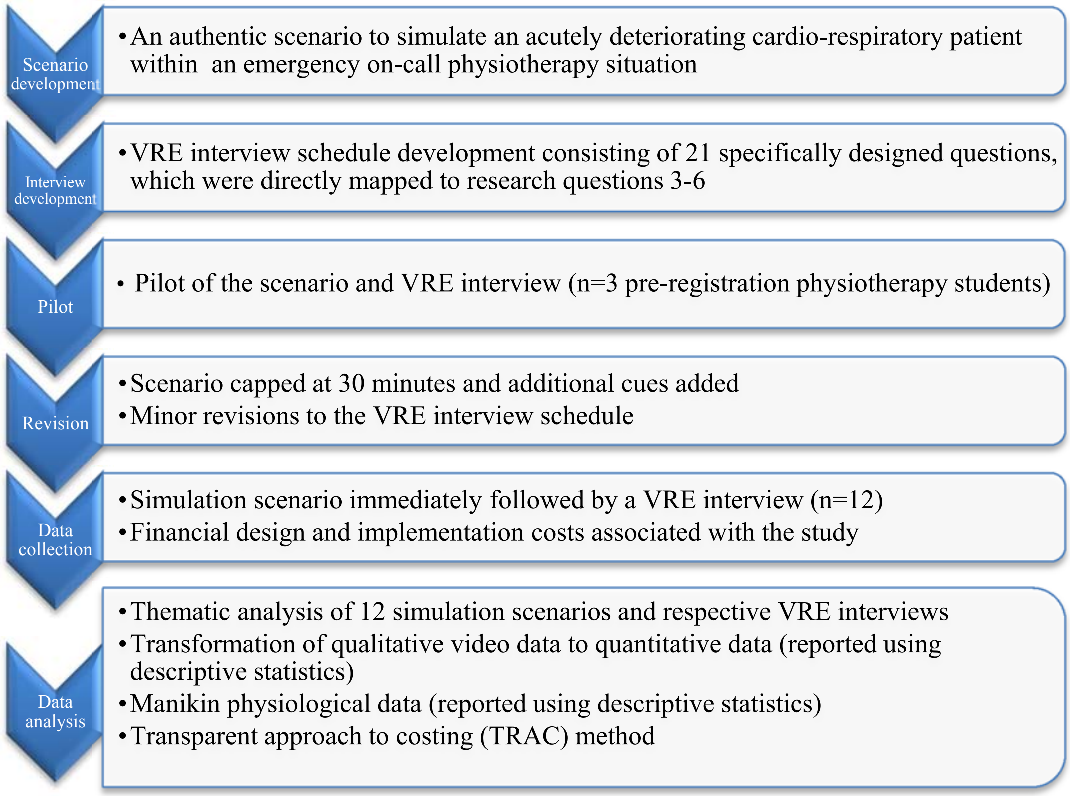
4.2.1 Phase 2 Research design

In Chapter 3, I described my decision to adopt a technical pragmatic approach to address all six research question. Phase 2 featured the use of VRE methodology to explore RQs 3-6. The methods of data collection included observation of the simulation scenario and a focused unedited VRE interview. These methods were selected to capture multiple perspectives (approaches and understandings) and the complexity of managing a deteriorating simulated patient. Figure 4.4 (on page 76) provides an overview of the procedures used in Phase 2.

4.2.2 Phase 2 Simulation and scenario development

This section presents the theoretical stance and development process that has underpinned the design of the simulation and scenario used within Phase 2. Despite the adoption of SBE in physiotherapy education and practice internationally (presented in section 2.2), no specific framework was identified to facilitate the design of SBE in physiotherapy (refer to section 2.3). Table 4.2 illustrates the seven key elements that underpinned the simulation design, development and analysis of the study. The simulation design presented in Table 4.2 drew on existing frameworks (Jeffries, 2005; Anderson et al., 2008; Dieckmann 2009; DH, 2011; the NHET-Sim Monash Team, 2012; Chiniara et al., 2013) and incorporated theoretical and educational practices that underpin SBE, as previously discussed in section 2.3.

Figure 4.4: Scenario and VRE interview schedule development and administration procedures



Simulation scenarios are often developed on critical events or near misses (NPSA, 2007a, 2007b; Donaldson, 2009; WHO, 2009, 2011). Therefore, such simulation scenarios are designed to avoid participants replicating poor practice/reducing human error/improving technical or non-technical performance. An authentic scenario was purposely designed to replicate the complexity of an emergency on-call physiotherapy situation involving an acutely deteriorating cardio-respiratory inpatient. SBE scenarios are usually generated by facilitators using past cases, clinical experience or anonymised clinical case records. The scenario was based on the findings from the national surveys undertaken in Phase 1 and an anonymised, authentic patient case study. As an academic, I did not have access to clinical records or actual patient histories from which to develop scenarios based on critical events or near misses. Therefore, I sought alternative authentic case study material from cardio-respiratory specialists in the UK. Two case histories were used to develop the standardised cardio-respiratory physiotherapy scenario. One of the case histories was based on data reported in a doctoral study (Shannon, 2011), in which errors were observed during the physiotherapy intervention provided in the management of critically ill patients.

Table 4.2: The integration of seven key elements underpinning the simulation design, development and analysis of the study

Elements	Details
1. Learner	Research study featuring final year BSc (Hons) physiotherapy students from one HEI in the UK. All students undertook active roles within a uni-professional simulation scenario.
2. Facilitator	Facilitator and researcher roles were identified. Skill set established and formal training acquired within specialist areas of simulation scenario design, educational theory, debriefing, human factors and patient safety.
3. Theories and educational practices	The simulation design was informed by social constructivism (Crotty, 1998; Pritchard and Wollard, 2010) and socio-material (complexity) theoretical perspectives (Johnson, 2007). The scenario and video-reflexive interview embraced social constructivist theories including Vygotsky's (1968) zone of proximal development, and situated and authentic learning (Lave and Wenger, 1991). Educational practices within the existing physiotherapy curriculum included blended learning (DH, 2011), flipped classroom (Roehl et al., 2013) and scaffolding (Bruner, 1967) with increasing levels of complexity of scenarios and the provision of opportunities for deliberate practice prior to practice (clinical) placements.
4. Learning design characteristics	Learning objectives were in line with social constructivism principles (Crotty, 1998; Pritchard and Wollard, 2010). The instructional medium included high fidelity simulation (equipment, environmental and psychological), featuring a human patient simulator. The modality was an immersive clinical simulation scenario featuring an acutely deteriorating medical inpatient. The simulation scenario has been outlined in Box 4.1 (on page 79). The instructional method included self-directed learning. A high degree of realism was achieved through authentic artefacts (equipment and environment) and scenario design. Antecedent, reality and conceptual cues were incorporated into the scenario (Burton et al., 1996; Paige and Morin, 2013). Fiction cues were avoided and responses to intervention were realistic in terms of physiological responses and timing. The scenario was designed to replicate the complexity of an emergency on-call physiotherapy situation and piloted to minimise cognitive overload (Sweller, 1998).
5. Pre-brief and debrief	Pre-brief information was provided in advance of the study through the participant information sheet in respect to the focus, style format, duration and use of assistive technology, and discussed in person on the day of the study. Information was also detailed relating to the debrief procedures in writing and discussed verbally during the pre-brief (format, style, anticipated duration and use of video-recording technology required to undertake the video-reflexive interview).
6. Linked learning activities	At the end of the video-reflexive interview (debrief), the linked learning activities were discussed with study participants. Participants were provided with a copy of their own video footage (scenario and video-reflexive interview), which they could combine with further written reflexive evidence for their personal e-portfolios. Further opportunities were available for the study participant's to transform learning from the simulated scenario to practice during their forthcoming (final, elective) practice-based placement.
7. Outcomes	This study focused on exploring the experiences of pre-registration physiotherapy students' experiences of managing a deteriorating simulated patient, the ability of the students to independently recognise errors, perceive elements of prior learning that may influence their performance and the value that pre-registration physiotherapy students attributed to the cardio-respiratory simulation-based learning experience. Video and thematic analysis was undertaken to explore knowledge, skills (technical and non-technical), attitudes, behaviours, clinical decisions and reasoning, elicited when managing an acutely deteriorating patient. A priori themes were integrated within the thematic video analysis from the acute illness management rubric (GMCCSI, 2011), Physiotherapy Framework CSP (2013a), and non-technical skills for surgeon's observational behaviour tool (Yule et al., 2008a).

Information was factored into the scenario and the learning objectives to facilitate safe practice of physiotherapy assessment and management of a deteriorating adult patient (Box 4.1, page 79). Further details for the case history was sought to overlay the parameters experienced in the doctoral thesis on the human patient simulator (METIman) programming software. This allowed the current study to utilise prospective simulation, whereby the participants can rehearse events, skills or scenarios before incidents or accidents have to occur.

Ahmed et al. (2012) advocate that deeper learning can be achieved if participants are able to reflect on personal experiences/mistakes rather than hypothetical scenarios or the mistakes of others. A summary of the scenario resources is provided in Appendices 14-16. (The full scenario documentation and METIman programme is available from the author). High frequency assessment and treatment skills identified within the UK surveys of EOC physiotherapy training and cardio-respiratory physiotherapy curricula identified in Phase 1 (Appendix 14) were mapped to the learning objectives and desired knowledge, skills and behaviours for each state of the scenario (Box 4.1). The scenario and resources were peer reviewed by members of the cardio-respiratory teaching team at the University. The baseline cardiovascular observations and case history were programmed into the METIman simulator and used within a series of simulation exercises with MSc (pre-registration) physiotherapy students at the University (between January 2010 and March 2011), to further develop a series of transitional 'states' that were subsequently programmed onto the METIman simulator (Appendix 15). The 'state' feature within the METI MUSE programming software enables the simulator to move seamlessly from one state (related to a trigger event/intervention) to the next. When a participant initiated an intervention, the appropriate state/event/action was activated, which progressed the simulator's clinical parameters to change in a manner that would occur (physiologically and in real time) in a human patient. The use of pre-programmed states and events enabled me to follow the participants' interventions with appropriate, physiologically accurate parameters.

Box 4.1: Summary of the emergency on-call physiotherapy scenario

The scenario exposed the pre-registration physiotherapy students to an adult medical patient whose condition has recently started to deteriorate. The patient was admitted to the Medical Ward via Accident and Emergency. An emergency on-call physiotherapy assessment is requested by the staff nurse.

The learning objectives were to:

- Demonstrate an appropriate respiratory assessment of an acutely deteriorating medical inpatient
- Implement appropriate physiotherapy intervention
- Adhere to safe working practices including health and safety, moving and handling and infection control
- Recognise universal precautions/unsafe practice and take appropriate action
- Provide a structured handover

Scaffolding and cues: The scenario built on prior acute illness management and cardio-respiratory knowledge and skills embedded throughout the pre-registration physiotherapy curriculum. Antecedent cues included temporal (realistic physiological timing of responses to intervention), interpersonal cues (verbal prompts outlined in the simulated patient and healthcare assistant role profiles) and internal cues (manikin responses). Verbal, visual monitor display and written cues were provided to enable learners to discriminate conditions and prompt the desired consequence in a scenario (e.g. normalisation of physiological status in response to appropriate physiotherapy intervention). Participants were encouraged to 'think aloud' during the scenario.

Role allocation and orientation: Randomisation of participants to the role of the EOC physiotherapists or HCA. All participants were then oriented to the simulated learning environment and equipment prior to the pre-brief.

Pre-brief synopsis: Mr Williams is a 61-year-old male who was admitted to the hospital 25 days ago. His admission diagnosis was Multiple Sclerosis, and a recurrent urinary tract infection. The previous physiotherapy assessment findings indicate that he has low tone in his upper and lower limbs and thorax. He has restrictive thoracic movement in particular extension. Recommendations for moving and handling include using a slide sheet and hoisting from bed to chair or wheelchair. Assisted drinking is required and prompting Mr Williams to cough post-swallow. The staff nurse reports that the patient is currently very tired, has a weak cough and has been sleepy since yesterday. He has become quite chesty since last night, when he had a drink of tea and thickened soup. An emergency on-call physiotherapy assessment is requested by the staff nurse.

State one (initial assessment): The healthcare assistant is seated in the side room reviewing the patient's notes. The patient's physiological condition starts to deteriorate (in real time) as the physiotherapist enters the simulated side room. The physiotherapist is expected to complete an initial respiratory physiotherapy assessment.

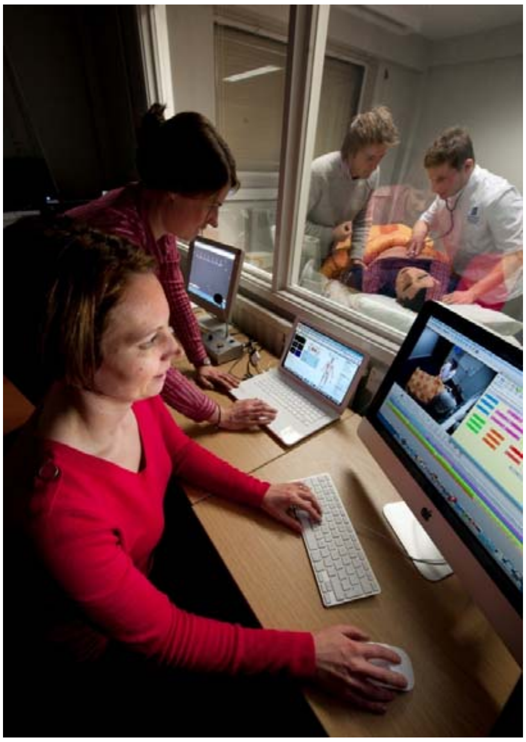
State two (physiotherapy intervention): The physiotherapist is expected to implement appropriate physiotherapy intervention based on clinically reasoned decisions. This included requesting a review and increase in oxygen therapy, repositioning the patient to optimise ventilation perfusion matching, selecting and administering appropriate chest physiotherapy intervention.

State three (reassessment and handover): The physiotherapist is expected to reassess the patient's status and provide a structured handover to the nurse/healthcare assistant.

Not all medium- to high-fidelity human patient simulators have been physiologically mapped and necessitate the operator to design similar transitions based on his/her own calculations e.g. using a percentage increment grounded on clinical experience for each individual vital sign under each individual condition/drug dosage/medical or surgical intervention. Therefore, by using the physiologically mapped METIman high-fidelity simulator, the potential risk of inadvertently introducing incorrect cues was minimised. Appendix 16 presents the supplementary scenario resource information available to the participants within the scenario. The full economic costs of designing and delivering the scenario are presented in Appendix 17.

The simulated medical side ward hospital environment was situated adjacent to the control room as illustrated in Figure 4.5. The one-way mirror partitioned the participants undertaking the scenario and observation and video-recording equipment in the control room. The video and audio recording equipment included a ceiling-mounted camera and microphone, which was controlled remotely from the control room.

Figure 4.5 Simulation ward and control room



The simulation scenario was recorded directly onto the simulation control room Apple iMac (large computer screen in Figure 4.5). The VRE interview video data were generated using Apple QuickTime software (http://www.apple.com/quicktime/download/), which permitted screen and audio recording. All of the video data were accessed via the Apple iMac and transferred onto the local area network (LAN) hard disc drives (HDD), specifically designed for the storage of the simulated learning environment server. The LAN and HDDs were password protected. Duplicate DVD copies of all files were made as advocated by Grant et al. (2010) to preserve the master copies. This avoided destruction of the master files or loss of data. The duplicate movies were reloaded onto the Apple iMac and designated project MacBook Pro for analysis.

4.2.3 Phase 2 VRE interview schedule development

The VRE interview schedule (Table 4.3, on page 82) was considered an effective method of structuring the reflexive interview, whilst allowing the participants to engage critically with their own simulated practice (Iedema et al., 2009). The purpose of the specific questions used within the interview schedule has been outlined and mapped to the respective Phase 2 RQs (3-6). The interview questions were developed to allow the participants to engage reflexively in their own experiences within the simulation scenario. The 'think aloud' method was integrated within the VRE interview schedule to encourage participants to review and verbalise their simulation video in relation to clinical decisions and clinical reasoning undertaken. The think aloud method has been extensively reviewed by Van Someren et al. (1994) and was originally developed for psychological research between the 1940s and the 1980s (Van Someren et al., 1994). A range of think aloud protocols have since been developed to explore task analysis, psychological modelling and verbalisation theory, coding schemes, coded protocols, predicted coded protocols, segmented protocols and raw protocols (Van Someren et al., 1994). The full VRE interview schedule is presented in Appendix 18.

Table 4.3: An illustration of the video-reflexive ethnography interview schedule questions, purpose and research questions they addressed

Number	Question (Student role that the question was directed to)	Purpose (Respective Phase 2 RQs)
1	What did you consider Levi Williams' main problem was during the scenario? *(Physiotherapist)*	Exploration of the participant's ability to correctly identify Levi's problem (RQ3)
2	What objective clinical findings/tests assisted in your decision making with respect to diagnosing Levi Williams' problems? *(Physiotherapist)*	Identify the objective/clinical findings that facilitated the participant's ability to diagnose Levi's problems (RQ3)
3	Please talk me through your assessment of Levi Williams. *(Physiotherapist)*	Independent reflexive review of the simulated experience (RQ3)
4	Please talk me through your intervention/treatment of Levi Williams. *(Physiotherapist)*	Independent reflexive review of the simulated experience (RQ3)
5	If you had more time to treat Levi Williams, what other assessment/interventions would you undertake? *(Physiotherapist)*	To facilitate reflective review of the student's assessment/interventions (RQ3)
6	Reflecting on your assessment/management of Levi Williams, what would you do differently if you were to repeat this exercise? *(Physiotherapist)*	To facilitate a reflective review of the student's assessment/interventions (RQ3)
7	Do you feel that you made any clinical errors during your assessment/treatment? If so, what and how would you change things if you were to undertake the scenario again? *(Physiotherapist)*	To facilitate a reflective review of the student's assessment/interventions (RQ4)
8	What did you perceive your role was in this scenario? *(Health Care Assistant)*	To facilitate a reflexive review of the student's perceived role in the simulated scenario (RQ3)
9	Did you feel that the physiotherapist undertook a *structured* assessment of Levi Williams? Please explain your answer. *(Health Care Assistant)*	To facilitate a reflective review of the student's perception of the lead physiotherapist's actions (RQ3)
10	Did you feel that the physiotherapist undertook a *thorough* assessment of Levi Williams? Please explain your answer. *(Health Care Assistant)*	To facilitate a reflective review of the student's perception of the lead physiotherapist's actions (RQ3)
11	If you had been bleeped to review Levi Williams, what other assessment/interventions would you undertake? *(Health Care Assistant)*	To facilitate reflection-on-actions observed whilst working alongside the physiotherapist (RQ3)

Number	Question (Student role that the question was directed to)	Purpose (Respective Phase 2 research question)
12	Do you feel that the physiotherapist made any clinical errors during the assessment/treatment? If so, what and how would you change things if you were to undertake the scenario again? *(Health Care Assistant)*	To facilitate a reflective review of the participant's perception of the lead physiotherapist's actions (RQ4)
13	What do you consider were your strong points during the assessment/management of Levi Williams? *(Both roles)*	To facilitate a reflexive review of the student's strengths within the simulated learning experience (RQ4)
14	What do you consider to be an area for improvement based on the scenario you have just undertaken? *(Both roles)*	To facilitate a reflexive review of the student's areas for improvement based on the simulated learning experience (RQ4)
15	Do you think that your previous physiotherapy clinical placements or university units (e.g. cardio-respiratory, foundations in professional practice, AIM Course) have prepared you for this simulated experience? If so, which? *(Both roles)*	To facilitate a reflexive review of prior clinical/academic experiences that may have prepared the students for the simulated learning experience (RQ5)
16	Which clinical placements have you undertaken to date? (e.g. cardio-respiratory, musculoskeletal, neurology, community) *(Both roles)*	To facilitate a reflexive review of prior clinical experiences that may have prepared the participants for the simulated learning experience (RQ5)
17	What type of placement is your elective placement and why did you choose this? *(Both roles)*	To explore the student's decisions regarding their choice of elective (final) placement prior to graduation (RQ5).
18	Reflecting on your simulation experience today, do you think that there is any value in undertaking simulated scenarios within pre-registration physiotherapy education? Please explain your reasons. *(Both roles)*	To explore the student's perceived value of the simulation experience (RQ6)
19	Reflecting on your simulation experience today, do you think that you will be able to transfer any of this experience into your clinical elective placement/once you graduate? *(Both roles)*	To explore the student's perceived ability to transfer any of their experiences into their forthcoming elective placement/post-graduation (RQ6)
20	Reflecting on your simulation experience today, do you think that it will assist your continuous professional development in any way? If so, which elements Prompts: a) The simulation experience, b) Think aloud review, c) DVD, e) Debrief, f) Further reflective practice? *(Both roles)*	To facilitate a reflective review of whether the students anticipated that the simulated learning experience would assist their continuous professional development in any way (RQ6)
21	Reflecting on your experience, do you think learning in a simulated environment will have any impact on patient safety, if so how?*(Both roles)*	To explore the student perceptions as to whether the simulation experience would have any impact on patient safety (RQ6)

4.2.4 Phase 2 Participant recruitment and consent

As a senior lecturer at one HEI, I situated my research within this institution for convenience. This enabled me to access a purposeful sample of pre-registration physiotherapy students. Purposeful sampling is recommended in qualitative research in order to select information-rich cases for detailed study (Denzin and Lincoln, 2000; Cohen et al., 2000; Roberts, 2007; Simmons, 2007; Creswell, 2009). The total population included three cohorts from the BSc (Hons) physiotherapy programme and two years from the MSc (pre-registration) physiotherapy programme.

To ensure that the physiotherapy students had already been exposed to clinical practice and SBE within cardio-respiratory units, only the final year students on either the BSc (Hons) or MSc (pre-registration) programmes[5] would be suitable for recruitment. Combining the cohorts was not possible as the final year MSc (pre-registration) physiotherapy students had already been exposed to the scenario during their cardio-respiratory units, which informed the scenario development process (outlined previously in section 4.2.2). Twenty-seven final year pre-registration physiotherapy students volunteered and consented to participate (34% of the maximum available sample size of 85). Accommodation of participants' preferred dates was undertaken to reduce the burden of participation and potentially the dropout rate. Despite allocating two students per simulation session according to participant preferences, three withdrew during the course of the study, three participated in the pilot and the remaining 21 completed the scenario and VRE interview reported in this article. Two doctoral students (from within the faculty) volunteered to undertake the role of the healthcare assistants (HCA) in place of the participants who withdrew. The two volunteers both had prior experience of participating in SBE within the physiotherapy programme and were pre-briefed with the respective physiotherapy participant.

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[5] The BSc (Hons) Physiotherapy programme is a three-year course, with placements commencing in year two. The programme starts annually in September, whereas the MSc (pre-registration) physiotherapy programme is a two-year programme, commencing annually in January, with placements beginning at the end of year one.

In three scenarios, the pre-registration physiotherapy participant was allocated to the role of the physiotherapist and the doctoral healthcare student was assigned to the HCA (volunteer A twice and B once). In the scenarios where a volunteer HCA was involved, only the pre-registration physiotherapy students participated in the VRE interview. Thus in the remaining nine scenarios, all participants were pre-registration physiotherapy students, and 21 pre-registration physiotherapy students participated in both the simulation scenarios and VRE interviews. Participant characteristics have been summarised in Table 4.4. No further comparison of the participant characteristics is possible with the entire cohort, as no further demographic data was collected for the participants. Ethical approval was not sought to compare the gender data with that of the entire cohort.

Table 4.4: Phase 2 participant characteristics

Participants	Gender	Frequency
Pre-registration physiotherapy students	Male	5
	Female	19
	Total	24
Doctoral healthcare students*	Male	1
	Female†	1

*Key: *, allocated to the role of the HCA only; †, the volunteer participated in the scenario as the HCA twice*

4.2.5 Phase 2 Pilot

All three pilot study participants were provided with a 'pilot study participant pack' by email and in their student pigeonholes featuring a covering letter (Appendix 3), information sheet (Appendix 5) and consent form (Appendix 8). The covering letter explained the nature of the study, simulation experience and procedure to be followed. All participants were offered the opportunity to contact me by telephone, email or mail prior to the commencement of the pilot study if they required further information. The pilot study occurred three weeks after initial enrolment to the study due to placement commitments. Minor modifications were made to the VRE interview schedule to ensure that participants were reminded to share their opinions as they arose throughout the video replay during the main study. The pilot also established the durations for the simulation (pre-brief, simulation and debrief), data collection and confirmed the timings required for the changeover between each set of participants. Pilot participants considered the timings appropriate.

The decision to apply a 30-minute cap on the scenario duration during the main study was based on the average time it took to complete an appropriate assessment and treatment. This also helped to ensure there was adequate timing for the VRE interview and debrief to take place without over-burdening the participants. The pilot also confirmed that the SLE fidelity (equipment, environmental and psychological) was appropriately designed for the pre-registration audience, and the learning objectives and pitch of the scenarios (difficulty rating/scope of practice/applicability of physiotherapy skills) were applicable. As previously stated, the pilot data were excluded from the data analysis presented later in Chapter 7. Piloting the scenario also provided valuable information of the nuances that exist between simulated and actual reality (Burton et al., 1996; Paige and Morin, 2013), which prompted cueing enhancements within the scenario design (Appendix 15). As a result of the pilot, the following changes were made:

1) Inclusion of an orientation to the room and equipment prior to release of the pre-brief information (allowing participants to concentrate on the simulation and healthcare equipment, environment layout, recording equipment and familiarise themselves with the simulation manikin's features).
2) Development of clearer cues for the HCA to prompt a handover at 25 minutes to simulate real encounters from the HCA/other staff on the ward (providing a natural conclusion to the scenario, if required in the main study)
3) The VRE interview schedule was revised to accommodate both physiotherapist and HCA responses simultaneously for each question (as presented in Table 4.3, page 82)

4.2.6 Phase 2 Data collection procedure

On arrival to the simulation suite, participants were orientated to the simulation environment and its equipment and randomly allocated roles. Participants were randomly assigned to either the role of the physiotherapist or HCA in the scenario by selecting a piece of card from a bag indicating either physiotherapist or HCA role. The pre-brief was provided just outside the simulation room and included details pertaining to the patient's situation, background, previous assessment findings and requested the responding physiotherapist to undertake an assessment of the patient (further details are provided in Box 4.1, page 79). The scenario commenced once the participant undertaking the role of the EOC physiotherapist entered the patient's room. On completion of the scenario (either at the request of the participant or once the 30-minute time limit had elapsed), all participants returned to the control room to complete the VRE interview together. The duration ranged between 45 and 60 minutes and was dependent on the individual simulation scenario duration and depth of participant elaboration/discussion during the VRE interview.

The VRE interview was conducted using the semi-structured interview schedule presented in Appendix 18). The VRE interview included a question that required both participants to review their respective simulation video and provide a running commentary (thinking aloud) with respect to their assessment, physiotherapy intervention and clinical decision-making processes. The participants were asked to pause and discuss the video at any point they felt necessary, until the entire video had been replayed. After all 21 questions had been asked, the conclusion statement was read aloud. This then concluded the formal interview and overall student participation. All students were then offered a debrief (which was not part of the data collection). The debrief was undertaken to resolve any erroneous events or discussions arising from the scenario or VRE interview. The debrief ensured that the participants were aware of any errors or intervention that contravened professional practice, and discussed how they could be mitigated in the future if these were not already addressed in the VRE interview. In addition, the debrief ensured that the scenario learning objectives had been met. After all 12 scenarios had been completed, each participant was offered a copy of his or her individual simulation scenario.

4.2.7 Transparent approach to costing

In order to report the cost of the study (RQ 7), I sought guidance from the literature (Roberts, 1990; Kernick, 2002, 2003) and the University financial accounting policies and procedures. Health economic costs according to Kernick (2003) consider the opportunity cost (the importance of value of the learning opportunity), perspective (viewpoint of the analysis that dictate which costs and benefits are important) and marginal analysis (the relationship between resources invested into the SBE intervention and the benefit, which is rarely linear in healthcare). From a health economics perspective, efficiency is concerned with maximising the benefits from available resources or alternatively ensuring benefits gained exceeded any forgone benefits and equity is concerned with fair distribution of resources (Kernick, 2003). The five different types of cost evaluations proposed by health economists that can be applied to SBE are summarised in Box 4.2.

Box 4.2: Economic cost evaluations applicable to SBE

1) **Cost minimisation analysis:** the consequences of two or more interventions being compared are equivalent. Analysis focuses solely on cost, with the cheapest intervention selected
2) **Cost effectiveness analysis:** to compare SBE that has common health outcomes, for example, improved function or life years saved
3) **Cost utility analysis:** used to assess cost and benefits of interventions where there is no single outcome of interest. This could include comparing different SBE interventions across different healthcare practices. The common unit of analysis is the quality adjusted life year, referred to as the QALY
4) **Cost benefit analysis:** this values all the costs and consequences of a SBE intervention in monetary terms. An intervention would be accepted if the benefits outweigh the associated costs
5) **Cost consequence analysis:** applied by decision makers as weighting can be applied to the different outcomes, and often reflects how decisions are made in the reality

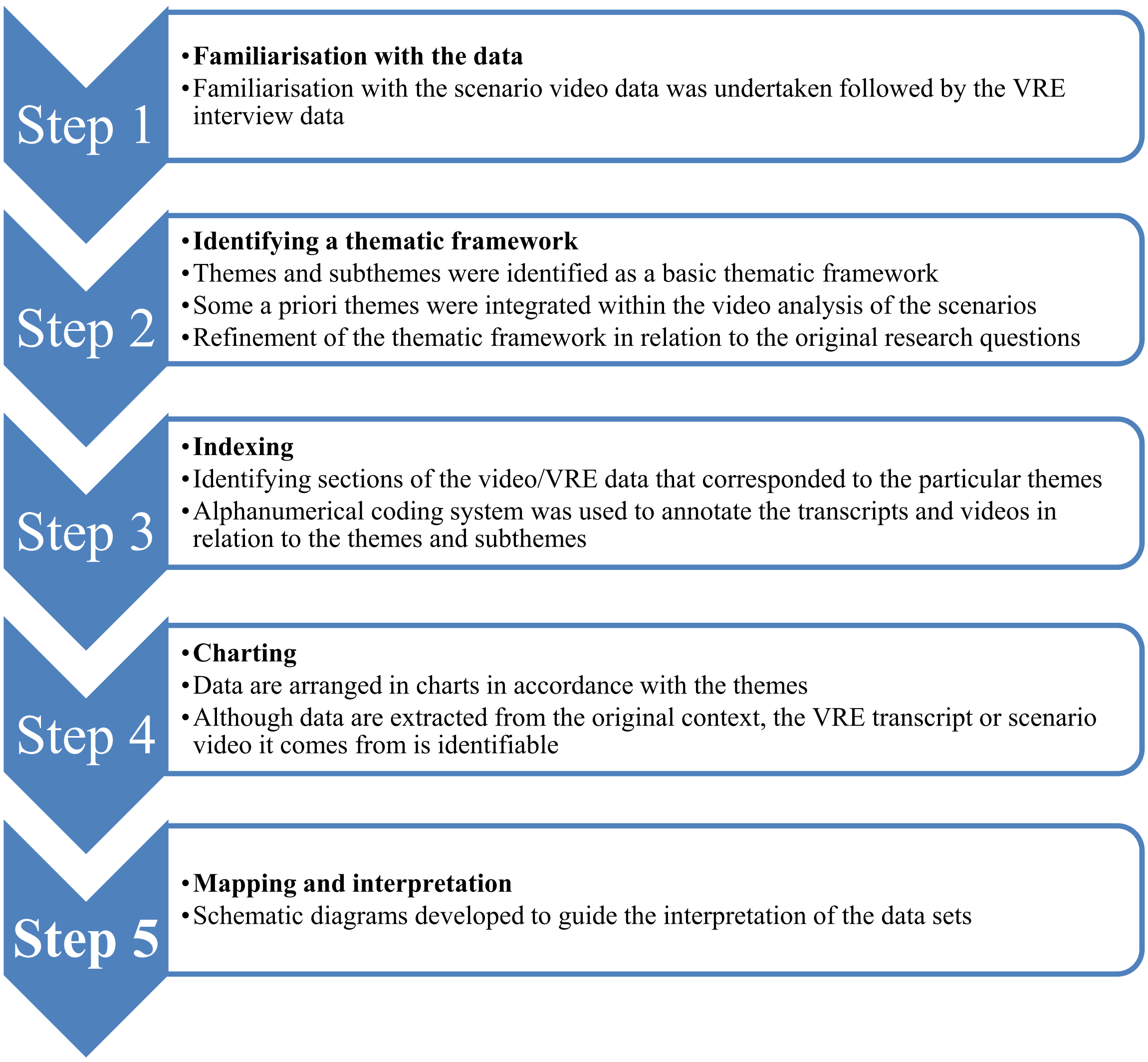
(Kernick, 2003)

A cost consequence analysis was undertaken, which includes the full economic cost (FEC) of the study. This was selected, since the focus of Phase 2 was not to demonstrate impact of the SBE intervention on patient care, neither was a comparative study of multiple interventions undertaken. The transparent approach to costing (TRAC) method was used to calculate the FEC of designing and undertaking the scenario and VRE (Appendix 17). Cost consequence analysis offers an interim formal method of economic analysis for evaluating SBE within physiotherapy and healthcare curricula (Kernick, 2003). Whilst this form of economic analysis disaggregates the case, cost and outcomes, it is an accepted approach on which current decisions are being made in an applied context e.g. healthcare or academic practice (Kernick, 2002, 2003).

4.2.8 Phase 2 Data analysis

Scenario and VRE interviews were transcribed verbatim (totaling 290 and 690 minutes respectively). The transcription convention has been outlined in Appendix 19. Thematic framework analysis (Ritchie and Spencer, 1994) was selected as the most appropriate method for this study, ensuring the relationship between the context and content could be adequately presented. Thematic framework analysis involves reviewing the data, recording and developing recursive coding rules that describe the event comprehensively (Ritchie and Spencer, 1994). One significant benefit of using the thematic framework analysis was that it enabled me to utilise a priori issues/themes. However, as recommended by Ritchie and Spencer (1994), it was important I maintained an open mind and tried not to force the data into any of the a priori themes. The five-step thematic framework approach was used to structure the analysis (Ritchie and Spencer, 1994). The overall thematic coding framework to analyse the video data was developed through an iterative process outlined in Figure 4.6. The video thematic coding framework forms part of the overall coding framework.

Figure 4.6: Application of the thematic framework analysis approach developed by Ritchie and Spencer (1994)



Thematic analysis of the VRE interview was similarly developed and analysed in accordance with RQs 3-6. Excerpts from the verbatim transcripts are provided in the results (see Chapter, 7) to provide illustrative examples of the subthemes. Comparative analysis (between a participant's scenario and interview) has also been presented. Excerpts from the verbatim transcriptions, supplemented by images from the scenario videos, have been integrated to present a comprehensive analysis.

Video analysis software (StudioCode) was used to analyse the scenario data and a priori themes were integrated within the thematic analysis from the acute illness management (AIM), rubric (GMCCSI, 2011), Chartered Society of Physiotherapy Framework (CSP, 2013) and non-technical skills for surgeon's observational behaviour tool (Yule et al., 2006, 2008a). The StudioCode software enabled me to analyse the moving images on the video and generate/apply new themes when reviewing the initial videos. Throughout the analysis, I was able to add in new themes/subthemes, rewind the timeline and then instantly re-analyse the video data as necessary. The transcription function within StudioCode allowed me to import transcribed (.xml) files or make further annotations onto the video. Srivastava and Thomson (2009) propose that due to the sheer volume of data that can be collected in qualitative research, a researcher may not be able to utilise all of the material collected.

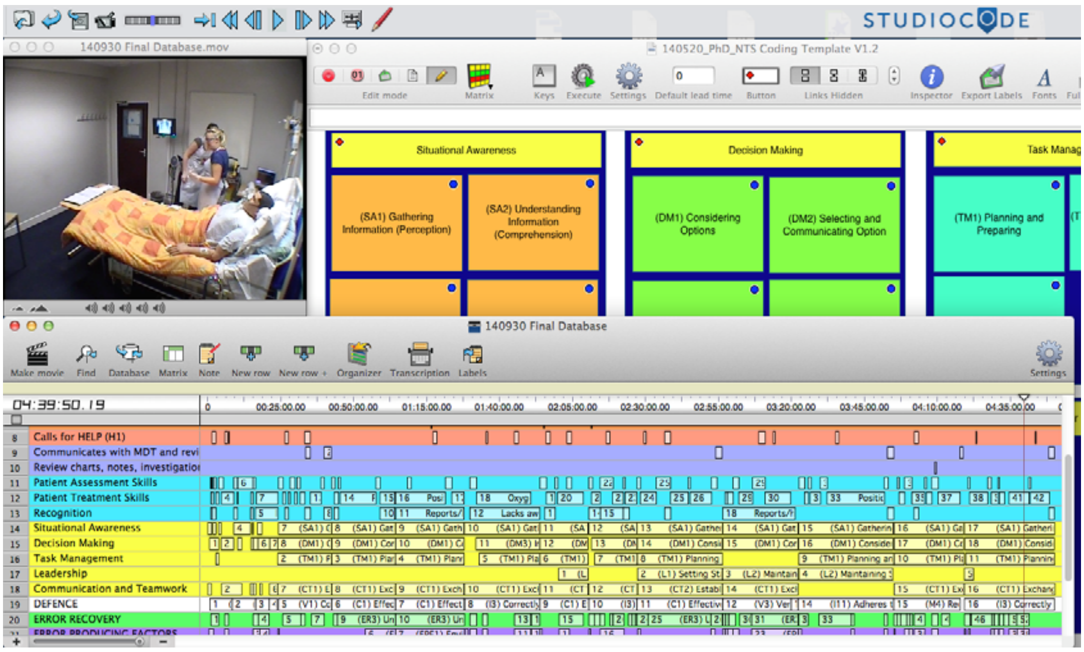
In this study, I have also explored the participants' actions, behaviours, and technical and non-technical skills in order to address RQ3 (physiotherapy management) and RQ4 (error recognition). Since the research was designed around the concepts of cardio-respiratory physiotherapy management and error analysis, it was thought that these a priori themes would inevitably guide the development of some of the overall analysis of the scenarios.

Additionally, quantitative physiological and programming data were obtained from the METIman software. The data files were exported as csv extensions and analysed using basic descriptive statistics in Microsoft Excel. The data were used to identify the changes in the patient's physiological parameters (vital signs) throughout the scenarios and the qualitative findings were triangulated in relation to the change in the patient's status throughout the scenario.

4.2.8.1 Transformation of qualitative data

The use of the video analysis software permitted the transformation of the qualitative data (Clarke et al., 2009). Qualitative research sometimes reveals patterns in data by identifying the frequency of observed themes and subthemes (Boyatzis, 1998). Creswell (2014) highlights the linkage between these methods with the richness of qualitative information and precision of quantitative methods. The qualitative data were transformed into quantitative data to illustrate key themes and recurring patterns of the participants' technical and non-technical skills in the management relating to the deteriorating patient during the scenario. Despite the transformation of some of the qualitative data, a process-orientated qualitative interpretative approach was maintained (Rees et al., 2013). The purpose of the data transformation was to explore the commonalities and difference of events/activities amongst all participants, which was then triangulated with data from the VRE interviews in order to understand the content and context of the interactions. Following individual video analysis of all of the scenarios, the data were combined (a screenshot example has been provided in Figure 4.7).

Figure 4.7 Transformation of video data – a screenshot of Theme 5 non-technical skills thematic coding template and video database



Key: Non-technical skills (NTS) Themes in yellow and subthemes in different coloured squares. The instances of NTS organising themes and basic themes are displayed on the final database timeline (e.g. situational awareness, the first yellow row)

The transformation was generated using the matrix function in the StudioCode software. The matrix data were exported as a Microsoft Excel file. Percentages of occurrences of themes and subthemes across all 12 scenarios are presented. Statistical analysis was not deemed suitable due to the small sample size, thus descriptive statistics have been presented.

4.2.8.2 Triangulation

One of the additional strengths of video data analysis is the possibility of comparative analysis (Najvar et al., 2009). Simulation and respective VRE interview videos were individually analysed and then databased to enable comparative analysis, identifying similarities, unique events and recurring patterns/actions/events. Data from the simulation video, VRE interview, transcriptions and matrix analyses were also triangulated to provide a holistic overview of pre-registration physiotherapy students' experiences of participation in the simulated scenario. The purpose of triangulating two or more methods of data collection in this study was to explain the complex nature of human behaviour and interaction within the simulated environment.

4.2.9 Phase 2 Methods summary

Section 4.2 has detailed the methods used in Phase 1 to operationalise the theoretical perspectives and methodology previously outlined in Chapter 3. This chapter has described the research methods used in Phase 2 of this study. Descriptions of participant recruitment, development of the simulation scenario and VRE interview schedule, pilot study, data collection and analysis procedures have been provided to permit replication. In order to present a coherent report, the results are presented in order of the RQs 3-7.

4.3 Conclusion

This chapter has presented the research design, data collection methods, pilot survey and data analysis methods employed in Phases 1 and 2. The respective research questions and supplementary questions have also been stated. Phase 1 results are presented in Chapter 5 and discussed in Chapter 6. Phase 2 results are presented in Chapter 7 and later discussed in Chapter 8.

Chapter 5: Phase 1 Results

5.1 Introduction

This chapter presents the research findings from both the national NHS and HEI questionnaire surveys. The findings of the surveys have been integrated to facilitate comparative analysis of common questions within the two surveys.

5.2 Demographics

The useable response rates for the NHS and HEI surveys were 55% (155/280) and 55% (16/30), respectively. The demographic information for respondents to both surveys has been provided in Table 5.1.

Table 5.1: Survey participant demographics

Demographics	**Frequency of NHS survey respondents/155** *(percentage in parentheses)*
Physiotherapy team leader/Band 7[6] (critical care/surgery/ICU)	86 (54)
Clinical specialist	35 (23)
Principal/therapy manager/superintendent	17 (11)
Senior I (Band 6)	12 (7)
Advanced cardio-respiratory physiotherapist	2 (2)
Physiotherapy practitioner	2 (2)
Critical care and outreach	1 (1)
Age	Median 35 years (IQR 30-40)
Female	135 (87)
Male	19 (12)
Gender not specified	1 (1)
Demographics	**Frequency of HEI survey respondents** *(number in parentheses/16)*
Lecturer	7 (44)
Senior lecturer	7 (44)
Lecturer practitioner	1 (6)
Course leader	1 (6)
Age	Mean 41 years (SD 9.3)
Female	14 (88)
Male	2 (12)

Key: ICU: Intensive care unit

The respondents' personal experience of participating in training featuring simulation varied between the NHS and HEI surveys. Respondents from both surveys reported personally completing training featuring simulation, which included basic life support; advance life support; 'ALERT' (Acute Life Threatening Event: Recognition and Treatment) course/Greater Manchester AIM© course at on-

[6] Band 7 refers to job description grading used in the NHS, which may precede one of the following titles: team leader, clinical specialist or senior I physiotherapist. Band 6 may precede a senior I physiotherapist title (responsible for less senior staff such as senior II (Band 5/6) and newly qualified (Band 5) physiotherapists.

call skills training or critical care study days (Physiotherapy Emergency Scenario Training Course); on-call updates; and cardio-respiratory clinical skills training (suction, airway management, scenario management, suction bagging/manual hyperinflation, tracheostomy care). Respondents also indicated they had received training on the use of simulators either by a regional expert or by the respective manufacturing company, in order to be able to use it within teaching. Details regarding respondents' individual participation in and perceived value of SBE are presented in Table 5.2.

Table 5.2: Respondents' simulation-based education (SBE): participation and perceptions

Statement	**Survey**	**Frequency of responses (percentage)**					
		Never	**1**	**2**	**3**	**4**	**≥5**
Frequency of participation in SBE in the past 2 years *(all participants: NHS/155, HEI/16)*	NHS	63 (40)	29 (19)	15 (9)	11 (7)	16 (10)	21 (14)
	HEI	2 (12)	3 (19)	3 (19)	1 (6)	2 (12)	5 (35)
Respondents' perceptions of SBE in relation to emergency on-call physiotherapy		**Not Answered**	**Strongly Agree**	**Agree**	**Neither**	**Disagree**	**Strongly Disagree**
SBE has a place in physiotherapy *EOC training*	NHS	6 (4)	56 (36)	76 (49)	17 (11)	0 (0)	0 (0)
SBE has a place in physiotherapy *cardio-respiratory education*	HEI	0 (0)	10 (63)	6 (37)	0 (0)	0 (0)	0 (0)
SBE has a place in physiotherapy acute respiratory training	NHS	6 (4)	53 (34)	76 (49)	19 (12)	1 (1)	0 (0)
	HEI	0 (0)	10 (63)	6 (37)	0 (0)	0 (0)	0 (0)
I am sceptical about the usefulness of SBE in physiotherapy	NHS	6 (4)	2 (1)	7 (4)	32 (21)	74 (48)	34 (22)
	HEI	0 (0)	1 (6)	0 (0)	2 (13)	9 (56)	4 (25)
SBE may contribute to increased patient safety	NHS	6 (4)	28 (18)	84 (54)	32 (21)	5 (3)	0 (0)
	HEI	0 (0)	5 (31)	8 (50)	3 (19)	0 (0)	0 (0)
SBE equipment is suitable for use *within EOC training*	NHS	6 (4)	37 (24)	94 (61)	15 (10)	3 (2)	0 (0)
SBE equipment is suitable for use *within cardio-respiratory education*	HEI	0 (0)	6 (38)	9 (56)	1 (6)	0 (0)	0 (0)
SBE equipment is suitable to develop *EOC competencies*	NHS	6 (4)	32 (21)	81 (52)	26 (17)	10 (6)	0 (0)
SBE equipment is suitable to develop *cardio-respiratory skills*	HEI	0 (0)	4 (25)	8 (50)	4 (25)	0 (0)	0 (0)
SBE is <u>not</u> suitable for the assessment *of EOC competencies*	NHS	6 (4)	4 (3)	27 (17)	30 (19)	62 (40)	26 (17)
SBE is <u>not</u> suitable for the assessment *of cardio-respiratory skills*	HEI	0 (0)	0 (0)	2 (12)	1 (6)	10 (63)	3 (19)
SBE could provide opportunities to practise critical events	NHS	6 (4)	45 (29)	88 (56)	13 (8)	3 (2)	0 (0)
	HEI	0 (0)	4 (25)	12 (75)	0 (0)	0 (0)	0 (0)

Despite 38% of respondents not participating in SBE within the last 2 years, the vast majority of the overall respondents agreed (strongly agreed/agreed) that SBE has a place in both EOC training and cardio-respiratory physiotherapy education, can contribute to increased patient safety, is suitable to develop EOC competencies/cardio-respiratory skills is suitable for the assessment of EOC competencies/cardio-respiratory skills, and provides opportunities to practise critical events.

No statistically significant differences were observed between the attitudinal statements or frequency of participation according to gender or age using non-parametric analysis (Appendix 20).

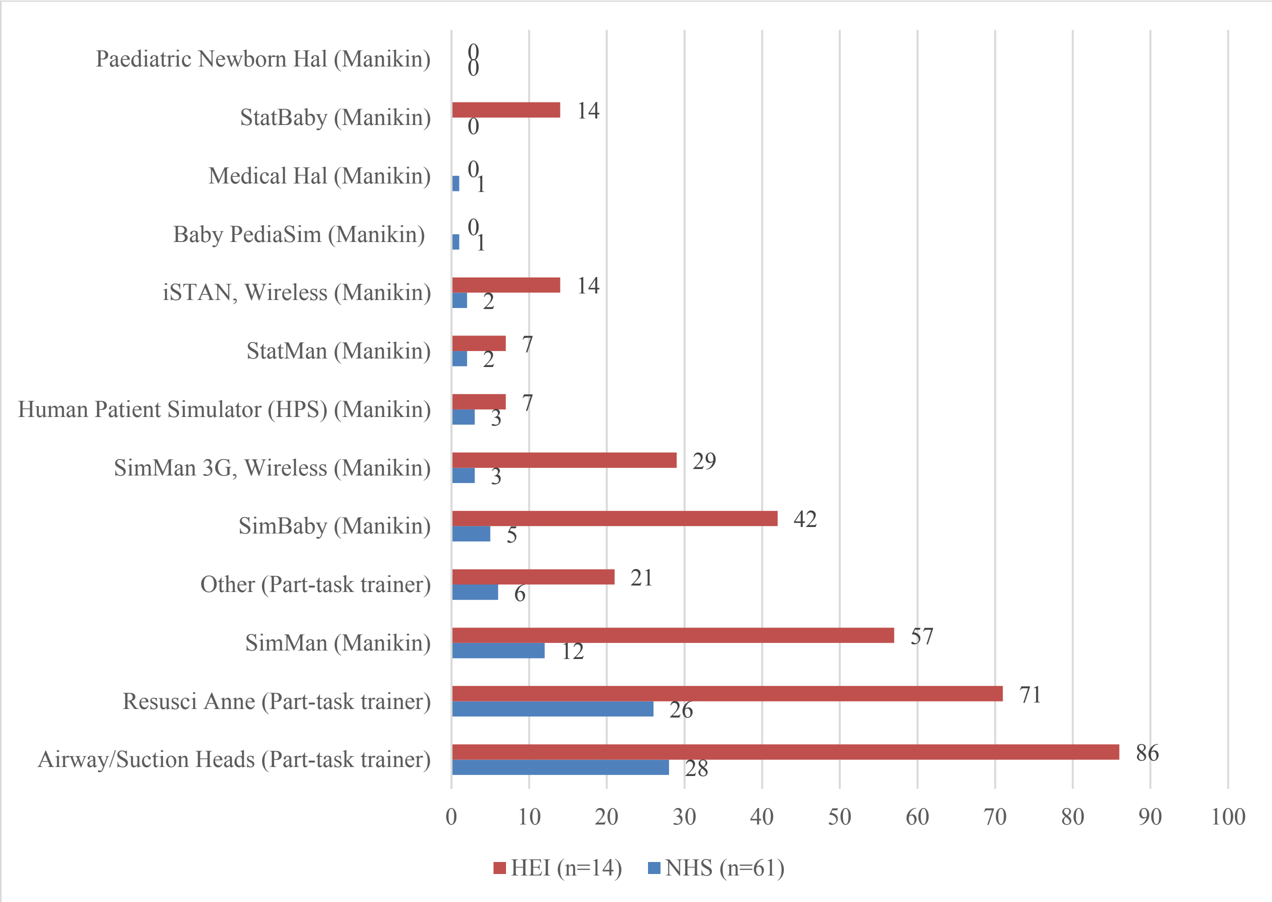
5.3 Research questions 1 and 2

The findings relating to RQs 1 and 2 have been synthesised in the following sections (5.3 to 5.5). The responses from the questionnaire addressed RQs 1 and 2 and all supplementary research questions as previously outlined in Figure 4.1 (on page 66).

5.3.1 Simulation technology provision and access

A wide variety of low- to medium-fidelity simulation equipment was reportedly being utilised in NHS trusts for EOC training and within cardio-respiratory physiotherapy education in HEIs (Figure 5.1). The provision of simulation equipment varied with respect to type, fidelity and amount accessible to the physiotherapy service or physiotherapy programme. Part-task trainers were reportedly most commonly used within both NHS trusts and HEIs.

Figure 5.1: Simulation equipment provision available to physiotherapy services in NHS trusts and physiotherapy programmes in HEIs in the UK



Percentage of respondents

Respondents from both surveys provided brief details of part-task trainer equipment available for use, these included the Tracheostomy Observational Model (TOM), Tutor VII Auscultation Trainer and an auscultation manikin. Lower fidelity manikins available to respondents included Nursing Kelly (Advanced), Nursing Anne (Advanced), Laerdal Mega Code Kelly and Laerdal Mega Code Kid. Additional comments related to the use of respiratory clinical scenarios within the virtual world of Second Life® and limited access to equipment:

> *Simulation equipment is only used for ALERT training and is only available for advanced physiotherapists.* (NHS 14)

5.3.2 Training provided and simulation access

The focus of the training questions in the NHS and HEI surveys differed in this section of the questionnaire. In the NHS surveys, the questions focused on EOC training provision, whereas the HEI survey focused more on accessibility.

EOC training is predominantly delivered locally, with regional training available for updates. Ninety-six percent of respondents who used simulation (149/155) indicated that their trust's EOC physiotherapy induction training was delivered in-house. Only thirteen percent (21/155) indicated their trust was able to access regional EOC training. Additional comments were provided: the provision of regional and in-house (provided within the department), EOC training, regional paediatric hospital visits and encouragement to visit critical care or the respiratory wards if necessary. Ninety-nine percent of respondents (154/155) provide in-house EOC update training with three respondents indicating both in-house and regional update training was available. Two respondents commented that occasional external on-call courses were available.

Access to simulation equipment varied amongst physiotherapy programmes in HEIs, with respondents indicating access to between six and 15 human patient simulators (manikins). Of the 12 HEIs that had access to human patient simulators, 10 (83%) reported that simulators were shared amongst other healthcare programmes. Only two respondents reported purchase of simulators for the sole use of their physiotherapy programmes. The location of the simulators varied amongst the 12 HEIs and included practical rooms (42%, 5/12), skills laboratories (25%, 3/12), a nursing skills laboratory (17%, 2/12), a clinical skills centre (8%, 1/12) and a simulation laboratory located in a separate building (8%, 1/12). Seven (44%) respondents indicated that they did not have access to a simulation centre. The remaining four HEIs (25%) had access to a simulation centre, of which three respondents offered different additional information:

> *Competing with the nurses for access, not always available.* (HEI 9)
>
> *But we have to pay to use it.* (HEI 5)

5.3.3 Simulation use in competency, formative and summative assessments

Table 5.3 indicates the types of situations where NHS trusts and HEIs were reported to be using SBE.

Table 5.3: Types of situations where SBE was reportedly used within EOC training and physiotherapy cardio-respiratory education

Current use of SBE in NHS Trusts	**Frequency (percentage)**
EOC training	61/155 (39)
EOC induction training	21/61 (34)
EOC update training	24/61 (39)
EOC assessment skills development	7/61 (11)
EOC competency assessments	10/61 (16)
Development of EOC scenarios using SBE	12/61 (20)
Pre-registration physiotherapy education	16/16 (100)
Postgraduate cardio-respiratory education	7/16 (44)
Formative assessment within postgraduate physiotherapy education	5/16 (31)

Situation where simulation is used in HEIs	**Frequency of pre-registration programmes (n=14)**		**Frequency of postgraduate programmes* (n=9)**	
	Yes	**No**	**Yes**	**No**
Basic Life Support (BLS)	14	2	4	5
Advanced Life Support (ALS)	14	2	6	3
Cardio-respiratory assessment skills	14	2	5	4
Cardio-respiratory treatment skills	14	2	5	4
Mock emergency on-call scenarios	1	15	2	7
Acute Illness Management scenarios	11	5	5	4
Acute Illness Management (AIM) (ALERT©/Greater Manchester AIM© or equivalent) course	14	2	7	2
Other	2	12	1	8

Other examples:
Pre-registration programmes
- Use of scenarios but not for Acute Illness Management
- Part-task trainers used for suction – no feedback given to the students

Postgraduate programmes
- Use of Wii-Fit for aspects of rehabilitation
- Simulation technology sometimes used on short-course teaching
- Use of Wii-Fit for aspects of rehabilitation

*Key: *Five respondents (31%) indicated that their HEI did not have a postgraduate physiotherapy programme at the time*

Free-text comments were provided by respondents related to the use of simulation within formative assessments including cardio-respiratory skills to evoke decision-making skills, basic life support, suction and manual hyperinflation.

> *Suction techniques and basic life support skills.* (HEI 2)
>
> *For assessing lung sounds in pairs. Not summative assessment though!* (HEI 6)

Only three (19%) HEIs reported using simulation technology in summative assessments. Two of these respondents provided additional information regarding the use of simulation within summative assessment:

> *Suction techniques and manual hyperinflation model.* (HEI 3)
>
> *Interpretation of assessment findings incorporating auscultation simulator.* (HEI 10)

The final question in this section acted as a filter question to identity NHS trusts and HEIs using SBE. Those who indicated that their organisation did not currently use SBE were not required to complete the remaining three sections of the questionnaire. Thus, 61/155 NHS and 14/16 respondents completed the remainder of the questionnaire.

5.3.4 Simulation features, scenario type and range used within EOC training and physiotherapy education

Table 5.4 summarises the simulator features, scenarios and skills developed using simulation equipment within EOC training and cardio-respiratory physiotherapy education.

5.3.4.1 Simulator features

NHS respondents provided additional free-text comments regarding simulation equipment features utilised including the use of simulator vital signs to explore blood pressure, respiratory rate, oxygen saturations, heart sounds and intra-cranial pressure:

> *A compact disc with normal and abnormal breath sounds.* (NHS 56)
>
> *Chest drains and a ventilator (invasive and non-invasive).* (NHS 12)
>
> *Used for practising intensive care unit treatment skills.* (HEI 12)

The HEI respondents provided additional comments regarding simulation equipment features utilised. The simulation features included simulator vital signs for blood pressure, respiratory rate, oxygen saturations, intra-cranial pressure and heart sounds, and practising intensive care unit treatment skills.

Table 5.4: Simulator features, scenarios and skills developed using simulation within emergency on-call training and physiotherapy education

Simulator features used	NHS survey Frequency/61 (percentage)	HEI survey Frequency/14 (percentage)
Normal lung sounds	21 (34)	11 (79)
Abnormal lung sounds	21 (34)	11 (79)
Normal airway sounds	15 (25)	9 (64)
Abnormal airway sounds	15 (25)	9 (64)
Other	10 (16)	4 (29)
Pulses	9 (15)	5 (36)
Ability to simulate a pneumothorax	8 (13)	0 (0)
Interactive voice (pre-set on simulator/microphone)	6 (10)	2 (14)
Scenarios currently utilised with simulation technology		
Adults with a tracheostomy (R10)	39 (64)	9 (64)
Adults on ventilators (R3)	27 (44)	7 (50)
Adults with acute medical disease (AR6)	18 (30)	7 (50)
Adults with chronic respiratory disease (R4)	16 (27)	7 (50)
Adults following abdominal surgery (R1)	12 (20)	3 (21)
Adults with neurological deficits (R8)	12 (20)	2 (14)
Adults who are unstable (cardiovascular instability) (R9)	12 (20)	2 (14)
Adults following cardiothoracic surgery (R2)	11 (18)	2 (14)
Adults with multiple trauma (R5)	10 (16)	2 (14)
Adults in 'end of life' situations (R12)	7 (11)	1 (7)
Adults with unstable spine (R7)	6 (10)	0 (0)
Adults with head trauma/raised intra cranial pressure (R11)	5 (8)	2 (14)
Other	5 (8)	4 (21)
Patient assessment skills currently undertaken using simulation within on-call training (ACPRC, 2007 – Patient Assessment Skills Matrix statements in parenthesis)		
Use a stethoscope to interpret auscultation findings (A4)	23 (38)	10 (71)
Identify the patient's main problems (A11)	19 (31)	5 (36)
Observe the patient's breathing and general status and identify significant findings (A6)	18 (29)	5 (36)
Interpret patient records, notes, charts and monitors (A1)	18 (29)	4 (28)
Collect accurate and appropriate information (A9)	18 (29)	5 (36)
Analyse assessment findings (A14)	18 (29)	4 (28)
Identify a patient who is deteriorating/becoming critically ill (A15)	18 (29)	4 (28)
Interpret chest x-ray findings of relevance to physiotherapy (A13)	17 (28)	3 (21)
Select appropriate outcome measures (A11)	16 (26)	4 (28)
Interpret arterial blood gases (A12)	14 (23)	3 (21)
Other	3 (8)	1 (7)
Patient treatment skills currently undertaken using simulation within on-call training (ACPRC, 2007 – Patient Treatment Skills Matrix statements in parenthesis)		
Nasopharyngeal suction (MX13)	48 (79)	12 (86)
Tracheal/tracheostomy suction (MX13)	48 (79)	11 (79)
Managing an airway (MX14)	47 (77)	9 (64)
Closed suction (MX12)	41 (67)	10 (71)
Tracheostomy management (MX15)	38 (62)	6 (43)
Vibrations (MX3A)	15 (25)	4 (28)
Humidifiers/nebulisers (MX4)	15 (25)	2 (14)
Shaking (MX3B)	14 (23)	3 (21)
Percussion (MX2)	13 (21)	4 (28)
Postural drainage positioning (MX5)	10 (16)	3 (21)
Other	8 (13)	2 (14)

Key: R1, A1, MX2 refer to statements from the ACPRC (2007) self-evaluation of competence questionnaire in relation to the range of scenario and assessment and treatment skills

5.3.4.2 Scenarios

Respondents provided additional free-text comments relating to scenario use within EOC training and cardio-respiratory physiotherapy education. Both adult and paediatric acute illness management simulation scenarios were reportedly used as well as scenarios featuring suctioning, MHI and management of the acutely deteriorating patient:

Simulation is only used for ALERT/UTOPIA training, only for advanced [postgraduate] *physiotherapy training.* (NHS 14)

Simulation is mostly used for skills education, which is then related to patient scenarios as we use a scenario-based learning approach. (HEI 5)

Adult scenarios who are unstable – deteriorating patient. (HEI 14)

5.3.4.3 Skill development

Respondents provided additional free-text comments relating to skills taught within EOC training and cardio-respiratory physiotherapy education. Skills included manual hyperinflation using a lung simulator, decision making, basic life support and skills specifically required in the intensive care environment:

They could have a history of any of the above [referring to the ACPRC, 2007 competency statements in the question] *but not using SimMan technology as yet.* (NHS 26)

All of the above [referring to the types of assessment skills] *are carried out on normal peers and patients – but not using simulation technology.* (HEI 13)

The use of additional gaming equipment within both undergraduate and postgraduate cardio-respiratory teaching sessions was also reportedly used when teaching aspects of rehabilitation.

5.3.5 Additional simulation product specifications

Respondents in both surveys were invited to comment on additional simulation product specification that would enhance human patient simulator use within postgraduate physiotherapy training or physiotherapy education. However, the eight additional recommendations included features that were already available within existing computerised human patient simulators, for example tracheostomy access, nasopharyngeal airway insertion and practise suction, and programmable scenarios to elicit clinical reasoning, implement treatment options and observe a predicted outcome. There was call for the need for *"better paediatric models"* (NHS 54), but no further specific details were provided by the respondents.

Additional comments related to the limitations of being unable to ventilate a specific manikin, requesting a more mobile trunk, spine and limbs to facilitate positioning and passive movements:

Currently SimMen are not really designed to be ventilated. It would be great to be able to ventilate a simulator. (HEI 5)

A more 'mobile' trunk and spine for positioning etc. More mobile segments (limbs) for assessment and interventions e.g. passive movements. (HEI 14)

The final open-ended question requested further comments that respondents may wish to provide that were not covered in either of the NHS or HEI questionnaires. Four themes were identified: access to equipment, training, and limitations of use and value of simulation.

Theme 1: Access to equipment

Simulation would help on-call training but simulation should not replace competency assessment entirely. Our Trust has lots of this equipment but we are not allowed to use it, it is for medics only. Simulation would be more used in this Trust if more simulation equipment were available. (NHS 5)

Simulation training would be ideal for on-call training but funding has been a problem. As an instructor in the [anonymised] *Simulation Centre, I think that one of the most useful parts of training is in the human factors.* (NHS 6)

Theme 2: Training

With regards to simulation training, participants reported the current use of the ACPRC EOC resources and future training incorporating human factor training and ventilated patient scenarios:

Compact Disc – On-course for on-call has been useful and is regularly used with both induction and update training. (NHS 42)

We will be using ventilated patient scenarios in the future once equipment set up. (NHS 18)

Theme 3: Limitations of use

Limitations of current simulation use related to lack of experience preventing use or insight, lack of time and cost implications:

My lack of experience with simulation specifically for on-call prevents more insight or opinion. It is something I can explore with the support of the team using technology in the Trust. (NHS 14)

Simulation increase in use would be advantageous. Cost is the main reason for not increasing use. (HEI 2)

Would love to do much more but we are pressured for time. I believe it to be important. (HEI 13)

Theme 4: Value of simulation

The value of simulation was reported in relation to decision making and participant acceptance of simulation as a valuable learning strategy:

> *An excellent adjunct to enhance education – opportunities to carry pace of decision making/skills quality without the consequences of clinical practice or the difficulty in bringing some aspects of more basic role plays alive. Although used interprofessional, we are currently seeking to develop more interprofessional learning opportunities using simulation.* (HEI 14)

> *We ran a short course 'on-call training' using our lab for local Trusts' qualified physiotherapists. It was not formally part of any Masters modules. Feedback from our short course indicated a high level of acceptance and usefulness of simulation even from those who only observed colleagues working with simulators. It is great from an on-call perspective.* (HEI 5)

5.4 Conclusion

This chapter has synthesised and interpreted the research findings for RQs 1 and 2, which were addressed by the NHS and HEI national surveys. The surveys illustrated the use of SBE within training, competency, formative and summative assessment. The findings highlighted the existing use of and access to simulation equipment, the integration of different simulator features and type of assessment and treatment skills that feature within simulation scenarios in EOC training and cardio-respiratory physiotherapy education in the UK. The barriers to using SBE and initial product specifications that would potentially enhance the update of simulation in physiotherapy have also been presented. Chapter 6 will discuss these findings with reference to the existing literature.

Chapter 6: Phase 1 Discussion

6.1 Introduction

Prior to this study, the extent, range and application of SBE within EOC physiotherapy services and cardio-respiratory physiotherapy education in the UK was unknown. The two national surveys provide a unique insight into the extent to which SBE was being utilised within NHS trusts and physiotherapy undergraduate and postgraduate curricula in the UK during 2009/10. This chapter presents a summary of the key findings and a comparison with existing literature, the methodological strengths and challenges, and implications for educational practice and further research. Box 6.1 below summarises the key findings from the national surveys.

Box 6.1: Summary of the key findings from Phase 1

- National inconsistencies in availability, fidelity and accessibility of simulation equipment that exists in relation to EOC training in NHS trusts and cardio-respiratory physiotherapy education in HEIs in the UK
- Adoption of SBE was dependent upon local facilities, need and training requirements in both NHS trusts and HEIs
- Simulation was reportedly used to teach a variety of cardio-respiratory physiotherapy technical skills but limited non-technical skills within both NHS trusts and HEIs
- Slight differences were reported in relation to the use of simulation for patient assessment and treatment skills development between NHS trusts and HEIs
- Simulator feature use, range of scenarios and skills developed using simulation was generally comparable between EOC training and physiotherapy education. Scenarios featuring patients with neurological deficits, cardiovascular instability, cardiothoracic surgery and multiple trauma were reportedly used to a lesser extent in HEIs
- Similar challenges and barriers of cost, time and access to SBE resources were identified within both NHS trusts and HEIs

6.2 Comparison with the literature

The findings of the surveys will be discussed in relation to the literature.

The extent to which SBE has been embedded within pre-registration physiotherapy curricula in Australia was outlined by a national survey in Australia (Jull et al., 2010). A review of the UK provision and use of simulation was commissioned by the Department of Health in 2009 (Inventures, 2011). The review highlighted varied provision and use across the UK in medical, nursing and midwifery, allied health professional and clinical psychology education and training (Inventures, 2011). However, only one reference was made to the use of SBE within a single physiotherapy programme and none reported use within postgraduate physiotherapy training provided by NHS trusts. National consistencies in adoption, availability, fidelity and accessibility have been similarly reported by respondents in both the NHS and HEI surveys, which concur with findings from Australia and the UK Department of Health (Jull et al., 2010; Inventures, 2011).

6.2.1 Perceptions of the value and application of SBE in cardio-respiratory physiotherapy

The current surveys provided unique insights into the perceptions of qualified physiotherapists who have responsibility for delivering EOC training and pre-registration or postgraduate cardio-respiratory education. The vast majority of respondents agreed (strongly agreed/agreed) that SBE has a place in both EOC training and cardio-respiratory physiotherapy education, can contribute to increased patient safety, is suitable to develop EOC competencies/cardio-respiratory skills and provide opportunities to practise critical events. These findings concurred with Savoldelli and Hamstra (2005), in which Canadian anaesthesiologists, with experience of SBE participation within the last two years, agreed that simulation can contribute to patient safety and is a valuable educational technology. SBE was positively rated by respondents despite almost a third having not participated in SBE within the last two years. The findings may be due to speculation or based on experiences of SBE participation from more than two years prior to answering the questionnaire.

No statistically significant differences were found in relation to the respondents' perceptions of the value and application of SBE in physiotherapy education or frequency of participation in SBE according to gender or age. The low representation of males to females in both surveys accounted for the inability to analyse associations of perceptions with gender. The respondent gender demographics reported in this survey possibly reflects the nature of the physiotherapy profession, which is reportedly female dominated (Owen, 2014). The positive attitudinal responses pertaining to the use and value of SBE concur with Savoldelli and Hamstra (2005).

6.2.2 Simulation equipment

The NHS and HEI surveys provided unique insights into the use and range of simulation equipment used in EOC and cardio-respiratory education in the UK. Similarities existed between HEI surveys in the UK and Australia (Jull et al., 2010), in which part-task trainers were more common than integrated within-EOC training and cardio-respiratory education than human patient simulators and SPs (peers). Slight differences between the reported uses of simulation equipment features were reported between NHS and HEI survey respondents, which may have been influenced by the accessibility of and type of part-task trainer or simulator/manikin available. Survey respondents referred to difficulties accessing simulation equipment (which, for some had cost implications) and others reported a lack of specific training in its use. This may account for the reported level of available equipment by respondents in both surveys. Alternatively, it is possible that EOC physiotherapy services were unaware of simulation equipment available within the organisation, locally or regionally, which may have influenced the reported use of simulator features, scenarios and range of skills developed using simulation equipment.

The use of virtual reality gaming technology for aspects of rehabilitation was reportedly used in cardio-respiratory education within the HEI survey. Both the HEI and Australian survey by Jull et al. (2010) have reported low use of virtual reality simulation within physiotherapy curricula. Haptic (walking) simulators (Schmidt, 2004) and low-cost commercially available virtual reality gaming technology have more recently featured in the literature with respect to enhancing physiotherapy rehabilitation (Groen and Goldstein, 2008; dos Santos Mendes et al., 2012; Fung et al., 2012; O'Donovan and Hussey, 2012; O'Donovan et al., 2012; Pompeu et al., 2012; Salem et al., 2012). The use of haptic simulators was not reflected in either of the national surveys. It is possible virtual reality and gaming technology may feature within physiotherapy education in the near future. The application of virtual reality and gaming technology to AR and EOC patient management has not been reported in the literature to date.

Jull et al. (2010) reported the use of problem-based learning or case-based learning approaches (featuring lectures, tutorials, practical sessions, clinical education and simulation-based learning experiences). However, no further details of the use and application of each simulation medium (mode of delivery) were reported. Three formal pedagogies that underpin Australian physiotherapy curricula include a constructivist approach, computer-assisted learning approach and Blooms Taxonomy, as reported by Jull et al. (2010). The HEI survey, similarly, reported the use of a scenario-based approach being utilised within cardio-respiratory education. However, none of the respondents provided additional details of how the scenarios were embedded within existing EOC training in NHS trusts.

6.2.3 Skills development and scenario range

Simulation was reportedly used to teach a variety of cardio-respiratory physiotherapy technical skills but limited non-technical skills within both NHS trusts and HEIs. Additionally, slight differences were reported in relation to the use of simulation for patient assessment and treatment skills development between NHS trusts and HEIs. The range and number of simulation scenarios reportedly used within initial and update EOC training varied. However, respondents of the current surveys did not elaborate or provide details relating to the level of complexity of existing cardio-respiratory/EOC scenarios. Respondents of the NHS and HEI or Australian (Jull et al., 2010) surveys did not specifically report the development or use of non-technical skill scenarios within the physiotherapy curricula or EOC training. Only the use of scenarios to elicit the non-technical skill of decision making was reported in the current surveys (section 5.3).

Smith et al. (2012) recommend that educators develop teaching and learning strategies that accurately replicate the complex, high stakes cardio-respiratory environment, where complex integration of realistic information is vital for deeper learning. The development of realistic, challenging scenarios featuring complex, less frequently observed as well as routine patient management is vital in the preparation of graduate physiotherapists who are ‘fit for purpose’ in the rapidly changing and complex discipline of cardio-respiratory physiotherapy (CSP, 2002a, 2012, 2013a, 2014a). Respondents in both of the current SBE surveys reported using human patient simulators with complex cardio-respiratory physiotherapy scenarios, e.g. featuring a patient on mechanical ventilation or with a tracheostomy in situ. Whereas, scenarios featuring patients with neurological deficits, cardiovascular instability, post-cardiothoracic surgery and multiple trauma were reportedly less commonly used by HEIs. Tracheostomy or ventilated patient scenarios were identified as being the most commonly integrated scenario in cardio-respiratory training within EOC training and physiotherapy curricula in the UK. However, the integration of ventilation or tracheostomy scenarios would be dependent on the available features of the existing simulator(s) a physiotherapy service/HEI had access to and the ability of trained staff to programme and run these more complex scenarios.

The survey of Australian physiotherapy curricula (Jull et al., 2010) indicated that simulation scenarios were reportedly being used in technical and professional skills education in cardio-respiratory, musculoskeletal, neurology, electrotherapy, orthopaedics (inpatients), paediatrics, continence and women's health and gerontology components of the curricula. Cardio-respiratory physiotherapy was the most common area for integrating simulation scenarios within pre-registration curricula (Jull et al., 2010), but specific details of the range of cardio-respiratory scenarios was not defined. Similarly, the use of SBE in American nursing programmes was reported in the National Council of State Boards of Nursing Simulation Survey (Kardong-Edgren et al., 2012). Their survey highlighted widespread curriculum integration of SBE including the use of mandatory simulation in between 47 and 77% of programmes (associate, baccalaureate, diploma and prelicensure nursing). Multiple scenarios were reportedly integrated within nursing curricula involving medical and surgical case activities, emergencies, obstetrics, care of the new born, teamwork, end of life community health and care of older adults (Kardong-Edgren et al., 2012). Although the Australian (Jull et al., 2010) and American (Kardong-Edgren et al., 2012) surveys did not focus on cardio-respiratory in particular, they illustrate the current scope of simulation scenario integration possible within physiotherapy and nursing education. The NHS and HEI surveys in this study have only focused on the integration of SBE within cardio-respiratory physiotherapy curricula in the UK. Further investigation relating to the extent to which SBE has been integrated within all sub-specialities of pre- and post-registration physiotherapy curricula in the UK, would enable further comparative analysis to the international healthcare literature.

Globally, physiotherapy students are required to complete 1,000 hours of placement-based education to prepare them for immediate clinical practice on graduation (CSP, 2002a; Jull et al., 2010). In 1998, Roskell and Cross (1998) first described the complex interactions a respiratory physiotherapist undertakes to function effectively within their clinical environment, and the importance of the physiotherapist's non-technical skills have been recognised including the need to maintain situational awareness to efficiently function whilst optimally managing the patient. In the UK, physiotherapy programmes are now required to demonstrate compliance with all nine of the Chartered Society of Physiotherapy's (CSP) learning and development principles (2012b), to prepare learners for the continually changing healthcare environment. In addition, programmes are required to incorporate the CSP's (2013a) Physiotherapy Framework: putting physiotherapy behaviours, values, knowledge and skills into practice. Findings from the NHS and HEI surveys highlighted similar widespread variability in the 'range of competency' scenarios (ACPRC, 2007) currently being used by NHS trusts and HEI physiotherapy programmes. The current surveys indicated scenarios were being used that incorporated the NTS of decision making. Whereas other NTS such as communication, team working, leadership and situational awareness, were not reported by participants in either of the current UK surveys or the Australian survey reported by Jull et al. (2010). Cardio-respiratory simulation scenarios provide potential opportunities to embed the physiotherapy learning and development principles, which include reference to technical skills, NTS (decision making, communication and teamwork) and putting the patient at the centre of physiotherapy practice.

Simulated patients have been embedded within musculoskeletal, cardio-respiratory and neurological physiotherapy scenarios within physiotherapy education internationally (Ladyshewesky and Gotjamanos, 1997; LaPier, 1997; Black and Marcoux, 2002; Jensen and Richert, 2005; Hale et al., 2006; Lewis et al., 2008; Hayward et al., 2006; Hayward and Blackmer, 2010; Cahalin et al., 2011; Jones and Sheppard, 2011; Jull et al., 2011; Hensman and Conduit, 2012; Smith et al., 2012; Wamsley et al., 2012; Watson et al., 2012; Blackstock et al., 2013; Ohtake et al., 2013). The current NHS and HEI surveys identified commonalities in the use of SBE to teach cardio-respiratory assessment and treatment skills within NHS trusts and pre-registration physiotherapy curricula, but very limited reference was made to scenarios featuring simulated patients beyond practising on peers.

The UK Physiotherapy Frontline article reported that SBE scenarios featuring both adult and paediatric simulators have been used to train all postgraduate members of Bradford's on-call respiratory physiotherapy service (Gaubert, 2013). Another article (Hunt, 2014) highlighted anecdotal reports that The Royal Free London NHS Foundation Trust believes that it was the first UK trust to use interprofessional high-fidelity simulation scenarios to train all of the Trust's band 5 (basic grade) physiotherapy on-call staff in emergency chest physiotherapy. The HEI survey highlighted limited examples of interprofessional problem-based learning featuring human patient simulators to teach physiotherapy, nursing and medical students about managing the critically ill patient. Since no other studies have provided details of scenarios within physiotherapy AR/EOC or the physiotherapy curricula in the UK, no further comparisons are possible.

6.2.4 Assessment strategies

The current NHS and HEI surveys provide unique insights into the use of SBE within the assessment processes, which featured competency assessment within NHS trusts and formative and/or summative assessment within cardio-respiratory (pre-registration and postgraduate) physiotherapy curricula. Competency-based assessment using simulation equipment existed in NHS trusts but it appeared to be locally driven, concurring with previous EOC surveys (Harden et al., 2005; Gough and Doherty, 2007). The HEI survey highlighted relatively low use of simulation within cardio-respiratory formative and summative assessments in the UK. Whereas in Australia, the Australian Standards of Practice (APC, 2006) have been used in the summative assessment of clinical placement competence (Jull et al., 2010; Jones and Sheppard, 2011; Jull et al., 2011; Watson et al., 2012; Blackstock et al., 2013). In the UK, the use of SBE to replace physiotherapy practice placement time has not been agreed by the CSP for pre-registration physiotherapy programmes (CSP, 2014a). No other literature has reported the use of SBE in formative or summative assessments in cardio-respiratory physiotherapy in the UK or internationally.

None of the respondents reported linking their EOC training to either the demonstration of achievement or competency. Examples of competency frameworks include the ACPRC (2007) self-evaluation of competence questionnaire and the Department of Health (2004) NHS KSF. The NHS KSF was designed as part of Agenda for Change, to support the appraisal process and help employers identify the knowledge and skills that staff need to do their jobs and their development needs (CSP, 2006; NHS Confederation, 2010). The NHS KSF is also central to the career and pay progression of contracts within the NHS (CSP, 2006); thus, mapping activities that demonstrate achievement of the NHS KSF dimensions of a job description could be beneficial to the potential/existing post holder.

An example of using a blended learning approach to enhance reflection and CPD featuring simulation-based scenarios mapped to the NHS KSF, podcasts and the PebblePad e-Portfolio was outlined by Gough and Hamshire (2010, 2012). Their small-scale project demonstrated how these digital technologies were carefully blended to enhance the student's educational experience and facilitate repetitive reflection post-event within the framework of an e-portfolio. The MSc (pre-registration) physiotherapy participants were able to select their own simulation activities independently to demonstrate achievement of a range of core dimensions within the NHS KSF (Gough and Hamshire, 2010). Furthermore, the authors suggested that evidence generated through SBE may be used to prepare for employment, professional CPD documentation and/or provide evidence for HCPC re-registration in the UK.

6.2.5 Barriers to the implementation of SBE in physiotherapy

Several barriers to the implementation of SBE within EOC training and cardio-respiratory physiotherapy education were highlighted by the UK surveys. These included access issues, resource issues (cost, time and funding), limited access to trained facilitators and current human patient simulator features that impede realistic physiotherapy assessment or intervention. Respondents from both NHS and HEI surveys indicated that cost, time and access to simulation centres/laboratories influenced the use of SBE within EOC training and cardio-respiratory physiotherapy education. These findings concur with those reported by Jull et al. (2010). The Australian-wide survey indicated similar barriers, including lack of availability of simulation facilitates, funding for simulation resources, and a lack of resources and training to develop and implement simulation scenarios (Jull et al., 2010).

Insufficient time and funding to support the implementation of SBE has similarly been reported as a barrier in Canada (Savoldelli et al., 2005), Australia (Jull et al., 2010) and the UK (Gough et al., 2012a). Additionally, the respondents in both UK surveys reported perceived simulation-specific skill insufficiencies within NHS physiotherapists and physiotherapy academics, which also concurred with survey findings reported by Jull et al. (2010). However, since the initial survey by Jull et al. (2010), the Australian government has made significant investment in equipment and research featuring SBE (Jones and Sheppard, 2011; Shoemaker et al., 2011; Jull et al., 2011; Watson et al., 2012), which may have influenced resource access, availability and training. NHS trusts and HEIs in the UK have not been fortunate to receive governmental funding to embed SBE within physiotherapy or healthcare. Local simulation networks have been established within the last decade across the UK, but their remit and purpose varies (Donaldson, 2009; NHSNW, 2010; DH, 2011).

The NHS survey highlighted a lack of awareness of trust simulation facilities, lack of trained facilitators within the EOC/AR services and limited access, which may have had an impact on the integration of SBE within NHS trusts and HEIs. Similarly, respondents in the NHS and HEI surveys reported competing with nursing and medicine education programmes for simulation facilities (laboratories, simulation centres and equipment). The current technical limitations of existing simulators were also acknowledged as a barrier to the use of simulation technology in EOC training and cardio-respiratory education. Respondents did suggest, however, additional features that may enhance the use and application of SBE within physiotherapy, including development of a more mobile trunk, spine and limbs, which allow facilitated passive movements and improved application of assessment and physiotherapy interventions. Although some of the human patient simulators do have mobile (hinged) joints, they are not currently anatomically accurate (e.g. they lack accurate range of motion and realistic joint end feel) and do not permit realistic passive movements. Passive movements are essential physiotherapy interventions routinely carried out by physiotherapists in UK ICUs

(Stockley et al., 2010; Wiles and Stiller, 2010; Stockley et al., 2012). Thus, the ability to include passive movements within simulated intensive care scenarios may facilitate learning and teaching related to the complexity and holistic management of critically ill patients.

Similarly, respondents of both NHS and HEI surveys reported that existing human patient simulators did not currently facilitate realistic positioning of patients with cardio-respiratory problems. The use of human patient simulators without hinged joints often limits the ability to position the simulator in the optimum position for postural drainage, clearance of secretions or to reduce breathlessness, which are essential cardio-respiratory skills (ACPRC, 2007). This problem is inherent in the design of some simulators that have more rigid extremities and where the internal mechanics of some important generic features (audio site for pulses during blood pressure measurement) impinge on other features that would enhance the usability of the simulators by physiotherapists. The inability to simulate realistic and optimum patient positioning has the potential to reduce the fidelity/realism of the overall scenario, owing to the break in the fiction contract and suspension of disbelief (Dieckmann et al., 2007). Human patient simulators with hinged joints attempt to overcome some of these barriers and facilitate slightly more realistic positioning for the cardio-respiratory patient, but there is still scope for further improvement.

The request by survey respondents for a more mobile trunk may have been related to current simulators; some have a rigid thorax whilst others have a more flexible thorax but the on-board computer is located behind the chest wall. Existing simulators appear not to have been designed with cardio-respiratory physiotherapy treatment interventions in mind. Whilst they are advertised as being able to portray realistic lung sounds with a variable number of speakers in the anterior and posterior chest area (CAE, 2010; Laerdal Medical Ltd, 2011), they do not have a flexible chest region to facilitate realistic chest wall vibrations, shaking or percussion. More recently designed simulators have included increasingly realistic chest appearances, e.g. contours of the thoracic cage and the ability to programme the left and right aspects of the thorax independently (CAE, 2010; Laerdal Medical Ltd, 2009). Scenarios undertaken using such simulators are also able to simulate a pneumothorax in more realistic detail through absent lung sounds and one side of the chest not moving in time with the other.

Shannon et al. (2010) used a prototype torso (part-task trainer) which included an anatomically accurate rib cage, inflatable synthetic lungs, realistic thoracic movement and end-feel (produced by TruCorp, Belfast, Northern Ireland). This prototype was used in a laboratory bench study, which investigated the effects of chest wall vibration timing on airflow and pressure. However, to date these realistic features have yet to be incorporated into commercially available human patient simulators. Physiological and physical cues, which enhance realism (Dieckmann et al., 2007) within a cardio-respiratory physiotherapy simulated scenario, also help to elicit appropriate clinical decisions and implementation of appropriate intervention. In the absence of these physical cues, it is possible that errors may be inadvertently made with delays in reaction or implementation of appropriate intervention within the simulated environment.

6.3 Methodological strengths and limitations

I acknowledge that the findings of Phase 1 were influenced by the methodological strengths and limitations of the postal surveys (Fowler, 2009).

6.3.1 Phase 1 Methodological strengths

The use of a survey research design allowed me the opportunity to collect information from NHS trusts providing EOC services and all physiotherapy programmes throughout the UK. The questionnaires were specifically designed around RQs 1 and 2 (as presented in Figure 4.1, on page 66). The questions were designed to generate both quantitative and qualitative response, to gain breadth of inquiry and allow respondents multiple opportunities to provide more detail in relation to specific statements or questions. The pilot NHS and HEI questionnaires provided the opportunity to determine the accuracy and clarity of the questions within both. This process sought to minimise measurement error by ensuring the professional language and terminology was appropriate for the respective EOC and HEI populations. Additionally, the pilot testing sought to remove ambiguity or confusion in any of the questionnaire items (Fowler, 2009). Sections 4.1.1 and 4.1.2 outlined the methods utilised to increase the overall response rates and to reduce the effects of non-response error (bias). These included questionnaire design and format considerations, directly addressing the questionnaire packs to the EOC leads/Cardio-respiratory unit leads, multiple reminder mailings and issuing self-addressed envelopes. I sought to minimise sampling and coverage error by inviting all NHS trusts and all HEIs providing pre-registration physiotherapy programmes in the UK to participate in the surveys.

6.3.2 Phase 1 Methodological limitations

Although good response rates were achieved in the NHS and HEI surveys, this represented 155/280 NHS trusts and 16/30 HEIs in the UK. The questionnaires in both surveys were not directly addressed to a named person and remained anonymous during the data collection process for ethical reasons. This process may have impacted on delivery to appropriate EOC/cardio-respiratory service leads/academic leads and also eliminated the opportunity to investigate the reasons for not returning questionnaires. Response bias is acknowledged as it is possible that the recipients may have perceived their EOC service, trust or HEI was being measured against others or the ACPRC self-competence questionnaire (ACPRC, 2007) or the practice of others nationally (Fowler, 2009). Thus, the findings of these surveys may have underrepresented AR/EOC services and/or HEI cardio-respiratory curricula, where the questionnaire recipient was not interested in or was not using SBE at the time of response.

Additionally, I acknowledge the potential measurement error, as it was not possible to guarantee who responded to the questionnaires or the accuracy or truthfulness of their answers (Fowler, 2009). The questionnaires were addressed to the most senior person (EOC leads and unit/module leaders in the NHS and HEI surveys respectively); I anticipated that the respondents would be the most appropriate to answer the questionnaire. All responses were reportedly completed by an appropriate grade of staff (Table 5.1) and the responses provided were accurate and indicative of the EOC service or cardio-respiratory physiotherapy unit/modules provided by the HEI. The questionnaires predominantly featured largely prescriptive answers and contained shared professional (physiotherapy, academic and simulation) language, which may have resulted in responses that were constrained by socialised expectations. The format of the questionnaires may have also restricted the detail provided by respondents, potentially reducing the depth.

However, an additional open-ended question was provided at the end of both surveys to allow participants to provide any further comments.

Whilst the postal surveys permitted generalisability to existing practice relating to the use of SBE in 2009-2010, the survey design may have limited the opportunity to explore fully the respondents' perceptions and application of SBE within their organisation. I also acknowledge that the NHS and HEI surveys have primarily focused on simulation equipment and not on environmental or psychological fidelity/realism, as the overarching research and supplementary questions aimed to identify and establish the extent of simulation technology, features and scenario utilisation within EOC training and cardio-respiratory physiotherapy curricula. Psychological fidelity, realism, scenario complexity and debriefing techniques are all areas that warrant further research in physiotherapy, as these were beyond the remit of my RQs 1 and 2 (see Figure 4.1 on page 66). A summary of the methodological strengths and limitations relating to Phase 1 is provided in Box 6.2.

Box 6.2: Summary of the methodological strengths and limitations

Strengths

- Pilot of the questionnaires were undertaken
- Methods utilised to increase response rate were undertaken to reduce the effects of non-response error (bias)
- Attempts to minimise sampling and coverage error were taken by including all NHS trusts and all HEIs providing pre-registration physiotherapy programmes in the UK
- The questionnaires generated data to answer research questions 1 and 2
- Skills development and scenario range data generated from the surveys provided information for integration within the scenario used in Phase 2

Limitations

- The potential for respondent bias and measurement error are acknowledged
- It is not possible to guarantee who responded to the questionnaires or the accuracy of their answers
- The surveys potentially limited the opportunity to fully explore the respondents' perceptions and application of SBE within their organisation

6.4 Implications for educational practice and further research.

The ever increasing evidence from healthcare research indicates that SBE has the potential to enhance educational provision, improve patient care and reduce clinical errors encountered in critical and complex healthcare environments (Gaba, 2004; Wilford and Doyle, 2006; Decker et al., 2008; Donaldson, 2009; Shoemaker et al., 2009), such as those encountered by physiotherapists. Despite the wealth of evidence supporting the use of SBE, reports of innovations and research involving physiotherapy lag behind the medical and nursing professions.

6.4.1 Resources

Owing to the use, reported interest and existing integration of SBE within cardio-respiratory physiotherapy identified in this study, potential collaborative training design and delivery opportunities featuring pooled resources for maximum utilisation across NHS trusts and HEIs may be possible. Rather than investing in further provision, physiotherapy services and HEIs across the UK may be able to seek access to equipment/facilities/experienced staff (or simulation faculty) to support the integration of simulation within physiotherapy training programmes in their region (as outlined in the 'NHS Simulation Provision and Use Study Summary Report', Inventures, 2011). Existing regional simulation education networks may also provide opportunities to share current and develop future simulation resources and scenarios to enhance the sustainability of SBE within cardio-respiratory physiotherapy. Examples of regional collaboration and sharing resources to increase the sustainability of SBE have been reported by one simulation network (NHSNW, 2010; Gough et al., 2013a). However, not all geographical healthcare regions in the UK have established simulation networks (Donaldson, 2009; NHSNW, 2010). In 2014, the CSP released the first guidance on the use and integration of SBE within pre-registration physiotherapy curricula and training of qualified physiotherapists (CSP, 2014a). The impact of this guidance has yet to be established.

6.4.2 Physiotherapy education and practice

Awareness of the availability of and access to simulation facilitator training programmes may also increase utilisation, through the increase in SBE specific knowledge and skills of EOC trainers and physiotherapy educators. The UK surveys highlighted that simulation scenarios are currently being used throughout NHS trusts and HEIs to a varying extent, but there is currently no means of sharing resources. The development of formal/informal simulation networks within the physiotherapy profession (e.g. within the CSP or Association of Simulated Practitioners in Healthcare[7]) may help to promote future collaborative practice/research and sharing/pooling of SBE resources. Further guidance from the CSP is required on the use of SBE within cardio-respiratory physiotherapy curricula integration, in line with other regulatory bodies such as the Nursing and Midwifery Council and General Medical Council (NMC, 2007a, 2007b, 2010; GMC, 2009). The use of SBE to replace physiotherapy practice placement time has not currently been agreed by the CSP for pre-registration programmes in the UK (CSP, 2014a). The evidence base surrounding the current use of SBE within EOC physiotherapy is growing but the transferability of knowledge, skills and behaviours developing during SBE to the practice arena remains relatively unknown. A summary of the implications for education and practice is provided in Table 6.1.

Table 6.1: Implications for physiotherapy education and practice

Research question	Implications for physiotherapy education and practice
1 & 2	a) The establishment of formal/informal networks within physiotherapy may be advantageous to promote future collaborative practice/research and sharing/pooling of SBE resources b) Access to specialist facilitator training is required to promote the appropriate use of SBE and development of resources for EOC training and physiotherapy education c) Existing regional simulation education networks may also provide opportunities to develop and share resources that may help to enhance the sustainability of SBE within cardio-respiratory physiotherapy

[7] The Association of Simulated Practitioners in Healthcare is the national simulation organisation within the UK.

6.4.3 Further research

Further research using qualitative methods such as interviews or focus groups could be undertaken in the future to explore the application and breadth of use of SBE in EOC training and cardio-respiratory education. Potential aspects for further research include cardio-respiratory and EOC paediatric training and the use of other simulation modalities (e.g. computer-based simulation including virtual reality and gaming technology), which respondents referred to in the current surveys. Additionally, future studies may explore how technological advancements, investments in technology-enhanced learning and development of regional simulation networks may have impacted on the use and integration of SBE within physiotherapy education since 2010.

The NHS and HEI surveys highlighted the need for further research to explore the use of SBE within paediatric EOC training and physiotherapy education. Future surveys may be designed to provide insights in the development of scenarios including the level of complexity, simulation fidelity and realism. Additionally, future research may be designed to explore the impact of emerging typologies such as virtual reality and gaming technology. It may also be of interest to explore how technological advancements, uni- and interprofessional simulation-based education research, investments in technology-enhanced learning and development of regional simulation networks may have impacted on the use and integration of SBE within physiotherapy education since 2010.

A further survey specifically targeting simulator features, which would enhance or broaden the usability of simulators for physiotherapy education, may influence the manufacturer's product development and in turn increase the use of SBE within physiotherapy. Additionally, further investigation of simulation-based learning intervention including educational practices, learner and facilitator roles, scenario complexity, simulation design characteristics and instructional design considerations (Jeffries, 2005; Chiniara et al., 2013) is warranted. The current surveys identified the range of scenarios currently in use; further examination of physiotherapy scenario design and delivery is warranted to ascertain the level of realism and depth of learning achieved within the simulated environment. Furthermore, essential components of simulation design (equipment, environmental and psychological fidelity, and debriefing) have also yet to be explored in respect to physiotherapy education.

A summary of the areas requiring further research is provided in Box 6.3. The latter four are addressed by Phase 2 of this thesis, which is presented in the forthcoming Chapters 7-9.

Box 6.3: Areas of further research

- Future surveys, focus groups or interviews may be used to provide insights with regards to:
    - The use of SBE within other specialties of physiotherapy e.g. musculoskeletal, neurology and oncology within primary, secondary and tertiary care settings
    - Essential components of simulation design (equipment, environmental and psychological fidelity, scenario complexity and debriefing practices)
    - The impact of emerging typologies such as virtual reality and gaming technology within physiotherapy education and practice

- Mixed methods studies may be undertaken to determine the impact of integrating SBE in EOC training, and physiotherapy curricula with regards to improving educational outcomes, impact on skill performance, competency, retention and patient safety

- Phase 2 will explore:
    - The extent to which pre-registration physiotherapy students are able to independently manage a deteriorating cardio-respiratory patient in a simulation context (RQ 3)
    - The extent to which pre-registration physiotherapy students are able to independently recognise errors within a simulation context (RQ 4)
    - The perceived influence of prior learning or experience on performance within a simulation scenario (RQ 5)
    - The perceived value attributed by pre-registration physiotherapy students to a cardio-respiratory simulation-based learning experience (RQ 6)

6.5 Conclusion

The two national surveys undertaken in Phase 1 have provided the first, unique insights into how SBE is utilised within respiratory and on-call physiotherapy services and cardio-respiratory physiotherapy programmes in the UK (RQs 1 and 2). These findings highlighted the extent to which simulation technology and scenarios for skills development have been embedded within EOC training and cardio-respiratory physiotherapy education in the UK. National inconsistencies in simulation provision and accessibility were identified in both surveys and similarly reported in the literature.

Chapter 7: Phase 2 Results

7.1 Introduction

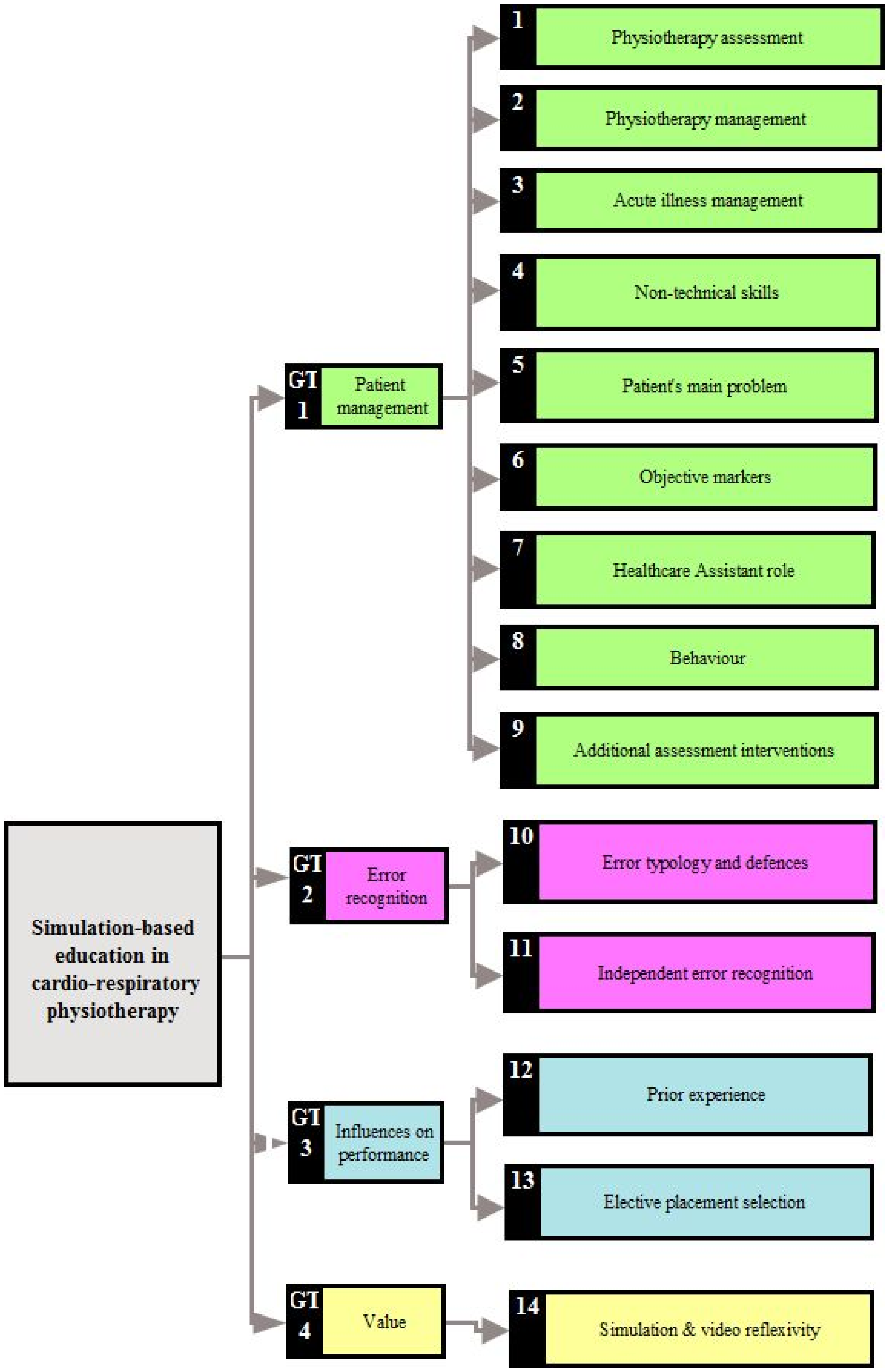
This chapter will present the results for Phase 2, which have addressed RQs 3-6 (as outlined earlier in Figure 4.3, on page 74). The findings are based on 21 students (5 males and 16 females) who participated in both the scenario and VRE interviews. The mean scenario and VRE interview durations were 24 mins (SD = 5) and 57 mins (SD = 10) respectively. The findings are presented in subsections as they relate to the research questions. Figure 7.1 (on page 123) presents an overview of the thematic analysis of the scenario and VRE data. A summary of the research findings is presented followed by the chapter conclusion.

7.2 Research question 3: Independent patient management

There are three foci of analysis, including video analysis of physiotherapy knowledge, behaviours, clinical (technical) skills and non-technical skills, thematic analysis of the VRE interview data and analysis of the METIman scenario physiological data log (generated by the simulator at timed intervals of less than 10 seconds throughout the scenario, Table 7.5 and event log, Table 7.6). Under the global theme of *patient management*, nine organising themes were identified, along with the respective basic themes (see Figure 7.1)

In all 12 scenarios, the participants completed an assessment and provided physiotherapy intervention without the need to pause the scenario or request guidance from a facilitator. Although all of the participants assessed the deteriorating patient in the simulation context, the assessments were basic (predominantly focusing on airway and breathing assessment components) and in the majority of cases lacked structure. During the pre-brief, the participants were not directed as to the type of assessment and management strategies to adopt. Within the cardio-respiratory programme, participants were exposed to two types of patient assessment, a physiotherapy assessment, which included components from the ACPRC (2007) assessment and treatment matrices, and the AIM approach (GMCCSI, 2011).

Figure 7.1: Overview of the thematic analysis for research questions 3-6



Key: Each global theme (GT1-4) is colour coded, with the corresponding organising themes listed in numerical order

In relation to the assessment components outlined in the ACPRC (2007) physiotherapy assessment matrix (Table 7.1, Organising theme 1: Physiotherapy assessment), all participants interpreted the patient's notes/monitors (basic theme 1.1), interpreted auscultation findings (basic theme 1.2), observed the patient's breathing/general status (basic theme 1.3) and collected appropriate information, although this was not always accurate (basic theme 1.4). Fewer participants verbalised their interpretation of the chest x-ray findings (basic theme 1.7), analysed the assessment findings (basic theme 1.8) and verbalised that the patient was deteriorating (basic theme 1.9). However, none of the participants verbalised their selection of an outcome measure (basic theme 1.5) or the interpretation of the patient's arterial blood gases (basic theme 1.6).

Table 7.1: Organising themes 1 and 2 – Physiotherapy assessment and management

Organising theme 1: Physiotherapy Assessment Basic themes	**Frequency of scenarios[a]**
1.1 Interprets records notes/charts/monitors (A1)	12
1.2 Uses a stethoscope to interpret auscultation findings (A4)	12
1.3 Observes patient's breathing and general status to identify significant findings (A6)	12
1.4 Collects accurate and appropriate information (A9)	12
1.5 Selects an appropriate outcome measure (A11)	0
1.6 Interprets arterial blood gases (A12)	0
1.7 Interprets chest x-ray findings of relevance to physiotherapy (A13)	1
1.8 Analyses assessment findings (A14)	4
1.9 Identifies a patient who is deteriorating/becoming critically ill (A15)	7
*Key: [a], excludes repetition. *, a priori themes were identified from the ACPRC (2007) assessment matrix with corresponding assessment matrix code in parenthesis*	

Organising theme 2: Physiotherapy Management Basic themes	**Frequency of scenarios[a]**
2.1 Administered a change in the patient's oxygen therapy*	12
2.2 Percussion* (MX2)	1
2.3 Vibrations* (MX3A)	9
2.4 Humidification* (MX4)	0
2.5 Nebulisers*∞ (MX4)	3
2.6 Postural drainage position (MX5)	0
2.7 Positioning and breathing exercises for the control of breathlessness* (MX6)	0
2.8 Positioning and breathing exercises for the removal of secretions*‡‡ (MX6)	12
2.9 Nasopharyngeal suction* (MX10)	2
2.10 Oropharyngeal suction* (MX11)	7
*Key: [a], excludes repetition; *, a priori themes were identified from the ACPRC (2007) treatment matrix, with corresponding treatment matrix code in parenthesis; †, required participants to undertake the assessment skill correctly and interpret the findings correctly;* ‡‡, vocalised/identified the intention of the intervention within the scenario*; ∞, verbalised but not administered*	

During the scenario, participants provided physiotherapy intervention, which was analysed in accordance with a priori themes from the ACPRC (2007) physiotherapy treatment matrix (Table 7.1, Organising theme 2: Physiotherapy management). All participants administered a change in the patient's oxygen therapy (basic theme 2.1), provided breathing exercises and repositioned the patient to aid the removal of secretions (basic theme 2.8). Fewer participants included vibrations (basic theme 2.3), administered oropharyngeal suction (basic theme 2.10) and to a lesser extent nasopharyngeal suction (basic theme 2.9), discussed the possibility of administering nebulisers (basic theme 2.5) or used percussion skills (basic theme 2.2). None of the participants considered humidification (basic theme 2.4), postural drainage (basic theme 2.6) or positioning and breathing exercises for breathlessness (basic theme 2.7). Some participants verbalised the use of the GMCCSI (2011) Acute Illness Management (ABCDE, airway, breathing, circulation, disability and exposure) approach to assess and manage the simulated patient. The scenarios were analysed in accordance with a priori themes from the GMCCSI (2011) AIM Tool (Table 7.2, Organising theme 3: Acute illness management approach). None of the participants completed a comprehensive assessment of the simulated patient using the AIM approach (as illustrated by the frequency analysis of the individual basic themes 3.1 to 3.11). A median of 4.5 (IQR = 2-5) of the 19 assessment components and mean 4.67 of the 10 relevant management actions (SD = 1.07) were completed.

Table 7.2: Organising theme 3 - Acute Illness Management approach

Organising theme 3: Acute Illness Management Approach Basic themes	**Frequency of scenarios[a]**
3.1 Airway assessment	
3.1.1 Check airway patency*	5
3.1.2 Checks if the patient can speak*	12
3.1.3 Checks for added noises*	3
3.1.4 Checks for see-saw movement*	2
3.2 Breathing assessment	
3.2.1 Observes the rate and pattern*	12
3.2.2 Observes the depth of respiration*	3
3.2.3 Observes symmetry of the chest movement*	2
3.2.4 Observes the colour of the patient*	2
3.2.5 Observes the patient's oxygen saturations*	1
3.3 Circulation assessment	
3.3.1 Observes the patient's manual pulse and blood pressure*	5
3.3.2 Observes the patient's capillary refill time*	0
3.3.3 Observes the patient's urine output/fluid balance*	2
3.3.4 Observes the patient's temperature*	0
3.4 Disability assessment	
3.4.1 Observes the patient's consciousness level using the AVPU tool* *AVPU refers to Alert, Voice, Pain and Unresponsive consciousness levels.*	0
3.4.2 Observes the patient's blood glucose level*	0
3.4.3 Observes the patient's pupil reaction and size*	0
3.4.4 Observes the patient for seizures*	0
3.4.5 Undertakes a pain assessment*	2
3.5 Exposure assessment	
3.5.1 Performs a head-to-toe examination of the patient*	0
3.6 Airway management	
3.6.1 Ensures the patient's airway is patent and maintained*	0
3.6.2 Applies simple airway manoeuvers*	0
3.6.3 Suctions the patient*†	8
3.6.4 Considers airway adjuncts and positioning of the patient*	0
3.6.5 Administers oxygen via a high concentration therapy† during airway component*	3
3.7 Breathing management	
3.7.1 Positions the patient*†	12
3.7.2 Considers physiotherapy and nebulisers*†	12
3.7.3 Considers/uses a bag-valve mask*	0
3.7.4 Administers high concentration oxygen therapy during breathing component*†	5
3.8 Circulation management	
3.8.1 Cannulates/ensures intravenous access patency*†	0
3.8.2 Takes appropriate bloods*†	2
3.8.3 Takes blood cultures*†	0
3.8.4 Administers a fluid bolus and titrates accordingly*	0
3.9 Disability management	
3.9.1 Considers putting the patient into the recovery position* *if appropriate*	0
3.9.2 Considers correcting the patient's blood glucose level* *if appropriate*	0
3.9.3 Considers controlling the patient's seizures* *if appropriate*	0
3.9.4 Considers the patient's pain control* *if appropriate*	0
3.10 Exposure management	
3.10.1 Manages abnormal exposure findings appropriately*†	0
3.11 Calls for help† *at any point during the scenario*	11
*Key: [a], excludes repetition; *, a prioiri themes identified from GMCCSI, (2011) AIM Tool. The AIM tool includes 19 assessment components (4.1 to 4.5) and 19 management components (4.6 to 4.11); †, pertinent intervention within this scenario*	

The thematic video analysis of the participants' non-technical skills (Table 7.3, Organising theme 4) included a priori themes identified from the CSP Behaviours, Values, Knowledge and Skills Framework (CSP, 2003) and the Non-technical Skills for Surgeons observational behavioural rating tool (Yule et al., 2008a), and the frequency of observed NTS are presented. Participants demonstrated variable situational awareness skills (basic theme 4.1: situational awareness). All participants demonstrated an ability to gather appropriate information and an immediate understanding of the situation. To a lesser extent, participants were able to project or anticipate possible future changes in the patient's condition. All participants verbalised their decisions, selected and communicated their options, implemented them appropriately and in eleven scenarios, participants verbally reviewed their decisions (basic theme 4.2: decision making). In the majority of scenarios, participants demonstrated their ability to independently manage tasks, including planning and preparing the environment and equipment, demonstrating an awareness of standards and responding flexibly to changes in the patient's verbalised needs or physiological parameters (basic theme 4.3: task management). Leadership skills varied amongst participants, in particular relating to setting and maintaining standards for moving and handling, and infection control (basic theme 4.4: leadership). In two scenarios, the participants undertaking the role of the physiotherapist demonstrated a supportive attitude towards the healthcare assistant during the assessment or intervention. Communication and teamwork skills (basic theme 4.5: communication and teamwork) also varied across the scenarios. Participants exchanged clinical information to co-ordinate activities and communicated requirements. To a lesser extent, participants communicated to ensure a shared understanding of the patient's evolving clinical status was reached. An additional basic theme (4.5.5) was identified relating to teamwork and communication, which referred to the use of a standardised communication tool when communicating with other members of the multi-disciplinary team.

Table 7.3: Organising theme 4 – Non-technical skills

Organising theme 4: Non-technical skills Basic themes	**Frequency of scenarios[a]**
4.1 Situational awareness	
4.1.1 Gathering information*† *Uses the patient's medical records, charts, x-ray to ascertain the pertinent information*	12
4.1.2 Understanding information*† *Verbalises awareness of the situation and evolving physiological status of the patient*	12
4.1.3 Projection*† *Demonstrates an awareness of possible future states (e.g. changes in the physiological states of the patient)*	5
4.1.4 Anticipating future states*† *Anticipates possible future states e.g. changes in the physiological states of the patient*	3
4.2 Decision making	
4.2.1 Considers options*† *Verbalises assessment/interventions/management options relevant to the patient or situation*	12
4.2.2 Selects and communicates options*† *Selects and communicates options relevant to the patient or situation*	12
4.2.3 Implements decisions*† *Implements decisions appropriately*	12
4.2.4 Reviews decisions*† *Reviews decisions following implementation of intervention or during the handover*	11
4.3 Task management	
4.3.1 Planning and preparing*† *Appropriately prepares the environment before implementing intervention*	11
4.3.2 Responds to change*† *Adopts a flexible approach to assessment of the patient, responding to changes in the patient's needs*	7
4.4 Leadership	
4.4.1 Setting standards*† *Demonstrates an awareness of moving and handling/infection control procedure*	11
4.4.2 Maintaining standards*† *Adheres to moving and handling policy standards. Adheres to infection control policy in relation to the management of the patient. Raises the awareness of the need for infection control equipment*	7
4.4.3 Supporting others*† *Demonstrates supportive attitude towards others in their role/duties/actions relating to the assessment/treatment intervention*	2
4.4.4 Coping with pressure* *Demonstrates the ability to cope with pressure*	11
4.5 Communication and teamwork	
4.5.1 Exchanges information*† *Demonstrates the ability to exchange verbal/written information with others*	12
4.5.2 Establishing a shared understanding*† *Demonstrates the ability to communicate information to ensure a shared understanding amongst members of the team (e.g. present or via telephone conversation) regarding the patient's current/evolving status*	7
4.2.3 Co-ordinating team activities*† *Demonstrates the ability to coordinate team activities (e.g. undertaking the lead role in moving and handling, repositioning the patient, suction)*	10
4.2.4 Communicates requirements† *Demonstrates an ability to communicate requirements (e.g. requesting further assistance from other members of the multi-disciplinary team)*	10
4.2.5 Use of a standardised communication tool *Uses a standardised communication tool when communicating with other members of the multi-disciplinary team (e.g. SBAR Situation, background, assessment and recommendation, NHSIHI, 2006).*	2
Key: [a], excludes repetition in same scenario; *, a *priori subthemes from the Non-technical Skills for Surgeons (NOTSS) behaviour rating tool (Yule et al., 2006) and †, CSP Behaviours, Values, Knowledge and Skills Framework (CSP, 2013)*	

During the VRE interviews, participants discussed what they considered Levi Williams' main problem. The organising theme 5: Patient's main problem is presented in Table 7.4 along with illustrative quotations for basic themes 5.1 to 5.3. In three VRE interviews, the participants provided a working diagnosis; two diagnosed that the patient had aspirated (basic theme 5.1, quote 1) and the other that the patient had consolidation in his left lower lobe. Other participants undertaking the role of the physiotherapist did not verbally identify a working diagnosis. Participants discussed the identification of abnormal clinical features (basic theme 5.2, quote 2) including interpreting added sounds on auscultation and identifying breathing abnormalities, retained secretions, an altered level of consciousness and location of abnormal breath sounds. However, there were discrepancies regarding the interpretation and location of abnormal breath sounds. The explanations provided by the responding participants undertaking the role of the physiotherapist also highlighted inconsistencies in terminology. Both 'crepitations' and 'crackles' were used to describe the abnormal breath sounds. Participants discussed timing (basic theme 5.3, quote 3) in relation to the recognition of the rate of deterioration and the impact of their interventions. One participant highlighted that the timing of the deterioration in the patient's oxygen saturations was used to prioritise future intervention.

Participants undertaking the role of the physiotherapist were asked to identify the objective markers they used to determine the patient's main problem (Table 7.4, Organising theme 6: Objective markers). Five basic themes were identified: oxygen saturations, auscultation, vital signs, communication and interpretation (basic themes 6.1-6.5 respectively). Participants of 10 scenarios reported that the patient's oxygen saturation was primarily used as an objective marker to identify the patient's main problem. Participants recalled changes in oxygen saturations from either baseline or peak deterioration and the increase following their intervention (basic theme 6.1, quote 4).

Table 7.4: Thematic analysis – Organising themes 5-8: Patient's problems, main objective marker, HCA role and behaviour

ORGANISING THEME 5 – THE PATIENT'S PROBLEMS	
Basic theme	**Example quotations**
5.1 Diagnosis	1) Just from looking at the history of Mr Williams, he had aspirated the night before when he had a drink and been having breathing problems since then. (FP4)
5.2 Identification of abnormal clinical features	2) I felt Levi's main problem was breathing, so his depth of breathing and bilateral expansion wasn't quite equal and his saturations were very low, especially for a patient who doesn't have COPD. (MP1)
5.3 Timing	3) The fact that his sats [referring to the patient's oxygen saturations] dropped pretty much as soon as I got in the room quite low. I had to sort that out first. It became the main priority. (FP8)
ORGANISING THEME 6 – MAIN OBJECTIVE MARKER	
Basic theme	**Example quotations**
6.1 Oxygen saturations	4) My main outcome was saturation of oxygen; it was pre-treatment 88 and after clearing his throat and trying to help clear his left base increased to 97/98. (MP3)
6.2 Auscultation	5) I listened to his chest, auscultation, I asked him to try active cycle of breathing technique and he wasn't able to cough any secretions up. His sats were dropping and they came to 80% at one point. When his position changed, his sats [referring to oxygen saturations] improved. On suctioning, some secretions were suctioned up. Oh and I changed his oxygen mask to a higher percentage. (FP9)
6.3 Supplementary objective markers	6) The main one was his oxygen saturations, which were down to 85%, when I auscultated. I used percussion notes and I had felt the expansion of his chest. (MP1)
6.4 Combining subjective and objective markers	7) Well, saturations and auscultation and feedback from him as well. Oh and looking at his notes and checking with the HCA. (FP8)
6.5 Interpretation	8) With the auscultation, he had reduced breath sounds on the right side, it was a little quieter and I think I must have chosen the wrong side for positioning. That wouldn't have helped him with that. (FP6)
ORGANISING THEME 7 – HEALTHCARE ASSISTANT ROLE	
Basic theme	**Example quotations**
7.1 Assist/support the physiotherapist	9) I think yeah, it was to support, to assist with manual handling at the same time and to offer support. (FHCA5)
7.2 Unsure	10) It felt very difficult not saying anything because I was thinking 'you could do this and this'. Or this is in my head and I was like 'oh no' I can't say anything so it was quite hard to just sit back and let [anonymised name] do it really. So I was a bit unsure of what my role was really from the little list of what I could and couldn't say**.** I found it difficult having the knowledge I do, it's difficult to sit back really. (FHCA1)

ORGANISING THEME 8 – BEHAVIOUR		
Basic theme	**Example quotations**	
8.1 Professionalism	11)	I feel like I am really loud and might be a bit condescending to be so loud, like the patient is deaf. Yeah, because I always listen to my voice and I am thinking why was I so loud, he can hear me…it's something that subconsciously I have started doing when I talk to patients and it's something that I need to tone down. (FP7)
8.2 Situational awareness	12)	So I went to listen to his chest, noticed the monitor going off, it was the sats [referring to oxygen saturations] dropping but I think they just dropped to 89/88, something like that so I was hoping it was a bit of a drop and he would pick up on his own. But, as I started auscultating the saturations continued to drop so I stopped auscultating, increased his oxygen because my main concern was to keep his sats up. Whereas if they dropped too low, things could start deteriorating more quickly, so if we get his sats up to a reasonable level and they stay there we could continue with the assessment and find out a little bit more about it. That's when I called [referring to the healthcare assistant] over to help me just reposition him and see if it was just a matter of positioning that his sats were dropping. And then, I think as we go on I finally reposition him and he doesn't pick up quick enough for my liking, so we upped the oxygen. (FP1)
8.3 Interruptions	13)	That was me jumping in then, there when I should have stepped back. Sorry. I am vocal too, so it was a bit of a clash because I should have just let you finish talking but you know how it is. It's hard we are both, both thinking the same thing. (FHCA)
8.4 Knowledge and skill deficit	14)	I wasn't sure whether to use the non-rebreathe mask or the 60% venturi mask. I was like ask the healthcare assistant…That's why I hesitated, because I was unsure what to do. Brain freeze there. (FP6)
8.5 Clinical reasoning	15)	So I also wanted to get him more of a high sitting position because in that slumped position he would be able to breathe more effectively, so to increase his V/Q [referring to ventilation perfusion] matching. I tried to use the sliding sheet to do that. (FP2)
8.6 Error identification	16)	At this point I didn't have gloves or an apron on, I should have. I still hadn't introduced myself after 50 seconds. Throughout all the assessment, I was being quite slow to get the gloves on and should have been quicker. (MP3)
ORGANISING THEME 9 – ADDITIONAL ASSESSMENT/INTERVENTION		
Basic theme	**Example quotations**	
9.1 Assessment components	17)	…if I had carried on I would have carried on through to the stages D and E [referring to disability and exposure] of the 'ABCDE', of the AIM course. But I don't think he had any real problems there, I think he just needed to really clear his chest. (MP1)
9.2 Structured approach	18)	Yeah, I could tell he was following the AIM (approach) but when he missed out the auscultation prior to moving him, I wanted to say maybe you should auscultate before you move him because maybe we could move him into a better position. After that, I think he followed the structure through the AIM [approach] really well. (FHCA1)
9.3 Same interventions	19)	I think I would do the same, but maybe in a more methodical manner. Maybe taken a bit more time to think things through before doing them. (FP6)
9.4 Chest physiotherapy	20)	…using other techniques like vibs [referring to vibrations], shakes, and stuff. Just to try and get the secretions up…Yeah maybe I would have tried that, but he may not have been able to tolerate it at all. (FHCA6)
9.5 Positioning	21)	If he was feeling better, I would like to try maybe sit him upright over the side of the bed, because being upright and also mobilising helps with mobilising secretions. And it's easier to get them to cough it up. (FP3)
9.6 Moving and handling	22)	…moving and handling as well I probably could have done that a bit better but things like the slide sheet were a bit difficult; I've not really done that before. I would have probably tried to do that a bit better as well. Things like lowering the bed and things, maybe sitting it up a bit more to make it easier to position him. (FP2)
9.7 Verification	23)	I still wasn't quite sure about changing his oxygen stuff, so we should have probably called a senior maybe and got a bit more advice from someone else. Just to make sure I was right or make sure it would make him better. (FP8)
9.8 Timing of interventions	24)	I think I would have probably paid more attention to the alarm going off to begin with and maybe sped up trying to get that oxygen on and change his position sooner. (MP2)

Participants in nine scenarios reportedly used auscultation as the main objective marker (basic theme 6.2, quote 5). Six participants indicated that they used both oxygen saturations and auscultation to identify his main problem. All nine participants discussed the use of supplementary objective markers used included respiratory rate, heart rate, blood pressure, urine output, work of breathing, breathing pattern, percussion note and the patient's chest x-ray (basic theme 6.3, quote 6). Additionally, three participants reported combining subjective and objective examination findings (basic theme 6.4, quote 7) to identify the patient's main problem. Participants also reflected on the interpretation of the outcome measures used during their assessment (basic theme 6.5, quote 8).

All participants were asked to consider the role of the HCA within the scenario (Table 7.4, Organising theme 7: Healthcare assistant role). Two basic themes were identified: to assist/support the physiotherapist and communication (basic themes 7.1 and 7.2 respectively). Predominantly comments related to either assisting or supporting the physiotherapist during moving and handling situations, and bringing/helping with equipment (basic theme 4.1, quote 9). HCAs also reported feeling part of their role included communicating/providing updates on the patient's vital signs to their physiotherapist. Whilst others felt that it was appropriate to offer treatment suggestions, some felt that in the HCA role, they should not interrupt or undermine their physiotherapist (basic theme 4.2, quote 10). During all 12 simulation scenarios, the physiotherapists actively involved their respective HCAs within the assessment of the patient.

Typical requests for help from the HCA included assistance with the assessment components, repositioning the patient, setting up the suction equipment, seeking telephone help from the doctor or nurse on behalf of the physiotherapist and providing a handover to the doctor or nurse on behalf of the physiotherapist. Only three requests for a prescription to increase the oxygen therapy were made. During two scenarios, the participants undertaking the role of the physiotherapist telephoned the doctor or nurse to discuss and request a prescription for an increase in oxygen therapy. The other request was made during the handover at the end of the scenario. During two of the scenarios, requests were made by the physiotherapist to assist with repositioning the patient, as they verbalised that they had a lack of experience of repositioning a patient on a manual bed. Still image 7.1 is a screenshot from the VRE interview, when the participants discussed the role of the physio and the realism of the scenario.

Still image 7.1: Role of the HCA and immersion in the scenario

The following excerpt is from the discussion at the time of Still image 7.1, in which the participants discussed their respective actions, interactions and reactions during the scenario:

> *FP7: …That was very assistant-like. No that was very forward thinking, that shows you're no longer thinking about the simulation but you are thinking about the situation as if with a real patient. Which, I had problems with doing at some points.*
> *FHCA5: Yeah, I think it was because it's a case of we know where we were going with it and the fact that we were communicating. I was thinking what would I need?*
> *FP7: No that was forward thinking…it shows that you're thinking ahead rather than just thinking it's like driving, you have to anticipate what's going to happen before it can happen.*
> *FHCA5: But then it makes you think if you were a healthcare assistant, would a healthcare assistant automatically go to do that or would they have to be told by you?*
> *FP7: It depends though if the healthcare assistant has worked with physios before, which is most likely true if they are working on a ward…That was another instance when you said I thought that at the same time…it's good to know that we are thinking the same thing because it gives me confidence anyway, that I wasn't doing anything that you wouldn't have done.*

The participants (FP7 and PHCA5) later reflected on their experiences during the scenario and how they operated as an effective team in managing the deteriorating patient in the simulation context. They concluded that being on placement together possibly influenced how they approached the situation and their communication and teamwork skills.

The extent to which participants were able to provide effective physiotherapy intervention varied between the 12 scenarios. Table 7.5 presents the individual deviances of physiological parameters from baseline, peak decline, peak increase and at the end of the scenario. The data for Tables 7.5 and 7.6 were generated from the METIman scenario physiological data log (generated by the simulator at timed intervals of less than 10 seconds throughout the scenario, Table 7.5) and METIman scenario event logs (linked to transition of pre-programmed scenario states, Appendix 15, recorded by the simulator software, Table 7.6). During 11 scenarios, the simulated patient's physiological status improved from baseline parameters[8]. An observed increase in respiration rate, oxygen saturations, heart rate and blood pressure was observed in all 12 scenarios (mean, 19.4, SD ±4.5, and range 10-25 minutes). Whilst 67% (8/12) of participant groups correctly repositioned the patient into left side lying, only 42 % (5/12) participants administered the optimal interventions (repositioning the patient from supine lying to left side lying, administering manual chest physiotherapy techniques with active cycle of breathing exercises and suctioning or encouraging an effective cough to clear the secretions). During these five scenarios, the patient's physiological status reached the optimal parameters by the end of the scenario (mean 23.6, SD± 4.9, range 17-32 minutes). The time to administer an increase in oxygen therapy also varied (mean, 9.4 minutes, SD ±3.3, and range 1-11).

The optimal increase in oxygen therapy to a high concentration face mask with reservoir bag was administered by 58% (7/12) of the participant groups. However, only two participant groups (17%) provided the most effective treatment possible (optimal increase in oxygen therapy using a high concentration facemask and optimal physiotherapy intervention[†], see Table 7.6, anonymised groups MP2 and

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[8] Baseline physiological parameters: Respiratory Rate: 29; Oxygen Saturation: 92% on 40% oxygen via a venturi facemask; Heart Rate: 93; Blood Pressure: 115/92. Optimal parameters established by the METIman (physiologically driven) programming software: Respiratory Rate: 11; Oxygen Saturation: 99% on high concentration oxygen facemask; Heart Rate: 71; Blood Pressure: 116/77.

FP6). All participant groups correctly increased the patient's oxygen therapy; however, only two participants undertaking the role of the physiotherapist requested to do so prior to administration, via the telephone (one to a doctor and the other to a nurse). In 92% (11/12) of the participant groups, the optimal physiological parameters were recorded at the end of the scenario. In one participant group, the optimal physiological parameters were recorded during the interim period of the scenario, then the patient deteriorated further due to selection and administration of sub-optimal and ineffective physiotherapy intervention. In 58% (7/12) of the participant groups, the patient's oxygen saturations failed to reach over 90%, during which the patient remained in either the upright position or had just been transitioned to left side lying for the first time (the target saturation was 94–97%).

Table 7.5: Physiological parameters from baseline, peak decline, peak increase and at the end of the scenario

Physiological parameter		Anonymised Group												
		MP1	**FP2**	**FP2**	**FP3**	**FP4**	**MP2**	**FP5**	**MP3**	**FP6**	**FP7**	**FP8**	**FP9**	**Mean (SD)**
Peak deterioration	Time elapsed	3	3	19	5	4	4	15	11	8	4	13	9	**8.2 (5.3)**
	Respiratory Rate	26	27	27	27	26	26	26	27	27	27	25	27	**26.5 (0.7)**
	SaO_2	83	80	81	81	83	83	84	80	83	80	84	80	**81.8 (1.6)**
	Heart Rate	92	92	92	94	92	92	92	94	92	94	92	94	**92.7 (16)**
	Blood Pressure	114/81	116/83	116/83	114/82	115/80	116/83	113/80	113/80	115/83	115/80	113/80	115/83	**N/A**
Peak increase	Time elapsed	19	17	21	19	10	17	18	27	25	20	16	24	**19.4 (4.5)**
	Respiratory Rate	23	9	23	24	24	9	24	9	9	24	24	8	**17.5 (7.7)**
	SaO_2	89	99	89	89	88	99	88	99	99	89	88	99	**92.9 (5.4)**
	Heart Rate	89	70	89	89	89	71	89	71	71	89	89	71	**81.4 (9.4)**
	Blood Pressure	114/80	117/77	115/81	116/81	116/82	116/77	116/80	117/77	118/78	116/82	116/82	118/78	**N/A**
End of scenario	Time elapsed	23	18	21	23	25	17	18	28	28	32	21	29	**23.6 (4.9)**
	Respiratory Rate	23	11	23	24	26	10	24	9	9	23	24	10	**18 (7.3)**
	SaO_2	89	99	89	89	85	99	88	99	99	89	88	99	**92.7 (5.7)**
	Heart Rate	89	70	89	89	92	71	89	71	71	89	89	71	**80.7 (9.5)**
	Blood Pressure	114/80	116/77	115/81	116/81	116/82	116/77	116/80	117/77	117/77	116/82	116/82	116/77	**N/A**
Period of optimal physiological parameters recorded: Start, Interim, End		**End**	**End**	**End**	**End**	**Interim**	**End**	**End**	**End**	**End**	**End**	**End**	**End**	

NB: Baseline Physiological Parameters: Respiratory Rate: 29; Oxygen Saturation: 92% on 40% oxygen via a venturi facemask; Heart Rate: 93; Blood Pressure: 115/92.
Key: Time elapsed (in minutes); Physiological parameter units: Respiratory Rate: breaths per minute; Heart Rate: beats per minute; Oxygen Saturation: percentage; Blood Pressure: systolic/diastolic; Scenario time: minutes; SaO_2*: Oxygen Saturations; (SD): Standard Deviation.*

Table 7.6: Variability in selected physiotherapy intervention and order

Anonymised Group	Increased oxygen therapy administration *(Time to administer in minutes, in parenthesis)*	Order of selected physiotherapy intervention *(respective METIman pre-hospital programmed state name presented below)*
MP1	High concentration oxygen mask † (3)	1) Baseline assessment 2) Upright position 3) Upright and ABCT 4) Upright position, manual chest physiotherapy including ACBT and cough
FP1	60% venturi face mask † (3)	1) Baseline assessment 2) Left side lying 3) Left side lying and manual physiotherapy techniques 4) Left side lying, manual chest physiotherapy techniques and suction 5) Left side lying, manual chest physiotherapy techniques, ACBT and cough*
FP2	High concentration oxygen mask (2)	1) Baseline assessment 2) Upright position, 3) Upright position and ABCT 4) Upright and suction 5) Right side lying, manual chest physiotherapy 6) Upright position and manual chest physiotherapy
FP3	High concentration oxygen mask (6)	1) Baseline assessment 2) Upright sitting 3) Upright sitting and suction 4) Upright sitting, manual chest physiotherapy techniques, ACBT and cough
FP4	60% venturi face mask (4)	1) Baseline assessment 2) Upright position 3) Upright position and ABCT 4) Upright and manual chest physiotherapy 5) Upright position and suction
MP2	High concentration oxygen mask † (4)	1) Baseline assessment 2) Left side lying 3) Left side lying and ACBT 4) Left side lying, manual chest physiotherapy techniques, ACBT and suction*
FP5	60% venturi face mask (1)	1) Baseline assessment 2) Upright position 3) Right side lying 4) Upright position 5) Left side lying 6) Left side lying and ACBT
MP3	60% venturi face mask (11)	1) Baseline assessment 2) Upright position and ACBT 3) Left side lying and ACBT 4) Left side lying and manual chest physiotherapy 5) Left side lying, manual chest physiotherapy techniques, ACBT and suction*
FP6	High concentration oxygen mask (3)	1) Baseline assessment 2) Upright position 3) Right side lying 4) Upright position 5) Right side lying 6) Right side lying and ACBT 7) Upright and ACBT 8) Left side lying and ACBT 9) Left side lying, manual chest physiotherapy techniques, ACBT and suction*
FP7	High concentration oxygen mask (5)	1) Baseline assessment 2) Upright position 3) Upright and ACBT 4) Left side lying and manual chest physiotherapy techniques
FP8	60% venturi face mask (8)	1) Baseline assessment 2) Upright position 3) Upright position and ABCT 4) Left side lying and ACBT
FP9	High concentration oxygen mask (11)	1) Baseline assessment 2) Upright position and manual chest physiotherapy techniques 3) Upright position and manual chest physiotherapy techniques, ACBT and suction 4) Left side lying, manual chest physiotherapy techniques, ACBT and suction*
Time to administer an increase in oxygen therapy (from the start of the scenario): Mean 9.4 minutes Standard Deviation: ± 3.3 minutes Range: 1-11 minutes		

*Key: ACBT: Active Cycle of Breathing Technique; Oxygen therapy prescription sought † during the scenario. Optimal intervention: * (Left side lying, manual chest physiotherapy techniques, ACBT and suction/cough).*

During the VRE interview, participants independently reviewed their unedited simulation video and reflexively discussed their behaviour. The thematic analysis is presented in Table 7.4, Organising theme 8: Behaviour (page 133). Six basic themes were identified including professionalism, situational awareness, communication, knowledge and skill deficit, clinical reasoning and error identification (basic themes 8.1-8.6 respectively). Participants discussed their professional behaviour and future modifications (basic theme 8.1, quote 11). Fluctuations in the simulated patient's physiological status and how this affected the situational awareness, clinical reasoning and choice of interventions were also discussed (basic theme 8.2, quote 12). The impact of their interruptions on the interactions with each other and the patient was also discussed by participants (basic theme 8.3, quote 13). Knowledge and skill deficits related to respiratory physiotherapy and oxygen therapy intervention (basic theme 8.4, quotes 14). Participants reviewed their ability to clinically reason their actions (basic theme 8.5, quote 15) and identify errors during the scenario (basic theme 8.6, quotes 16).

Still image 7.2 is a screenshot of a discussion during the VRE interview, whereby the participants reviewed their behaviour including their clinical reasoning, communication skills and situational awareness of the evolving physiological signs that indicated the patient was deteriorating.

Still image 7.2: Behaviour

Later the participants discussed how their actions may have changed if the HCA had verbalised her actions and thoughts at the specific point during the scenario as indicated in Still image 7.2:

> *FHCA5: I think the reason that I moved down the bed was because there wasn't anything for me to assist* [name of the physio] *with at that time. And the reason I was looking at the urine output is because I wasn't sure, obviously we were focusing on the chest side of it but I was thinking AIMs* [referring to the AIM approach] *as well. So I decided, so I thought maybe that fact that the saturations had dropped and his temperature was high, there was something going on?*
> *FP7: …it would have been nice if you had told me that, exactly what you have just told me now in there* [referring to during the scenario].
> *HCA5: Because what I said was not useful?*
> *FP7: No, its fine…I didn't know what to do at that moment so I wasn't ignoring you. …I just didn't know what to do at that point. You could have taken the initiative there. You should have.*

Other participants also discussed possible assessment/interventions they may have undertaken, if they had more time to treat the patient within the simulation context. Thematic analysis is presented in Table 7.4, Organising theme 9: Additional assessment/intervention (see page 133). Six basic themes were identified: assessment components, same interventions, chest physiotherapy, positioning and timing of interventions (basic themes 9.1-9.5 respectively). Participants discussed a range of additional assessment components (basic theme 9.1, quote 17), including chest expansion, assessment of the patient's cough effort and positioning the patient in sitting to auscultate the posterior aspect of the lungs. Additionally, participants considered circulation, disability and exposure elements of the AIM approach (GMCCSI, 2011), which they omitted during their scenario. Other assessment approaches included a neurological assessment (considering the patient had an underlying diagnosis of multiple sclerosis) and a musculoskeletal assessment, which included the assessment of upper and lower limb strength and gross motor function. Participants also considered reviewing the patient with a doctor and completing the assessment in a more concise and structured order. Participants reflected that on review of the video they would change their actions to adopt a more structured approach to their assessment (basic theme 9.2, quote 18), if given the opportunity to repeat the scenario or in their future practice.

Furthermore, on reviewing their video, they reflected that they felt they should have used the AIM or Airway, Breathing, Circulation, Disability and Exposure (ABCDE) approach earlier in the scenario. Some participants reported they would follow roughly the same process (basic theme 9.3, quote 19) if they were to repeat the scenario again. Others reflected on the possible provision of other physiotherapy interventions including alternative chest physiotherapy (basic theme 9.4, quote 20) involving alternative breathing exercises, use of a positive pressure breathing device and the addition of nebulisers prior to treatment. Alternative positions were suggested including sitting and lying. Participants clinically reasoned the need to change the patient's position to improve respiratory function (basic theme 9.5, quote 21). Moving and handling (basic theme 9.6, quote 22) improvements related to repositioning with the assistance of three people, due to the weight of the patient (manikin). Another participant reported a lack of experience of using a slide sheet. Reflections regarding the need to verify some actions (basic theme 9.7, quote 23) with the HCA in the room and with the doctor over the telephone were discussed. Additionally, the lack of improvement in oxygen saturations was discussed in relation to raising this with the doctor. Participants specifically reflected on the need to verify their clinical decisions with a senior colleague or doctor, especially concerning oxygen therapy. Discussions also related to the impact of the timing of their intervention and overall duration with the patient (basic theme 9.8, quote 24). In addition, participants discussed how their interactions influenced the changes in the patient's physiological parameters and overall clinical status.

Overall achievement of the learning objectives relating to the assessment and management of the deteriorating patient, adherence to safe working practices and provision of a verbal handover varied within the 30-minute scenario (Table 7.7).

Table 7.7: Achievement of the scenario learning objectives

Learning objective*	Frequency of scenarios[a]
1. Demonstrate an appropriate respiratory assessment for an acutely deteriorating medical patient	
• **Undertake a physiotherapy respiratory subjective assessment**	12
• **Undertake a physiotherapy respiratory objective assessment including:**	12
o Respiratory rate	12
o Rhythm	12
o Depth of respirations	3
o Heart rate	5
o Blood pressure	5
o Capillary refill time	0
o Urine output	2
o Head to toe examination	0
• **Interpret and respond to trends in vital signs in the acutely deteriorating patient**	12
o Identifies normal and abnormal values (with/without assistance)	12
o Interprets findings	0
o Documents findings	0
• **Interpret and respond to trends in laboratory values**	1
• **Interpret and respond to chest radiography**	1
o Interpret the chest radiograph	0
o Correctly interpret the chest radiograph	
2. Implement appropriate physiotherapy intervention	
• **Identify problems relating to the deteriorating patient**	12
• **Devise/implement a plan of care for the deteriorating patient**	12
• **Deliver appropriate physiotherapy intervention based on the physiotherapy assessment**	12
• **Interpret the physiotherapy reassessment findings in order to identify whether the patient's condition is responding to intervention**	12
3. Adhere to safe working practices	
• **Health and safety**	11
• **Moving and handling (using a slide sheet to reposition the patient)**	5
• **Infection control**	9
4. Recognise universal precautions/unsafe practice and take appropriate action	1
5. Provide a structured handover	
• **Deliver a handover**	10
• **Use a structured approach**	1

*Key: [a]: excludes repetition.; *: The five scenario learning objectives were stated in Box 4.1 and the related behaviours indicated in the scenario facilitator information within the assessment, intervention and handover presented in Appendix 15*

7.3 Research question 4: Independent error recognition

There are two foci of analysis for RQ4. Under the global theme of *error recognition*, two organising themes were identified. The video analysis of the simulation scenarios, identifying error types and defences utilised by participants to mitigate errors, is presented in Table 7.8, Organising theme 10: Error typology and defences. Thematic analysis of the participants' abilities to recognise errors is also presented in Table 7.9, Organising theme 11: Independent error recognition.

Video analysis identified 107 errors during the scenario (Table 7.8, Organising theme 10). The participants independently identified 28 of the 107 errors, two during the scenario and the remaining 26 during the unedited review of their scenario during the VRE interview. Thus, 79 errors were unrecognised by the participants either in-action (during the scenario) or on-action (when reviewing their video). The unrecognised errors related to key physiotherapy skills (poor auscultation skills, suction skills, failure to recognise abnormal assessment findings, failure to seek/obtain a prescription for the change in oxygen therapy prior to administration, errors in the delivery of physiotherapy intervention and a communication error). Errors and defences were analysed according to a priori themes identified from Reason (1997) and Henneman et al. (2009), as presented in basic themes 10.1-10.8. The presence of multiple oxygen therapy policies were identified in all 12 scenarios (basic theme 10.1). Fifty-three active errors were identified and related to rule-based errors (basic theme 10.2), verification errors (basic theme 10.3) and monitoring errors (basic theme 10.4). The highest number of active errors were identified as intervention errors (basic theme 10.5). Forty-two error-producing factors were identified (basic theme 10.6), relating to the environment (handwashing provisions) and lack of an individual's knowledge and skills.

Table 7.8: Organising theme 7 - Error typology and defences

Organising theme 10: Error typology and defences Basic themes	**Frequency of scenarios[a]**
10.1 Latent errors* 10.1.1 Organisational processes – multiple oxygen therapy policies present	 12
10.2 Rule based errors* 10.2.1 Communication error with the patient/HCA/Physio† 10.2.2 Communication error† *incomplete/incorrect readback error*	 2 4
10.3 Verification errors* 10.3.1 Fails identification of the patient† 10.3.2 Fails to verify infection control status†	 3 1
10.4 Monitoring errors* 10.4.1 Partially completes a respiratory assessment† 10.4.2 Failure to recognise abnormal assessment findings†	 11 5
10.5 Intervention errors* 10.5.1 Incorrect/ineffective repositioning of the patient† 10.5.2 Incorrectly implements oxygen therapy† 10.5.3 Fails to seek/obtain oxygen therapy prescription† 10.5.4 Error in the selection/delivery of chest physiotherapy treatment† 10.5.5 Moving and handling violation† *Failure to adhere to moving and handling protocol* 10.5.6 Infection control violation† *Failure to adhere to infection control protocol*	 7 1 9 1 7 3
10.6 Error producing factors* 10.6.1 Environmental – lack of handwashing provisions† 10.6.2 Knowledge-based error† *Individual's lack of knowledge* 10.6.3 Skill-based error† *Individual's lack of skill* 10.6.4 Patient complexity† *Complex/communication difficulties*	 12 10 20 0
10.7 Error recovery† 10.7 1 Error identified by a participant 10.7.2 Error corrected by a participant 10.7.3 Error uncorrected by a participant	 2 1 105
10.8 Defences erected to mitigate errors* 10.8.1 Effective communication *between the patient/healthcare assistant/physiotherapist* 10.8.2 Effective communication/complete/correct feedback 10.8.3 Correct identification of the patient 10.8.4 Verifies the infection control status 10.8.4 Comprehensively completes a respiratory assessment 10.8.5 Recognises abnormal findings 10.8.6 Correctly repositions the patient 10.8.7 Correctly implements oxygen therapy 10.8.9 Seeks/obtains oxygen therapy prescription 10.8.10 Selects and delivers appropriate chest physiotherapy treatment 10.8.11 Adheres to moving and handling protocol 10.8.12 Adheres to infection control protocols 10.8.13 Structured handover	 8 4 2 5 1 8 7 12 3 11 1 5 10
Key: [a], excludes repetition in same scenario. *, *a priori error typology themes from Reason (1997); † active failure a priori subthemes from Henneman et al. (2009); MRSA, Methicillin-resistant staphylococcus aureus; SBAR, Situation, Background, Assessment, Recommendations (NHSIHI, 2006)*	

Thematic analysis of the VRE interview identified six basic themes (Table 7.9, Organising theme 11: Independent error identification). The basic themes were identified including no errors, assessment, communication, infection control, manual handling and intervention. Whilst some participants felt that no clinical errors were made during their scenario (basic theme 11.1, quote 25), the general feeling was that the assessments were not comprehensive and lacked structure.

Table 7.9: Thematic analysis – Organising theme 11: Independent error identification

ORGANISING THEME 11 – INDEPENDENT ERROR IDENTIFICATION		
Basic theme	**Example quotations**	
11.1 No errors	25)	I don't think I did anything majorly wrong. Like I said the main thing I would have probably, would have left him on his other side. If I did do anything wrong I don't think it was anything that would have put him any major danger or risk. But as far as I can tell I didn't do anything that I didn't clinically reason to be safe and in the patient's best interest. (FP1)
11.2 Assessment	26)	I wasn't too sure what I was hearing with the crackles…So if I did it again I would probably try to clinically reason it a bit better so that I wouldn't make errors like that. (FP2)
11.3 Verbal communication	27)	I think I would have hopefully done better with the telephone conversation to the nurse to explain what I had done and how Levi was. (FP6)
11.4 Infection control	28)	Also just things like putting my gloves and aprons on and just simple things like that I forgot to do which maybe I wouldn't have forgotten to do in a real hospital setting. I would have done that automatically… although that is quite real, it is real patients and I just think about it more when I am in that setting. It just seems to come more naturally to me to do those things. Because it's a real person they might have real infections, I think it makes you more aware to it. (FP2)
11.5 Manual handling	29)	I think at one point I did lose control of his head when lifting him up. I would ensure that didn't happen but I did ensure that didn't happen afterwards. (MP1)
11.6 Intervention	30)	When she rolled on the right hand side I kind of mumbled good lung down hoping that she would go towards me. And I grumbled when she rolled towards me, try towards me. But yeah, I think that was one of the errors. (FHCA3)

Participants felt that interpretation errors were made, particularly in relation to auscultation findings (basic theme 11.2, quote 26), and how this resulted in clinical reasoning of intervention relating to those findings. Discussions surrounding verbal communication (basic theme 11.3, quote 27) related to the variable quality of explanations offered to the patient during the scenario and expressions of concern of the patient's evolving status. Participants also discussed how they could improve verbal communication with the patient and other members of the multi-professional team in future clinical placements.

Some participants discussed infection control errors (basic theme 11.4, quote 28), particularly in relation to not wearing an apron and being unsure whether to prompt the physiotherapist to apply their apron and gloves before patient contact. Still image 7.3 illustrates both participants applying appropriate protective equipment (aprons and gloves) prior to interacting physically with the patient. During the VRE interview, the participants discussed the need to apply an apron and gloves as the patient was known to have MRSA.

Still image 7.3: Appropriate application of protective equipment

Errors relating to the 'process' of moving and handling the patient (manikin) within the simulation context were identified by participants, which referred to suboptimal positioning of the bed prior to repositioning and lack of control of the patient's head (basic theme 11.5, quote 29). During the VRE interview, the participants in Still image 7.4 reflected on an error during their scenario, which was as a result of their actions whilst repositioning the patient (computerised human patient simulator). During the moving and handling procedure, the participants discussed being unsure of how to adjust the head of the bed, and their inability to control the patient's head whilst they repositioned the headrest. They reflected that their erroneous actions resulted in the patient's head sharply hitting the mattress as the headrest collapsed onto the bedframe.

Still image 7.4: Error recognition

After a pause, the participant undertaking the role of the physiotherapist reflected on her feelings immediately after the situation shown in Still image 7.4:

> *I was just glad it wasn't a real patient…They are normally electric beds in hospitals aren't they? It made me feel quite awful really. Because we are there to help the patient and we could have made it worse if it had been a real patient. Probably would have shook him up really I think. (FP4).*

During the VRE interview, other participants discussed intervention errors (basic theme 11.6, quote 30), relating to administering changes in oxygen therapy without permission from a doctor, a lack of knowledge about oxygen therapy and the need to be guided by trust protocols in an actual clinical environment. When referring to the specific positioning and interventions that the participants provided, they also discussed alternatives that may facilitate improvements in the patient's physiological status, if they were to repeat the scenario.

7.4 Research question 5: Factors influencing performance in simulation

The sole focus of analysis for RQ5 is the thematic analysis of VRE interview data, presented in Table 7.10, which presents the two organising themes under the global theme of *influences on performance*. The themes were the participant's perceived influence of prior elements within university (Organising theme 12: Prior experience) and the motivations behind the participants' choices of elective placements (Organising theme 13: Elective placement selection). The types of university organised practice placements (one to five), which the participants had already undertaken, and the self-organised elective placement is summarised in Table 7.10. Thematic analysis of the participants' prior experiences (Table 7.10, Organising theme 12: Prior experience) identified three basic themes: university units, placements and the AIM course (GMCCSI, 2011). Participants' opinions were split as to whether the university (academic units) had prepared them for this SBE experience.

Participants reported that the cardio-respiratory units had provided relevant foundation skills required by the scenario (e.g. auscultation, positioning and the ability to clinically reason manual chest physiotherapy techniques and positioning). Others felt that, whilst the cardio-respiratory skills sessions in particular had provided opportunities for abstract skills acquisition, they had not had the opportunity to contextualise the skills and the sessions lacked realism (basic theme 12.1, quote 31). Participants perceived that their respiratory/general ward/surgical and critical care placements had prepared them to participate in the scenario. Some participants reported that they had similar experiences on placement and that ICU placements in particular, had prepared them to be able to clinically reason their interventions undertaken during the scenario. Participants also reflected that their placements had provided an opportunity to build on the knowledge and skills learned in university units.

Table 7.10: Thematic analysis – Organising themes 12 and 13 and participant placement experiences

ORGANISING THEME 12 – PRIOR EXPERIENCE		
Basic theme	**Examples**	
12.1 University units	31)	…in Uni, you're just doing it on your peers so you don't think about it as a real patient and deteriorating and you don't have that pressure on you so I don't think that's really prepared you for that kind of situation. (FHCA3)
12.2 Placements	32)	No. No, I don't because on placement I had done a placement on ICU [Intensive Care Unit]. Well partly on ICU but it was a surgical ICU, so people were only there who had major surgery, they weren't actually poorly as such so I haven't had experience with people actually deteriorating on me. (FP5)
12.3 Acute illness management (AIM) course (GMCCSI, 2009)	33)	…my work in uni gave me the background knowledge for assessments and treatment interventions. Then clinical placements helped build on that but I hadn't done the critical care placement. So when I did the AIM course through Uni, I think this helped me understand what to do in a situation like this. (MHCA2)
ORGANISING THEME 13 – ELECTIVE PLACEMENT SELECTION		
Basic theme	**Examples**	
13.1 Placement gap	34)	Medical surgery and intensive care, because I have not done it yet. It's an aspect that I don't think I will be confident with unless I learnt more practically, so getting more experience with things like that. (FHCA4)
13.2 Preference	35)	I am doing my elective placement with the armed forces in [anonymised]; it's more of an MSK [musculoskeletal] approach. It's sort of MSK outpatients. I chose this because I am considering joining the forces after I leave. (FP3)
13.3 Overseas	36)	I decided to do it because I wanted to learn about conditions that we don't really see here as well. And also I wanted to develop my skills outside of equipment so things like exercise skills which I think would be more predominantly used in those countries, that don't have electrotherapy and things that we have here, so that when I come back here I will have more confidence in that area. (FP7)

Placement order	**Number of participants completing each type of placement**				
	Respiratory	**Musculoskeletal**	**Neurology**	**Specialist Areas**	**Total**
1	5	**7**	5	4	21
2	4	3	4	**10**	21
3	2	**10**	5	4	21
4	2	**9**	5	5	21
5	4	**12**	4	1	21
Elective	**9**	3	7	2	21

Key: Bold text used to highlight the highest frequency per placement period. Placements 1-5 are arranged by the University. The elective placement is arranged by the pre-registration physiotherapy student

Whilst participants reflected on being able to utilise prior assessment and treatment experience gained on placement, others felt that they had no relevant placement experience to draw upon (basic theme 12.2, quote 32). Only positive comments were received regarding the relevancy of the AIM course in preparation for this scenario (basic theme 12.3, quote 33). Participants felt that the AIM course (GMCCSI, 2009) provided them with the confidence to undertake the scenario and that it helped them to provide a structure within the scenario. Some participants felt that the AIM course was the main/biggest influence on their ability to participate in the scenario. Participants reported feeling able to use the AIM information more readily in the scenario and that it provided a reminder and reinforced their knowledge gained from the AIM course.

Individual placement experiences reportedly varied with some participants organising a forthcoming respiratory-biased elective, as they had not yet been responsible for the management of an acutely or critically ill patient during placements. The most frequent types of placement have been highlighted in each university organised placement period (one to five) and the elective placement six (Table 7.10). Musculoskeletal (including out-patients and orthopaedics) was the most common placement type allocated to the participants in four of the five university organised placements, with the exception of placement two, which was in specialist areas. Twenty students received one respiratory placement, leaving only one participant without a university organised respiratory placement. Four participants had reportedly completed two respiratory placements. Despite this, some participants who had undertaken a respiratory placement reported they were not required to assess an acutely ill or deteriorating patient.

Thematic analysis of the motivations behind the participants' elective placement selection (Table 7.10, Organising theme 13: Elective placement selection) identified four basic themes: placement gap, preference, accommodation and overseas. In relation to the perceived placement gap, some participants reported selecting their elective based on a lack of confidence in that area (basic theme 13.1, quote 34). Participants reported that their personal preference towards a specialist area of physiotherapy had influenced their choice of elective. This was based on previous placement experience, enjoyment, location of accommodation or the area being of personal interest to their future career options (basic theme 13.2, quote 35). Other participants reported selecting an overseas elective placement to facilitate the development of additional physiotherapy skills predominantly used in countries with limited resources and facilities (basic theme 13.3, quote 36).

7.5 Research question 6: Perceived value of the simulation experience

The thematic analysis of the perceived value of the simulation experience (RQ6) drawn from the VRE interview data is presented in Table 7.11. Under the global theme of *value*, one organising theme 14: Simulation and video-reflexivity was identified. Seven basic themes were identified: skills development, increased self-awareness, placement preparation, added realism, patient safety, video review and digital video disc (basic themes 14.1-14.7 respectively).

Participants felt that the experience provided an opportunity to further develop their skills (basic theme 14.1, quote 37), by providing an opportunity to put the theory into practice. Participants were critical of their self-awareness (basic theme 14.2, quote 38) and how their behaviour may be perceived by others. Participants perceived the scenario provided an opportunity to utilise their clinical skills in a safe learning environment, where they were able to learn from their mistakes without any risk to patients. Additionally, adopting more professional behaviour during the scenario was discussed as compared to practising with peers with normal physiological parameters, ranges of movement and abilities. The experience was deemed valuable for placement preparation or as a refresher (basic theme 14.3, quote 39). Whilst some participants valued the realism afforded by the scenario (basic theme 14.4, quote 40), others felt that it was false, in the sense that additional members of the multi-disciplinary team would be required to facilitate greater improvements in the patient’s overall condition.

Table 7.11: Thematic analysis – Organising theme 14: Value of simulation and video reflexivity

ORGANISING THEME 14 – VALUE OF SIMULATION AND VIDEO REFLEXIVITY	
Basic theme	**Example quotations**
14.1 Skills development	37) I feel there is massive benefit to undergraduates and pre-reg [pre-registration] experience as it did replicate a clinical environment…and I personally felt that I learnt more about aspects of treatment and assessment rather than undertaking a less realistic assessment on one of your colleagues in university as a student. (MP3)
14.2 Increased self-awareness	38) I think it will definitely help me on my elective because I will be doing respiratory, so I might not feel quite so daunted coming to see someone that is acutely ill. I think it's quite good as well watching back yourself on a video; you don't realise at the time how you come across and how long time seems, when sometimes it feels like its flying but really it's just not. I think it's just helpful to get an overall picture of you and then reflecting on that as well. (FHCA3)
14.3 Placement preparation	39) I think the review is definitely going to have helped because, while I was in there it felt like a train wreck but having come out and being able to talk about it and think about it, it helps to recognise where you went wrong, because I think if I hadn't done this I would have gone away and just thought that was a disaster and tried not to think about it as much as I could, so I definitely think that's going to have helped. (FP5)
14.4 Realism	40) The exposure to the pressure I think it's a good realistic thing that you wouldn't get in a skills scenario like [name] said, with the beeping with somebody actually realistically in front of you who is acutely unwell it's definitely a beneficial thing to be exposed to. (FHCA4)
14.5 Patient safety	41) I think it will massively impact on patient safety through continually being to be able to adapt new environments even for the same patient, where many problems could be presented. For example, the patient we saw today, a completely different problem could be shown with the same dummy allowing a person to experience all various different types of problems that would present in clinical practice with real patients. Therefore, having all these learning experiences to draw from that they have reflected on and thought out loud about would definitely improve their clinical practice with real patients, like quality of care and safety. (MP3)
14.6 Video review	42) Yeah, because you wouldn't ever see stuff what you're actually doing, and what you think you're doing and what you're actually doing might be different. And you get to see your own approach to patients, you don't know how you actually interact with patients, so it's good to see that. (FHCA6)
14.7 Digital Video Disc (DVD)	43) In reference to general continuous professional development, I am going to complete a written reflection and also I feel the DVD, I will continually revisit that so I have got a constant picture of how next time I can always improve my respiratory assessment and treatment. (MP3)

Other participants reflected on the absence of hand-washing facilities within the SLE, which hindered their practice in relation to adhering to infection control requirements during patient contact. Conversely, others perceived that the scenario provided a more realistic experience than practising with peers, with normal conditions and normal physiological parameters. For some, the added realism generated through the presence of abnormal physiological parameters, provided a greater sense of realism and was reported to be the mid-point between peer-practice and interaction with patients in clinical practice. Additionally, other participants valued the added realism afforded by the equipment fidelity, in particular the auditory stimuli from the patient monitors, the weight of the manikin, its responsiveness to physical and verbal interactions, and functionality (e.g. audible abnormal breath sounds).

For some, the lack of physical responsiveness (movement and inability to alter the manikin's physical temperature) and lack of visual feedback was considered to be off putting and hindered clinical decision making surrounding the diagnosis of whether the patient was actually septic. For others, the scenario provided a more realistic opportunity to put their prior knowledge and skills from the AIM course into practice. The scenario was deemed an opportunity to reinforce prior knowledge and skills without impacting real patients and their safety. All participants agreed that the SBE opportunities provide opportunities to positively impact patient safety (basic theme 14.5, quote 41). Value was reportedly attributed to the scenario, as it provided an opportunity to practise and utilise physiotherapy skills in a safe environment, learning from their own mistakes without risks to patients. Furthermore, participants valued the ability to practise without the added pressure of a clinical situation. Participants discussed how they felt safe to make mistakes in the SLE and potentially not replicate those mistakes in the future in clinical practice, when it could impact a patient's quality of care and safety.

All participants positively valued the opportunity to reflexively review their simulation video to influence future practice (basic theme 14.6, quote 42), which afforded the ability to scrutinise their own and each other's behaviour. Additionally, they valued the opportunity to extrapolate their existing behaviours and activities within the simulated scenario and project into the near future (elective placement, EOC situations and post-graduation). The possibility of developing action plans and using the digital simulation resources (generated from the scenario and reflexive review) to evidence their personal development within their electronic portfolio was positively reported. This was perceived as providing an opportunity to explore their experience in detail and discuss their role (physio/HCA), and to be able to reflect on what they could have done differently if the roles were reversed. Value was also attributed to the opportunity to reflect repeatedly on their experience using the digital resources provided in preparation of future learning activities in their forthcoming placement (basic theme 14.7, quote 43). Participants perceived the provision of a DVD (featuring resources generated from their scenario and VRE interview) would provide a lasting reminder of their encounter, facilitate identification of errors and assist in the development of their clinical reasoning skills.

7.6 Research question 7: Transparent approach to cost analysis

The full economic cost of designing, and providing all 12 scenarios, VRE interviews and debriefs (lasting three hours, including set up and pack away) was £3706.00, equating to £154.42 per learner (see Appendix 17).

7.7 Summary of the findings for research questions 3-7

A summary of the research findings has been presented in Box 7.1.

7.8 Conclusion

This chapter has presented and interpreted in great depth a unique exploration of the experience of 21 pre-registration physiotherapists participating in a simulation scenario and VRE interview. The findings of RQs 3-7 have been presented, which have explored patient management in a simulation context, independent error recognition abilities, perceived influences on performance in the SLE and the value of the simulation-based learning experience.

Box 7.1: Summary of the key findings from Phase 2

Research question 3	• In all 12 scenarios, participants completed an assessment and provided physiotherapy intervention without the need to pause the scenario or request guidance from a facilitator • All participants partially completed a basic respiratory assessment, which lacked structure • Five participants selected physiotherapy intervention that resulted in optimal improvements in the patient's physiological status within the simulation context
Research question 4	• A total of 107 errors were identified within the 12 scenarios including latent errors, error-producing factors and violations • Error identification and recovery abilities of pre-registration physiotherapy participants were limited. Unrecognised errors related to key physiotherapy assessment, intervention and communication skills. Participants lacked insight into their own abilities regarding cardio-respiratory physiotherapy and AIM skills, moving and handling, and infection control procedures
Research question 5	• Participants identified multiple influences on their performance within the SLE, including placement and academic experiences, and the opportunity to undertake the Greater Manchester Critical Care Institute's (2011) AIM course • Individual placement experiences reportedly varied, with some participants organising a forthcoming respiratory-biased elective as they had not yet been responsible for the management of an acutely or critically ill patient during the five placements arranged by the university
Research question 6	• Value was attributed to the scenario and video-reflexivity in relation to providing a positive opportunity for skills development, increasing self-awareness, placement preparation and influencing patient safety. The video review and DVD were deemed valuable for post-event reflection and to influence future practice. For some, the scenario promoted a realistic encounter, whereas others felt a lack of handwashing equipment and limitations of the manikin hampered the realism of the scenario to some extent
Research question 7	• The full economic cost of designing, and providing all 12 scenarios, VRE interviews and debriefs was £3706.00, equating to £154.42 per learner

Chapter 8: Phase 2 Discussion

8.1 Introduction

This chapter will discuss the findings from Phase 2 previously presented in Chapter 7. The chapter starts with a comparison of the findings for RQs 3-7 with the existing literature (see figure 4.1, page 66). The development of the Integrated Simulation and Technology Enhanced Learning (ISTEL) framework is introduced, which was the outcome of a synthesis of the literature review, methodological design and findings of Phase 2. This is followed by a discussion of the methodological strengths and limitations of the study. Finally, the educational implications of the research will be explored before suggesting areas of future research.

8.2 Comparison with the literature

This section will explore the findings in relation to the literature in accordance with each of RQs 3-7. Each research question is addressed in a separate subsection.

8.2.1 Research question 3: Independent management of an acutely deteriorating patient in a simulation context

All 12 participants undertaking the role of the responding physiotherapist demonstrated a degree of competency in managing a deteriorating patient, which was characterised by their ability to prioritise actions, demonstrate an understanding of abnormal clinical findings and implement appropriate intervention (ACPRC, 2007; CSP, 2013). In all 12 scenarios, the participants completed an assessment and provided physiotherapy intervention without the need to pause the scenario or request guidance from a facilitator (as illustrated on page 123). Thus, the participants remained immersed in the scenario and did not break out of role at any time. The ability of the participants to independently assess and manage the deteriorating patient in the simulation context indicated skill acquisition beyond the level of an advanced beginner (Dreyfus and Dreyfus, 1980; Benner, 1984). Advanced beginners are defined as requiring the use of lists or direction/facilitation to undertake a specific task (CSP, 2013). When participants sought advice or reassurance, this was achieved through consultation with the HCA or an appropriate telephone call with a senior colleague (a simulated nurse/doctor).

The scenario pre-brief information did not specify that a particular approach to assessing the patient was required. This facilitated emergence of multiple and diverse ways of thinking and acting on information provided within the scenario (Fenwick and Abrandt Dahlgren, 2015). Although all of the participants independently assessed the deteriorating patient in the simulation context, it was basic (predominantly focusing on airway and breathing assessment components) and in the majority of cases lacked structure. Within the cardio-respiratory programme, participants had previously been exposed to two types of patient assessment, a physiotherapy assessment, which included components from the ACPRC (2007) assessment and treatment matrices and the AIM approach (GMCCSI, 2011). All pre-registration physiotherapy students at the University have the opportunity to undertake the AIM course prior to graduation (Gough, 2009c-e; Finch and Gough, 2010). Participants utilised some of the key respiratory physiotherapy assessment skills outlined in the ACPRC (2007) physiotherapy assessment matrix, including interpreting the patient's notes/monitors, auscultation findings, observation of the patient's breathing/general status and collected appropriate information, although this was not always accurately undertaken or interpreted. Fewer participants verbalised their interpretation of the chest x-ray findings, analysed the assessment findings and verbalised that the patient was deteriorating. However, none of the participants verbalised their selection of an outcome measure or the interpretation of the patient's arterial blood gases, which were artefacts provided within the scenario in the medical notes.

The AIM approach (GMCCSI, 2011) requires the consideration of all elements in the assessment and management components (airway, breathing, circulation, disability and exposure). Despite previously being taught the AIM approach at pre-registration level, none of the participants in this study completed a comprehensive assessment or devised a management plan as specified by the AIM approach. Additionally, an AIM chart (GMCCSI, 2010) was on display next to the telephone, but this visual cue did not prompt participants to follow a structured approach. Previous pilot studies undertaken at MMU with pre-registration nursing and physiotherapy students have confirmed the ability of the students to successfully complete the AIM course assessment, which involved achieving ≥80% on the MCQ and passing a short (low equipment, environmental and psychological fidelity) AIM scenario. Findings indicated that students were able to complete the AIM course to the same standards as qualified healthcare professionals (Gough and Finch, 2009). Whilst the participants in the current study adopted a mixed assessment approach featuring elements of the AIM and ACPRC assessment components, they predominantly focused on assessing the respiratory system, as opposed to completing a holistic systems (airway, breathing, circulation, disability and exposure) approach to their assessment as advocated by the NICE (2007) guidance. In general, the participants' actions and discussions were consistent with the requirements of the airway and breathing components of the AIM assessment and management protocol (GMCCSI, 2011) and as directed by the Modified Early Warning Score (of four), which indicated the patient was acutely deteriorating (Subbe et al., 2001).

In seven of the scenarios within the current study (Phase 2), the participant undertaking the role of the physiotherapist verbally identified that the patient had deteriorated during their assessment. During these scenarios, the participants' actions were in line with guidance on the management of acutely deteriorating patients (NICE, 2007; GMCCSI, 2011; ALERT, 2014). When later discussing the patient's management during the VRE review, some participants recognised that they had administered a change in oxygen therapy without first discussing this with a doctor and obtaining a revised prescription. Others appropriately made requests for help from the nurse/doctor since physiotherapists are not routinely able to prescribe or administer oxygen, fluid or drug therapies. The requests made to increase the patient's oxygen therapy administration was in line with current guidance relating to the management of an acutely deteriorating adult patient in hospital (NICE, 2007; GMCCSI, 2011; ALERT, 2014).

During the VRE interview, the participants reflected on the intervention they provided during their respective scenarios and verbalised appropriate additional assessment and physiotherapy-specific intervention that may have facilitated further improvements in the patient's condition within the scenario. Shannon et al. (2015)

proposed that the clinically important differences they observed between non-respiratory and specialist respiratory physiotherapists' treatment outcomes may have been related to differences in the selection and application of respiratory physiotherapy techniques. Findings from both the current study and Shannon et al. (2015) suggest that it is important to ensure that pre-registration physiotherapy students and non-respiratory on-call physiotherapists are appropriately trained to deliver essential physiotherapy techniques effectively to patients.

Several NTS behavioural marking systems (observational tools) have been developed for healthcare staff involved in surgery and anaesthesia (Fletcher et al., 2003; Healey et al., 2006; Yule et al., 2006, 2008a; Flin et al., 2010; CPSSQ, 2011; Walker et al., 2011). These NTS tools provide clinicians, facilitators, educators and researchers with a means to observe and rate behaviours (e.g. situational awareness, communication, teamwork, decision making, task management and leadership), which may be integrated within debriefing or feedback. Although these NTS scales have been used with other professions e.g. nursing (Hull et al., 2011), anaesthetic practitioners (Rutherford et al., 2013), scrub practitioners (Mitchell et al., 2013) and in the simulated environment (Flin et al., 2010), to my knowledge this present study is the only one to have explored the NTS of pre-registration physiotherapy students within SBE. Participants in all 12 scenarios demonstrated situational awareness skills (the ability to gather appropriate information, decision-making skills including considering options, selecting and communicating options and implementing decisions, and communication and teamwork skills when exchanging verbal and written information (Yule et al., 2006, 2008a; Flin et al., 2008). Similarly, in 11 scenarios participants also demonstrated the ability to review their decisions, demonstrated task management skills (planning and preparing the environment before implementation decisions) and leadership (setting standards, coping with the pressure of the complex and changing situation). These findings are consistent with the Non-technical Skills for Surgeons (NOTSS) behavioural rating system, designed and validated by Yule et al. (2006; 2008a), which can be used to provide feedback or debriefing in the workplace to trainees and surgeons (Yule et al., 2008b). Overt scaffolding of NTS e.g. situational awareness, decision making, task management, communication, and teamwork and leadership, may help to improve patient safety within scenarios and facilitate translation through to the practice environment.

The extent to which participants were able to provide effective physiotherapy intervention varied between the 12 scenarios. In 11 scenarios, the simulated patient's physiological status improved from baseline parameters. However, only five participants administered the optimal interventions (as reported on page 133). Previous small-scale, single cohort postgraduate physiotherapy studies have also reported positive findings involving human patient simulators within scenarios, but in the context of an intensive care environment (da Silva Bezerra Fitipaldi and da Caetano Azeredo, 2005; Shoemaker et al., 2009). Direct comparison with patient management and skills is not possible due to the limited reported findings of individual physiotherapy-specific skills and an absence of NTS exploration in the existing literature. Australian RCTs have measured professional competency achieved during the normal practice placement or a combination of SBE and placement experiences using the APP tool (Dalton et al., 2011, 2012). This APP tool is a generic competency tool used to grade students on any practice placement, but data pertaining to the individual skills and interventions has not yet been reported. Moreover, the AAP tool has not yet been compared to the individual/regional placement metrics used in the UK.

Overall, the participants in this study demonstrated skills that aligned with the UK professional standards of physiotherapy practice (CSP, 2013) expected of entry-level physiotherapists (Appendix 21). Examples of how the participants in this study demonstrated achievement of the physiotherapy standards relating to knowledge, skills, values and behaviours (CSP, 2013) within the VRE interview are provided in Appendix 21. In the majority of cases, the findings mapped directly to the entry-level descriptors e.g. physiotherapy practice skills, communication, teamwork and putting the person at the centre of practice. There were some exceptions, where advanced graduate level reflective practice descriptors (CSP, 2013) were observed during the VRE interview. These exceptions included physiotherapy practice skills (by reflecting on clinical decisions, evaluating the outcome and recognising how this may inform future practice), helping others to learn (by reviewing personal learning and identifying future actions) and ensuring quality (of future practice). All participants undertaking the role of the responding physiotherapist demonstrated a degree of competency in managing a deteriorating patient, which was characterised by their ability to prioritise actions, demonstrate an understanding of abnormal clinical findings and implement an appropriate intervention (ACPRC, 2007; CSP, 2013).

The findings of this study highlighted differences in the clinical reasoning abilities of the pre-registration physiotherapy participants. The concept of clinical reasoning in physiotherapy refers to the cognitive elements of the clinical decision-making process (Higgs, 1990), which is combined with clinical judgement to identify problems and justify decisions to influence patient care. Thackray (2014) developed a new conceptual model of clinical reasoning in physiotherapy, based on previous work by Higgs (1990) and Case et al (2000). Thackray's clinical reasoning model focuses in four main categories including: 1) information perception; 2) information processing (hypothesis formation, diagnosis/development of a problem list); 3) taking action and 4) evaluation and reflection. The findings of the current study indicated that the pre-registration physiotherapy students demonstrated varied clinical reasoning abilities (Higgs, 1990; Case et al., 2000; Thackray, 2014). In relation to 'information perception', participants in this study demonstrated an ability to utilise cardio-respiratory specific knowledge and skills to extract pertinent information from their respiratory assessment. However, the ability to recognise cues (normal and abnormal physiological parameters) and gather pertinent information to identify that the patient was deteriorating varied amongst participants (Tables 7.1, 7.2 and 7.7: learning objective 1).

'Information processing' including hypothesis formation and problem identification abilities also varied amongst all participants. The accuracy of interpretation and analysis of continually changing physiological parameters varied throughout all 12 scenarios (Tables 7.1-7.2). In less than half of the scenarios, the participants demonstrated an awareness of or acknowledged the anticipation of possible future changes in the physiological status of the patient (Table 7.3). The extent to which the information was communicated between participants (physiotherapist and HCA) to gain a shared understanding of the unfolding situation also varied (Table 7.3). Participants discussed that they had primarily selected either auscultation or a combination of oxygen saturations and auscultation as objective markers during the scenario to give their assessment (Table 7.4). However, only a third of participants re-analysed the findings from their assessment (Table 7.1). None of the participants formally documented their findings during the scenario (Table 7.7: learning objectives 1). Only two participants discussed the interpretation of the patient's main problem and accurately diagnosed that the patient had aspirated. The remaining participants demonstrated reasoned identification of abnormal clinical features during the scenario (Table 7.4 and Table 7.7: learning objective 2).

In relation to the phase of 'taking action', all 12 participants acknowledged the patient deteriorated during the scenario, the effectiveness of their chosen interventions varied (Table 7.5). The selection of appropriate interventions and timely administration varied widely across all 12 scenarios (Tables 7.5 and 7.6). Participants demonstrated variable ability to predict potential deterioration, anticipate changes in the patient's condition as a result of their chosen intervention and troubleshoot problems as they arose (Table 7.3 and Tables 7.4). This included demonstration of an awareness of the situation, interruptions, error identification and additional interventions that they felt may have been beneficial in the given situation. Error analysis revealed deficits in participant knowledge and skills, which had an impact on the selection of intervention, and adherence to safe working practices e.g. infection control and moving and handling (Table 7.7: learning objectives 3 and 4). Participants demonstrated variable non-technical skills including task management, leadership, communication and teamwork (Table 7.8), which could impact on clinical decision making process. In particular, the non-technical skills relating to development of a shared understanding throughout the scenario, co-ordination of activities, communication requirements (Table 7.8) and provision of a structured handover at the end of the scenario (Table 7.7: learning outcome 5 and Table 7.8).

The depth of 'evaluation and reflection' by participants during the scenario was limited (Table 7.3, basic theme 4 and Table 7.7: learning objectives 2 and 5). Whereas, the VRE interview provided an opportunity for participants to specifically 'evaluate' the effectiveness of their actions, behaviours, identify errors, explore their strengths and weaknesses and plan appropriate intervention in the future.

Differences in the clinical reasoning process for novice and expert cardio-respiratory physiotherapists have similarly been reported by Case et al (2000) and Thackray (2014) with qualified physiotherapists. However, as no studies having explored clinical reasoning abilities of pre-registration physiotherapy students within a simulation context, further comparison with the literature was not possible. The findings of this study highlight the potential impact of the clinical reasoning process on patient outcomes, specifically in relation to the nature and timing of clinical decisions and physiological effects of chosen interventions. One specific advantage of integrating computerised human patient manikins within the context of a deteriorating patient scenario, is the ability to extrapolate the physiological parameter and event log data (Tables 7.5 and 7.6). This data has the potential to provide additional depth for participants to evaluate the effectiveness of their interventions and clinical reasoning. This could be utilised within the debrief process or as integrated into reflective practice activities, to fine tune clinical reasoning skills in pre-registration physiotherapy students.

The scenario was designed to replicate the complex interactions a respiratory physiotherapist undertakes to function effectively within their clinical environment, including constant observation of the patient, and the noise and visual disturbances generated by monitors and equipment located within the visual field around the patient's bed space and ward (Roskell and Cross, 1998; Iedema, 2011; Iedema et al., 2013a-c). Participants discussed their interaction with the environment, artefacts embedded in the scenario and their resultant behaviours (Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). Despite being pre-registration physiotherapy students, the participants in this study demonstrated the ability to recognise the complexities and dynamics that unfold within a simulated scenario (as detailed in section 7.2), and were able to suggest alternative practices for future situations (Iedema, 2011; Iedema et al., 2013a-c). Participants demonstrated an ability to both reflect-in-action (during the scenario) and later review their own and others' actions in the midst of the uncertainty of the situation and the physiological disturbances that unfold during the scenario (Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). During the scenario and VRE review, participants discussed their own level of expertise, requested help and delegated tasks appropriately.

Additionally, participants demonstrated attunement through their ability to listen to the patient and healthcare assistant (HCA) and patient, observing, touching and sensing the scenario that was unfolding (Dekker, 2011; Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). The scenario exposed the participants to the complexity of clinical care that is influenced by the human body, behaviour of any individuals, web of relationships and the dynamic and fluid interaction of these systems (Plsek and Greenhalgh, 2001; Wilson and Holt, 2001). As the scenario unfolded, the participants were exposed to what is referred to as the amplification effects in complexity theory, as small changes in the web of interactions (e.g. correct/incorrect clinical decisions) may lead to larger changes in another part, e.g. improvement/deterioration in physiological parameters of the patient. The combination of SBE and VRE provided an opportunity to stimulate learning through the social interaction and provided a means to develop capability for future practice. Fraser and Greenhalgh (2001) advocate that capability is enhanced through challenges of unfamiliar contexts (situations or environments) and the use of non-linear methods of learning (SBE), coupled with the provision of feedback on performance.

In summary, this study has provided a unique exploration of physiotherapy technical and NTS utilised within the management of a deteriorating patient in a simulation context. The combination of the scenario and VRE provided an opportunity for transformational learning to occur (Fraser and Greenhalgh, 2001; Fenwick and Abrandt Dahlgren, 2015) as the participants engaged with an uncertain and unfamiliar context of managing an acutely deteriorating patient that replicated the complexities of an EOC situation. The scenario and VRE also facilitated participants to explore the interconnectedness of multiple complex elements (e.g. the patient monitor, digital chest x-ray and the medical notes) within the emerging situation (patient deterioration) and the impact of their own interactions (Ma, 2015). The scenario challenged the participants to draw on their problem-solving skills, technical and NTS to integrate diverse ranges of information in order to appraise the situation, prioritise and then implement interventions. Within the VRE interview, participants demonstrated attunement by openly discussing their assessment strategies, mental models and suggesting modifications to future practice (e.g. the adoption of a structured AIM approach to facilitate effective assessment and the provision of more timely intervention to maximise efficiency and minimise patient deterioration).

8.2.2 Research question 4: Independent error recognition

To my knowledge, this is the first study to apply incident analysis concepts (Reason, 1990, 1997, 2000; Coombes et al., 2008; Henneman et al., 2009; Vincent, 2011, 2012) and to explore error types committed or recovered by pre-registration physiotherapy students in a simulation context. Only 28 of the 107 errors (latent errors, active failures and error producing factors) identified by thematic video analysis were independently identified by participants. Two of these were identified by participants during the scenario and the remaining 26 within the VRE interview. This is an important finding since a lack of insight into one's own skills can have a fundamental impact on patient safety (Dekker, 2011). The unrecognised errors related to key physiotherapy skills (poor auscultation skills, suction skills, failure to recognise abnormal assessment findings, failure to seek/obtain a prescription for the change in oxygen therapy prior to administration, errors in the delivery of physiotherapy intervention and a communication error).

To date, no previous studies have explored pre-registration physiotherapy students' abilities to identify errors in the simulation context or when using VRE. The participants' limited abilities to independently recognise errors encountered during SBE in the current study was consistent with findings by Henneman et al. (2009) relating to student nurses. Henneman et al. (2009) undertook a retrospective analysis of error identification and recovery in either one of two SBE scenarios completed by senior student nurses, from one HEI in the USA. Video recordings of all 50 nursing students' experiences were analysed with respect to four rule-based error categories: coordination, verification, monitoring and intervention (originally identified by Rasmussen, 1986). As in the current study, all nursing students made at least one error during their scenario. Similarly, participants in both the current study and nursing students in Henneman et al. (2009) made errors in all four rule-based error categories. The highest reported errors identified in both studies related to monitoring and verification errors. Whilst Henneman et al. (2009) also analysed the students' abilities to recover errors, their findings related to errors embedded in the scenario. Unlike Henneman et al. (2009), the current study did not embed prior errors into the scenario design. Error recovery by nursing students of embedded errors in the scenarios was reportedly low, with only 14% overall embedded medication errors identified and appropriate actions taken. However, in the current study only one error (relating to positioning the patient in the incorrect position) was actually recovered by participants during the scenario.

Findings from Phase 2 (sections 7.2 and 7.3) support the need to ensure pre-registration students have the ability to develop skills to enable them to identify and manage potential risks in their clinical practice. Additionally, there is a need to ensure pre-registration physiotherapy students have an understanding of how human factors impact on their own practice and how this ultimately impacts patient safety (WHO, 2009, 2011). In March 2016, The Commission on Education and Training for Patient Safety established a series of 12 recommendations to facilitate improvements in patient safety in the NHS over the next 10 years, through education and training to Health Education England and the wider healthcare organisations. Recommendation six from the recent report for improving patient safety through education and training (HEE, 2016) also highlights that learning environments must be developed to provide support for all learners to both raise and respond to concerns about patient safety. The report highlights the importance of embedding patient safety education across all healthcare disciplines from apprenticeships, undergraduate and postgraduate education to retirement to optimise patient safety (HEE, 2016).

During the VRE interview, participants discussed the consequences of not speaking up during the scenario and the impact of their suggestions and contributions (e.g. reducing infection control/moving and handling violations) and overall outcome for the patient. Participants acknowledged improvements in their communication skill were required including non-verbal, verbal, use of a structured handover approach and speaking up or being unafraid to offer suggestions. Communication of actions that may trigger or mitigate errors is recognised as vital to improving patient safety (Reason, 1990; NCEOPD, 2005; NPSA, 2007a, 2007b; NICE, 2007; Flin et al., 2008; NCEOPD, 2009; WHO, 2009, 2011; Carroll, 2009a, 2009b; Iedema et al., 2013a-c). Leonard et al. (2004) suggest that teaching individuals how to speak up about errors is a vital element of improving patient safety. Critical language, originally developed and utilised in the airline industry, has been similarly used in healthcare to facilitate individuals to speak up regarding any concerns or errors (Leonard et al., 2004; WHO, 2011). CUS is a three-step approach, which includes key phrases such as ‘I’m concerned’, ‘I’m uncomfortable’, ‘this is unsafe’ or ‘I’m scared’ (Leonard et al., 2004; WHO, 2011). This simple universal approach could be embedded within cardio-respiratory physiotherapy simulation scenarios and clinical practice to mitigate communication errors and improve patient safety.

Whilst Henneman et al. (2009) undertook retrospective analysis of two student nursing SBE scenarios to identify rule-based errors (also referred to as active failures by Reason, 1990), they did not analyse the scenarios for latent errors, skill or knowledge-based errors or error-producing factors, thus no further comparison is possible. In the current study, coordination errors related to incorrect description of physiotherapy intervention to the patient (e.g. description of percussion was used instead of vibrations). Verification errors related to failure of participants to undertake formal identification of the patient and failure to verify the infection control status of the patient (despite information provided in the pre-brief relating to previous history of infections). Participants perceived that the absence of hand-washing facilities contributed to the violations during the scenario, irrespective of the existence of gloves and aprons, violations still occurred as they were not routinely applied prior to patient contact, despite written cues embedded within the scenario medical notes.

Monitoring errors were evident during the respiratory assessments when participants failed to auscultate all areas of the patient’s lungs. Some participants also failed to recognise all of the abnormal respiratory findings. Intervention rule-based errors related to ineffective physiotherapy intervention, failure to obtain an oxygen therapy prescription prior to administration and failure to apply an apron and gloves when in contact with the patient (with MRSA). Misapplication of rules (Reason, 1990) relating to the performance of auscultation, suction and effective timing of chest wall vibrations were also identified. During some scenarios, despite participants verbalising/demonstrating an awareness of specific rules of effective positioning of a patient (for both secretions clearance and ventilation perfusion), these rules were later misapplied.

Skill-based performance errors were also identified during the thematic analysis of the scenarios, as related to basic physiotherapy assessment skills (which included auscultation, inaccurate interpretation of abnormal findings and the inability to interpret the chest x-ray correctly) as well as inappropriate selection of intervention skills. Further discussion took place during the post-VRE interview and debrief to ensure the participants were aware of the skill and rule-based performance errors and how they could be mitigated in the future. Discussions included the need to auscultate under clothing, appropriate timing of chest wall vibrations, component elements of the active cycle of breathing technique and re-iterating the rules pertaining to effective positioning (for secretion clearance and enhancing ventilation perfusion). However, participants in the current study demonstrated the use of a range of defences, which helped to mitigate a clinical incident in all but one scenario. In 11 scenarios, there were sufficient defences to mitigate a clinical incident and the patient's overall condition improved, albeit to differing degrees (Appendix 20, Organising theme 10, on page 315). The defences included the demonstration of effective communication with members of the MDT and patient throughout the scenario, awareness of abnormal clinical signs and correctly administering physiotherapy intervention. Handovers were also provided by participants in 11 of the scenarios, but only one participant undertaking the role of the physiotherapists used the structured 'situation, background, assessment and recommendation' (SBAR) communication tool (Institution for Healthcare Improvement, n.d.). All participants had been previously introduced to the SBAR tool during the AIM course, and had experience of using it to provide handovers to the relevant member of the MDT in simulated scenarios (GMCCSI, 2011). The SBAR tool is being increasingly used in the UK to improve communication (Henneman et al., 2013) and ultimately patient safety within healthcare (GMCCSI, 2011; WHO, 2013).

The current study has highlighted that despite standardised procedures (moving and handling, and infection control) and tools to enhance patient safety (AIM and SBAR) having already been introduced during the formal physiotherapy curriculum, participants were not able to recall this information and put it into practice within this scenario. This also questions whether these participants would be able to transfer these essential skills into clinical practice effectively.

Additionally, this study has identified that the use of VRE has the potential to facilitate the identification of participants who lack insight into their knowledge, skills and behaviours and has the potential to play an important part in improving patient safety (Iedema et al., 2013). Ahmed et al. (2012) also proposed that reflection on personal performance and errors is critical in ensuring deep learning and positive behavioural change. The importance of allowing learners to make mistakes during SBE is welcomed (Ahmed et al., 2012; Lefroy and Yardley, 2015), and may help reduce the burden and fear of harming a patient in clinical practice by assuming responsibility for risk during a scenario (Lefroy and Yardley, 2015). The range of errors identified by this study highlights the complexity of managing an acutely deteriorating patient in a simulation context and requirements of the learners to apply prior knowledge and skills. It is acknowledged that for some the lack of realism or break in the fictional contract (Dieckmann, 2007) may have influenced some errors observed. For others, the element of uncertainty created by not informing participants which assessment or management approach may lead to sub-optimal patient management may also have influenced the number of errors observed. However, incorporating the element of uncertainty of the optimal approach to manage deteriorating patients may help to facilitate transfer of the learning to other contexts (Fenwick and Abrandt Dahlgren, 2015; Lefroy and Yardley, 2015). This study did not seek to compare errors encountered in a simulation context to the practice placement environment, thus it is not possible to ascertain whether the findings would resemble performance in a practice setting.

In conclusion, the findings relating to error recognition abilities of pre-registration physiotherapy students have implications for local curriculum design. Implications include incorporating opportunities to increase the awareness of error recognition and optimisation of defences to mitigate errors, in order to minimise the impact on patient safety in the practice setting.

8.2.3 Research question 5: Influential factors on performance within a simulation-based learning experience

Participants identified multiple influences on their performance within the SLE, including university units (academic) and placement experiences, and the additional opportunity to complete the AIM course. In the UK, physiotherapy programmes draw on educational theories and practices to support the development of the holistic curricula, which are driven by current practice, and regulatory and statutory requirements (DH, 2011; Ravert, 2012; CSP, 2015). The CSP allows individual HEIs the flexibility to design and deliver the physiotherapy curricula according to their organisation's strengths and resources (CSP, 2013a, 2015). The principle tenant of the CSP (2002b) curriculum framework relates to the provision of a student-focused learning environment that values equally, and fully integrates learning within the university and practice placements. Placements are currently organised by individual HEIs and typically take place within healthcare practices with close geographical proximity to the HEI. Practice placements provide the opportunity to learn new skills and ideas, and integrate existing, university-acquired learning into real-world practice with patients under the supervision of qualified physiotherapists.

Whilst participants reported that the university units had influenced their actions, clinical decisions and intervention provided during the scenario, they indicated this simulation experience offered a unique and realistic experience that had not been previously provided within cardio-respiratory skills sessions. The participants in this study experienced a curriculum that incorporates social constructivist theoretical principles and educational practices such as flipped classroom, scaffolding, and repetitive and deliberate practice. The learning activities within the physiotherapy curriculum focus on the learning process and emphasise the achievement of the learning objectives, which are directly related to the curriculum framework (CSP, 2002b, 2013a). Physiotherapy students are encouraged to learn to think, process and organise the information through the use of problem-solving and SBE activities. The scenarios increase in complexity by firstly introducing simple case studies then progressively introducing co-morbidities and more complex care requirements. The participants discussed peer-on-peer practise and felt that whilst the cardio-respiratory units had provided the relevant foundation skills required by the scenario, these were taught in a more abstract manner. The participants perceived that they had limited opportunities to contextualise the skills, which for some lacked realism compared to the current scenario. During the VRE interview, the participants omitted reference to other academic units beyond cardio-respiratory that they could have drawn transferable skills and experiences in relation to NTS or neurological pathophysiology and intervention. These were particularly relevant considering the patient's underlying condition of multiple sclerosis. Academic units are presented in terms of neurology, cardio-respiratory, musculoskeletal, transfer to professional practice and health care delivery. Perhaps it was due to this manner of teaching that participants failed to draw on their experiences beyond these cardio-respiratory sub-speciality.

A wide range of placement types was provided for the participants, with musculoskeletal placements being most frequent. Twenty participants had received at least one respiratory placement. Despite participants reporting they had undertaken a respiratory placement, some reported that they had not had the opportunity to assess an acutely ill or deteriorating patient. Following each placement, reflective sessions are timetabled within the curriculum to encourage pre-registration physiotherapy students at the University to review their placement experiences, explore strengths and weaknesses and develop action plans prior to their next placement. Findings from the VRE interview indicated that the participants already had insight into their perceived lack of expertise in relation to respiratory and neurological physiotherapy, and had subsequently arranged their own elective placements to address such issues.

In physiotherapy, practice placements are a mandatory component of pre-registration education (CSP, 2002a, 2009, 2010, 2012a, 2014a, 2014b) whereby 1,000 hours are required to have been successfully undertaken prior to graduation (CSP, 2002a, 2009, 2012a). Whilst it is not possible to provide all students with the exact same placement profile, individual HEIs are responsible for ensuring equity and balanced placements are offered to ensure the development of essential skills (CSP, 2012b, 2014b). Placement organisation in the UK is becoming increasingly challenging (CSP, 2014a, 2015), which concurs with the previously reported difficulties encountered in Australia (Jull et al., 2010). In response to the shortage of placements, funding was granted by Health Workforce Australia to explore the use of SBE within practice placement education. Whilst the Australian RCTs provided encouraging statistical findings relating to the combination of SBE and traditional in-placement education (Jull et al., 2011; Watson et al., 2012:

Blackstock et al., 2013), the CSP stipulated that it does not currently support the use of SBE to replace practice placement education (CSP, 2014a).

Additionally, the findings from Phase 1 identified existing challenges and barriers relating to cost, faculty training and access to equipment that influenced the use of SBE within EOC training and cardio-respiratory education within HEIs. The development of robust scenarios and supplementary simulated patient role profiles would also be required. Further scoping exercises, as undertaken by Jull et al. (2010), across the HEIs and placement providers would be required in preparation of adopting a combined SBE and placement model in the UK. Considerable capital investment (e.g. simulators and part-task trainers), an increase in simulation faculty development (e.g. proficiency in SBE design, facilitation and debriefing), technical support and trained simulated patients would be required. Significant monetary investment would also be necessary to enable HEIs to offer support to placement providers, to support the use of SBE within practice placements beyond the NHS.

The participants in this study highlighted that the AIM course helped them identify the signs of patient deterioration to undertake a relatively structured assessment, identify abnormal clinical features and initiate appropriate intervention. However, these views contrasted with the objective findings that indicated participants failed to comprehensively assess the deteriorating patient using the AIM format (section 7.2, and Appendix 20, Organising theme 3 on pages 313-314). This indicated an apparent mismatch in participant perspectives of their own abilities and actual observed skills. Participants were, however, able to suggest areas for improvement in their assessment process, which included undertaking a more structured (AIM/ABCDE) assessment. Participants also felt the need to practise elements encountered in the scenario and to address the deficits in their respiratory knowledge. Participants acknowledged personal limitations and discussed how they may make improvements to the management of a deteriorating patient and the overall safety of a given situation (NCEOPD, 2005; NPSA, 2007a, 2007b; NICE, 2007; NCEOPD, 2005, 2009; WHO, 2009, 2011). Thus, this study has highlighted the benefits of integrating SBE and VRE approaches to provide a holistic understanding of students' knowledge, skills, attitudes and behaviours. This could be applied to other situations such as learning through peer-on-peer practise for assessment preparation, interview preparation and analysis of academic assessment, to support the transition to placements and the practice environment.

For some participants, their interactions with the patient (in the simulation context) was influenced by constructs, mental models and rules they had been exposed to during their academic and placement-based experiences, whilst others verbalised their actions or inactions were linked to deficits in knowledge, skills and lack of direct respiratory placement experience (section 7.4, pages 140-141). Some participants perceived that participation in the study provided an opportunity to explore new possibilities through experimentation in a safe learning environment, working at the edge of their knowledge and experience (Plsek and Greenhalgh, 2001). Fraser and Greenhalgh (2001) refer to developing capability when learning takes place in the zone of complexity (the midpoint between simple and chaos in the certainty-agreement diagram developed by Stacey, 1996). The zone of complexity is referred to as the intersection between task familiarity and unfamiliarity, and environment familiarity and unfamiliarity, and between competence and capability (Fraser and Greenhalgh, 2001).

In summary, this study has highlighted the diversity and complexity of pre-registration physiotherapy education featuring academic and placement learning and its perceived influence on performance within a SBE. The combination of SBE and VRE has the potential to draw on academic and placement learning, to enable students to generate new knowledge, skills, attitudes and behaviours, and adapt flexibly to change and unfamiliar contexts in order to continually improve performance through personal and professional development. Thus, the combination of the scenario and video-reflexivity may be useful in physiotherapy to enable learners to develop not only competency prior to placement exposure, but capability for the transition to practice upon graduation.

8.2.4 Research question 6: Value attributed to the cardio-respiratory simulation-based learning experience

The value attributed to the cardio-respiratory simulation-based learning experience will be firstly explored in relation to the participants' perceptions and then in relation to cost consequence analysis.

8.2.4.1 Value attributed by the participants

The perceived value attributed to the cardio-respiratory simulation-based learning experience included skill development, increased self-awareness, placement preparation, realism, patient safety, video review and DVD. The scenario and VRE interview permitted participants to experiment with knowledge, skills, clinical reasoning and decision making within a simulated situation. The provision of situated and authentic learning activities and scenarios are embedded in the physiotherapy programme to help facilitate a deeper level of learner engagement, information and ideas (Pritchard and Wollard, 2010). Such learning activities are intended to enable skills development, increase self-awareness and provide suitable placement preparation in a safe learning environment without impacting patient safety.

Participants in this study valued the opportunity to influence future practice during the video-reflexive review of their scenario, which afforded the ability to scrutinise their own and each other's behaviour (Iedema, 2011; Iedema et al., 2013a-c). These are essential skills required for autonomous practice as a physiotherapist (CSP, 2002a, 2002b; Thomas et al., 2003; Gough and Doherty, 2007; CSP 2012a, 2012b, 2013a; Shannon et al., 2015). Additionally, participants valued the opportunity to extrapolate their existing behaviours and activities within the scenario and project into the near future (elective placement, EOC situations and post-graduation). Value was also attributed to the opportunity to repeatedly reflect on their experience using the digital resources provided in preparation of future learning activities in their forthcoming placement, which concurs with medical education (Sandars, 2009) and physiotherapy literature (Gough and Hamshire, 2012). It is possible that evidence generated through SBE could be used to prepare physiotherapy students for employment and provide evidence for HCPC re-registration in the UK. The combination of SBE and VRE and provision of the DVD provided an opportunity to encourage linked learning activities beyond the debrief, which is not overtly promoted in existing simulation and TEL frameworks (Jeffries, 2005; Adamson et al., 2005; DH, 2011; The NHET-Sim Monash Team, 2012; Chiniara et al., 2013).

The perceived value of the realism afforded by the scenario varied amongst participants. The scenario was specifically designed to replicate the complexity of an EOC scenario, whereby a physiotherapist is expected to undertake an assessment in order to manage an acutely deteriorating patient with either respiratory, cardio-respiratory or cardiothoracic physiotherapy or combinations of respiratory and orthopaedic symptoms, requiring physiotherapy out of normal working hours (Gough and Doherty, 2007). The scenario design had been piloted to minimise cognitive overload of the participants (Sweller, 1998) by placing materials (e.g. the patient monitor with audible alarms, digital chest-x-ray) in the foreground of learning and emphasising the importance of situational awareness in the unfolding complexity of the scenario (Ma, 2015). Some participants valued the degree of realism that was achieved with authentic artefacts (equipment and environment) and scenario design.

The scenario design included specific consideration of antecedent cues, including temporal (realistic physiological timing of responses to intervention), interpersonal cues (verbal prompts outlined in the simulated patient and HCA role profiles[9]) and internal cues (manikin responses). Verbal, visual monitor display and written cues were provided to enable learners to discriminate conditions and prompt the desired consequence in the scenario e.g. normalisation of physiological status in response to appropriate physiotherapy intervention (Burton et al., 1996; Paige and Morin, 2013). Other discussions surrounding realism related to the absence of physical cues (absence of handwashing facilities) that contributed to infection control violations during the scenarios. However, despite the presence of other physical cues relating to infection control requirements (gloves and aprons), violations still occurred as they were not routinely applied prior to patient contact, despite written cues embedded within the scenario (medical notes).

Some participants also acknowledged the limitations of the manikin's response e.g. to realistically replicate physical cues of cyanosis and temperature changes, which affected their perception of realism of the patient's condition. Dieckmann et al.

[9] The detailed role profiles for the facilitator, patient and HCA are available from the author.

(2007) refer to the creation of a fiction contract to enable participants to suspend disbelief during SBE. Clarification of a fiction contract during the pre-brief may have enabled some participants to engage better when they were presented with a gap in the simulated reality and actual reality during the scenario, to enable them to try to focus on the learning objectives and behave accordingly (Dieckmann, 2007; Lefroy and Yardley, 2015). However, the provision of cues in any teaching situation presents challenges. Whilst educators may include a series of cues and prompts within a scenario, to some participants these may still not be overt or transparent enough to prompt appropriate responses. Lefroy and Yardley (2015) propose that any disturbances or breakdown in fiction (loss of reality) should be incorporated within feedback/debrief, to emphasise the differences in clinical practice.

For some participants the scenario was perceived to provide an encounter that was considered more realistic than practising on their peers during their academic studies. Peer learning or peer physical examinations are common place in physiotherapy education (Wicksteed, 1948; French, 1989; Dickinson et al., 1991; Thornton, 1994; Quitter et al., 1998; Parry and Brown, 2009; Jull et al., 2010; Smith et al., 2012), However, no research studies were identified that investigated the value or impact of peer learning on learning in physiotherapy skills development, proficiency, competency or retention (Kirkpatrick level 2), behaviour change (Kirkpatrick level 3), degree of achievement of targeted outcomes (Kirkpatrick level 4) or effect on realism of a learning activity. Meakim et al. (2013) report that fidelity is used synonymously with realism and authenticity, whereas Bland et al. (2014) differentiate between fidelity and authenticity and their contribution to learning. Bland et al. (2014) define simulation fidelity as reproduction of object reality being as close as possible; authenticity, in comparison, is considered a subjective interpretation or response in relation to a constructed, interactional situation between learners, facilitators and varying degrees of technological fidelity. As the interpretation of authenticity can be highly variable, increasing fidelity and realism does not necessarily increase authenticity (Bland et al., 2014). Differing levels of fidelity, realism and authenticity have been shown to exert variable influences on learning in healthcare (Bland et al., 2014).

Two roles were developed to create a realistic EOC encounter for the learners, which included the responding physiotherapists and the HCA/nurse looking after the patient. During this study, multiple reasons contributed to the decision to allocate one volunteer participant to the role of the EOC physiotherapist and the other to the HCA. These reasons have been summarised in Box 8.1. I acknowledge that the effect of role allocation of participants to either the physiotherapist or HCA rather than having a qualified nurse (simulated by a qualified staff member) on the realism of the scenario is unknown. However, none of the participants voiced concern at being asked to undertake the role of a HCA.

Box 8.1: Influential factors affecting role allocation

Difficulties affecting the ability to embed a simulated HCA/nurse into the scenario	• No funding was available to train or pay for an independent contributor (simulated person) to portray the role of a nurse throughout the duration of this study • The lack of availability of one member of the physiotherapy or nursing programme team to consistently portray the role of the nurse for 24 sessions (which would have been necessary in order to permit each participant to portray the role of the physiotherapist)
Allocation of participants to the role of the HCA	• There was a very narrow timeframe for data collection between the participant's placement, exams and forthcoming elective placement, which negatively affected availability of teaching staff and the simulation facilities • The number of participants wishing to volunteer to participate in the study outweighed the number of available timeslots to conduct the study • Participant recruitment from the consecutive cohort was not possible due to my impending maternity leave. Following my return there would have been a difference of two academic years between cohorts, which would have influenced participants' experiences of different curricula content and exposure to SBE • The potential impact of allocating two participants as responding physiotherapists may have resulted in the participants sharing the duties of the EOC physiotherapists or one participant becoming more dominant and delegating physiotherapy tasks to the other. This is sometimes observed during placements when multiple students are allocated to a single clinical educator. This would not be replicated in EOC situations, thus affecting the overall desired realism and authenticity of the scenario

HCAs are employed within the NHS and are required to work under the supervision of a qualified nurse; they would realistically be involved in the management of an acutely deteriorating patient. Currently there are no set entry requirements to become a HCA (HEE, 2015). Some NHS employers require good literacy and numeracy skills, with qualification expectations including General

Certificate of Secondary Education (or equivalent) in English and Maths. Others expect some experience of healthcare or care work. Phase 2 participants were suitably qualified to undertake the role of the HCA as they had already completed five placements that would have likely involved working with a variety of HCAs. The allocation of participants to roles outside of a learner's scope of practice and experience is reported to negatively affect learning within SBE (Jeffries and Rogers, 2012).

The VRE interview allowed participants to openly discuss their respective roles and share any tensions they felt during the scenario and explore how they may change their actions if they were to repeat the scenario or in future clinical practice. The participants discussed their perceptions of the role of the HCA within the scenario. This was perceived to include providing assistance/support to the physiotherapist, whilst also communicating and providing updates on the patient's evolving status. Participants also discussed the appropriateness of speaking up/interrupting the physiotherapist and how withholding information may impact patient care. Whilst some participants felt unsure of the remit of the HCA role, one participant reported feeling constrained by the scenario role profile and prompts. Other participants undertaking the role of the HCA voiced that they were aware of what to do next and verbalised appropriate suggestions to their respective physiotherapist. Some felt they held back because they were participating in the HCA role. This may be due to the lack of experience of role portrayal within high-fidelity scenarios, as physiotherapy students are typically assigned to work in groups together, rather than as a sole EOC physiotherapist.

In reality, the HCA may offer very valid suggestions and may verbalise their opinions/suggestions to the multi-professional team. In all of the scenarios, the physiotherapists actively involved their respective HCA within the assessment and made appropriate requests for help and appropriately delegated tasks. During one VRE interview, the participants openly discussed their performance in a positive manner, including their openness to role delegation, and effective team working and communication skills, which they attributed to being on placement together (see section 7.2, still image 7.1 and page 135). It is recognised that hierarchical barriers in healthcare teams can be counterproductive and may result in ineffective healthcare practice and negatively affect patient safety (WHO, 2012). The WHO (2012) multi-professional patient safety curriculum advocates the inclusion of teamwork principles within undergraduate education. These include exploring how values, assumptions and awareness of the roles of team members all influence team interactions. In this study, the scenario provided an opportunity for the participants to explore the roles of the responding physiotherapist and HCA, and during the VRE interview, they also observed and challenged their own behaviours.

Since completion of this study, several standardised training programmes to increase the capacity and quality of provision of simulated patients within healthcare education in HEIs and organisations across the North West of England have emerged (Gough et al., 2015; Greene and Gough, 2015; Greene et al., 2015). A simulated patient training programme for both simulated patients and simulated patient trainers has been developed on behalf of Health Education England North West. It aims to help provide a safe environment for the patient and learner in which to rehearse patient-centeredness and other critical aspects of healthcare professionalism (Gough et al., 2015; Greene and Gough, 2015; Greene et al., 2015). However, it is acknowledged that by increasing the number of non-learner roles (simulated people[10] e.g. patients, relatives, carers or other healthcare professionals) involved within any given scenario, the cost of delivery will undoubtedly increase. The costs associated with the delivery of the scenario embedded in this study are discussed in the following section (8.2.4.2) and presented in Appendix 17.

In summary, the participants perceived the combination of SBE and VRE provided a valuable opportunity to promote skills development, increase self-awareness and provide placement preparation, and has the potential to influence patient safety. Whilst the participants valued the different aspects of realism afforded by the design of the scenario, the perceived value of SBE learning experiences with

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[10] A simulated person is defined by Palagnas (2012) as a person trained to portray a patient (simulated patient), family member, carer or other healthcare provider in order to meet the objectives of the simulation.

differing levels of realism and authenticity, and the effect on educational outcomes (e.g. knowledge, skills, attitudes, behaviours, critical thinking, clinical decision making, achievement of professional standards) has yet to be determined.

8.2.5 Research question 7: Cost as a measure of value

The transparent approach to costing method was used to calculate the full economic cost of undertaking the scenario and VRE, which is presented within Appendix 17. The FEC of designing and scheduling all 12 scenarios, VRE interviews and debriefs was £3706.00, equating to £154.42 per learner. (It should be noted that the scenario design costs of £1319 would not need to be replicated for future delivery). When the intervention is extrapolated to the provision of 42 sessions to cover the entire cohort of 86, this would equate to a cohort cost of £8553.56. However, the cost of replicating a single scenario and video-reflexive review during a debrief would not only have a large financial associated cost, but would also add logistical issues of timetabling specialist staffing and rooms. Especially as any given learning and teaching session has to be provided to all learners to ensure consistency of delivery and equitable learning experiences (CSP, 2013). In Appendix 17 I have also included the cost of a technician to assist with the set-up, control of the manikin and audio-visual requirements, which mirrors existing practice at the HEI location for the current study. This would have increased the design and delivery cost per 12 scenarios to £4444.00, with an associated increase in the cost per learner to £185.17. The replication cost for an entire cohort would therefore increase to £11,197.92.

There is a paucity of literature pertaining to the cost analysis of SBE in physiotherapy. The literature review identified only two research studies that have reported the cost of embedding SPs within a targeted physiotherapy educational intervention (Black and Marcoux, 2002; Shoemaker et al., 2011). Both studies omitted the FEC associated with delivery of their given SBE interventions. Black and Marcoux (2002) and Shoemaker et al. (2011) only reported the costs related to a single SBE intervention within a research study. Black and Marcoux (2011) reported a cost of US$1760.60 for the 19 physiotherapy students undertaking a 90-minute SP learning activity, whereas Shoemaker et al. (2011) reported the cost of US$500.00 for providing a four-hour interprofessional simulation exercise for 64 physiotherapy and occupational therapy students. Black and Marcoux (2011) did, however, acknowledge that inefficient integration of student scheduling, camera set-up recording, streaming and post-event processing contributed to higher staff costs (taking eight hours of staff time to run a four-hour intervention). Unlike the current study, full economic costs (direct costs and overheads relating to specialist laboratory use) were not reported (Black and Marcoux, 2002; Shoemaker et al., 2011).

To date, comparative literature pertaining to the health economic costs of SBE in healthcare is also limited. Medical researchers have reported the cost effectiveness of a SBE intervention focusing on central venous catheter insertion in the medical ICU, at one American teaching hospital. The authors estimated that approximately 9.95 catheter-related bloodstream infections were prevented among medical ICU patients with central venous catheters during the year post-simulation intervention (Barsuk et al., 2009; Cohen et al., 2010). The estimated incremental costs attributed to each infection were approximately US$82,000 in 2008 and 14 additional hospital days, including 12 medical ICU days (as reported by Barsuk et al., 2009). The total annual cost of the simulation intervention for 92 medical residents was US$111,916.07, or US$1216.50 per learner, which consisted of one hour of video lectures and three hours of deliberate practice featuring SBE with targeted feedback (Barsuk et al., 2009; Cohen et al., 2010). This reportedly generated a net annual saving of more than US$700,000 with a 7 to 1 rate of return on the targeted SBE programme.

More recently, the cost effectiveness of SBE for laparoscopic inguinal hernia repairs has been reported by Hernandez-Irizarry et al. (2016). Similarly, Hernandez-Irizarry et al. (2016) acknowledged the underestimation of the actual cost per learner of US$183.20 and cost of US$4030 per cohort of 44 general surgery residents for a one-hour SBE intervention. However, unlike the current study, their analysis excluded staff costs associated with the design and delivery of the SBE intervention, consumables and overheads (Barsuk et al., 2009; Cohen et al., 2010; Hernandez-Irizarry et al., 2016).

The value of SBE may be perceived differently depending on the perspective of the stakeholders involved, e.g. the learners, healthcare programme leads, organisations, professional bodies and society. Learners may focus their attention on academic achievement, whereas academic achievements gained at first examination attempts or reduction in the number of students requiring remediation may be a priority for HEIs. Current HEIs may review the sustainability and cost effectiveness of programme delivery models featuring SBE in the light of changes to funding. In contrast, in clinical practice costs may be averted through a reduction in pre-registration or qualified physiotherapists making fewer errors in practice by adhering to policies and guidelines. However, the value of SBE on healthcare delivery and costs to society realised through improved clinical performance and efficiency are more difficult to ascertain in monetary terms (Kernick, 2002; Donaldson, 2002; Kernick, 2003).

Table 8.1 presents the cost consequence analysis (benefits and challenges) of embedding SBE and VRE within a debrief in the pre-registration physiotherapy curriculum at the University. Firstly, the cost of delivering a scenario and video reflexivity to an entire cohort are considered. Secondly, the capital investment costs to create multiple realistic and authentic SBE scenarios are presented. Thirdly, the associated cost of training physiotherapy staff to develop proficient skills in simulation facilitation and debriefing is considered. Future economic analysis is warranted, but it may be inherently difficult to provide a comparative analysis of a series of specific educational interventions in relation to the intermediate measurement with associated clinical meaning in relation to long-term outcomes for patients or patient care. Potential influential factors include the complexity of healthcare practice, whereby teams frequently change on a daily basis and inability to control variables such as staffing changes related to rotational positions and attrition, the inability to control mandatory training requirements, frequency of patient contact and variances in patient complexity, and staff experience and working hours. In summary, the combination of SBE and video-reflexivity was positively perceived by pre-registration physiotherapy participants in this study as a valuable opportunity to promote skills development and increase self-awareness, and to provide placement preparation and the potential to influence patient safety. TRAC and cost consequence analysis of combining SBE and video-reflexivity during this study has been provided and compared to limited information reported in the existing literature.

Table 8.1: Cost consequence analysis

Costs	Consequences (benefits and challenges) associated with delivering the scenario and VRE intervention
Cost of delivering a scenario and video reflexivity to an entire cohort	**Benefits** • Provision of opportunities to conceptualise skills within a realistic environment, with equipment and psychological fidelity appropriate to the complexity of the scenario and level of the learners • Opportunities to increase self-awareness of the learners regarding their knowledge, skills, attitudes and behaviours, error recognition and patient safety • Opportunities for facilitators to identify learners' developmental progress (including those that excel, to those who require remediation or lack insight in their performance and/or development) • Provision of learning opportunities within a realistic and safe environment without impacting patient safety • Facilitating the transition from university-based to placement-based learning • Provision of digital resources (podcasts of the scenario/video-reflexive review of the video) to facilitate further reflection and evidence of professional development (e.g. within an e-portfolio) **Challenges** • High staff costs due to high staff (facilitator) to learner ratio • Timetabling issues due to frequency of repetition of a scenario to ensure equity of learning experiences for the entire cohort. This is increasingly more difficult with larger cohorts • High costs to develop realistic environmental, equipment and psychological fidelity • High costs of developing and piloting authentic scenarios
Capital investment costs to create multiple realistic and authentic SBE scenarios	**Benefits** • Increased realism for learners • Increased capacity for larger cohorts and equity of learning opportunities • Increasing the availability of rooms with specialist equipment thus facilitating increase in synchronous timetabling for SBE **Challenges** • Time delay associated with procurement, installation and staff training • Additional costs of technicians to support new equipment and specialist teaching facilities, and purchase of external support contracts
Cost of training multiple physiotherapy staff to develop proficient skills in simulation facilitation and debriefing	**Benefits** • Increased skill level of all programme staff • Increased capacity for learning, teaching and research featuring SBE and video-reflexivity • Opportunities to engage in research and knowledge exchange in the future **Challenges** • Time delay of training • Loss of staff availability for other aspects of research, education and knowledge exchange

8.3 The development of the Integrated Simulation and Technology Enhanced Learning (ISTEL) framework

The literature search identified an absence of a framework to facilitate the design, development and evaluation of physiotherapy SBE. One additional outcome from this research study was the development of the Integrated Simulation and Technology Enhanced Learning (ISTEL) framework. The ISTEL framework integrates the theoretical and educational practices that underpinned the simulation design, development and analysis of the study, and the implementation and evaluation of STEL interventions (Figure 8.1). Table 8.2 provides an overview of the influence of the literature review, research methodology and methods, and analysis on the development of the ISTEL Framework.

The ISTEL Framework design has been influenced by existing simulation and instructional design frameworks (Jeffries, 2005; Dieckmann, 2009; DH, 2011; The NHET-Sim Monash Team, 2012; Chiniara et al., 2013) and guidance on best practice of simulation in healthcare (Issenberg et al., 2005; Motola et al., 2012; Meakim et al., 2013; Gloe et al., 2013; Lioce et al., 2013; Franklin et al., 2013; Boese et al., 2013; Decker et al., 2013; Sando et al., 2013). In this instance, STEL is defined as the inclusion of simulation, simulated patients and other:

> innovative educational technologies, such as e-learning, smart phones, which provide unprecedented opportunities for health and social care students, trainees and staff to acquire, develop and maintain the essential knowledge, skill, values and behaviours needed for safe and effective patient care. (DH, 2011:6)

It incorporates technology to enhance learning such as video-recording equipment to support the use of video debriefing, video-reflexivity and generation of podcasts of simulation scenarios. The decision to name the framework 'ISTEL' was due to the integration of technology to support learning during all three components: preparation (e.g. when using a flipped classroom approach and or a virtual learning environment), intervention (e.g. during the pre-brief and debrief, scenario and linked learning activities) and evaluation/research.

Figure 8.1: The Integrated Simulation and Technology Enhanced Learning (ISTEL) Framework

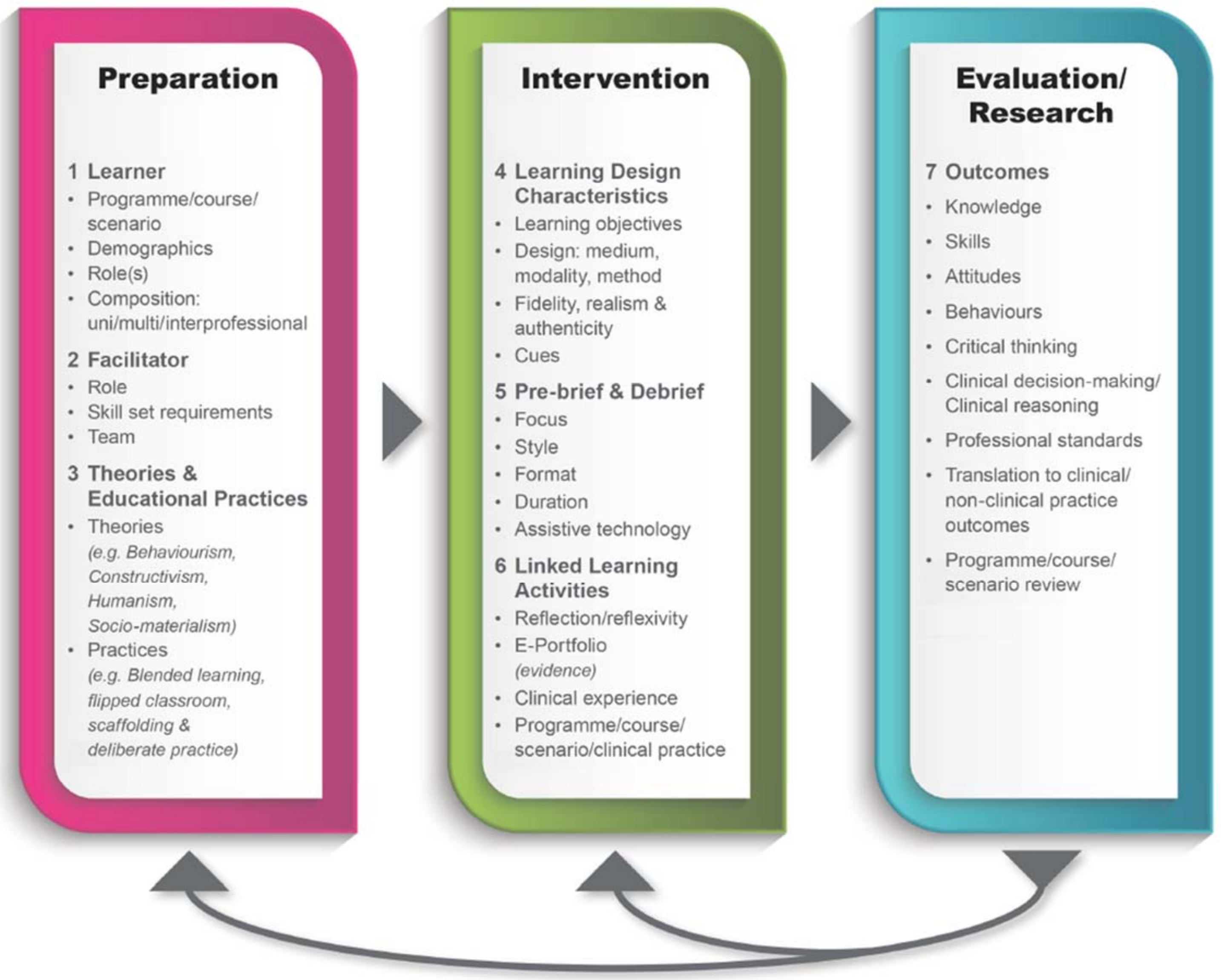

Table 8.2: Development of the ISTEL Framework

ISTEL components and respective elements	Highlighted by the literature review	Implementation in the study design	Research findings	Details of the design of the ISTEL preparation, intervention and evaluation components and some of the findings derived from the research study
PREPARATION 1. Learner	√	√	X	Final year BSc (Hons) Physiotherapy students from one HEI in the UK. All students undertook active roles within a uni-professional simulation scenario and debrief featuring a VRE interview.
2. Facilitator	√	√	X	Facilitator and researcher roles were identified. Skill set established and formal training acquired within specialist areas of simulation scenario design, educational theory, debriefing, human factors and patient safety. PhD supervisory team available.
3. Theories and educational practices	√	√	X	The methodological design was informed by social constructivism (Crotty, 1998; Pritchard, 2008; Rutherford-Hemming, 2012) and socio-material (complexity) theoretical perspectives (Johnson, 2007; Iedema et al., 2013; Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). The scenario and video-reflexive interview embraced social constructivist theories including Vygotsky's (1968) zone of proximal development and situated and authentic learning (Lave and Wenger, 1991). Educational practices within the existing physiotherapy curriculum included blended learning (DH, 2011), flipped classroom (Roehl et al., 2012) and scaffolding (Gould, 2009) with increasing levels of complexity of scenarios and the provision of opportunities for deliberate practice prior to practice (clinical) placements.
INTERVENTION 4. Learning design characteristics	√	√	√	Learning objectives were developed in line with social constructivist principles (Pritchard, 2008; Rutherford-Hemming, 2012). The instructional medium included high (equipment, environmental and psychological) fidelity simulation, featuring a computerised human patient simulator. The modality was an immersive clinical simulation scenario featuring an acutely deteriorating medical in-patient. The simulation scenario has been outlined in Box 4.1. The instructional method included self-directed learning. Realism was achieved through authentic artefacts (equipment and environment) and scenario design. Antecedent, reality and conceptual cues were incorporated into the scenario (Burton et al., 1996; Dieckmann et al., 2007; Paige et al., 2013). Fiction cues were avoided and responses to intervention were realistic in terms of physiological responses and timing (Dieckmann et al., 2007). The scenario was designed to replicate the complexity of an emergency on-call physiotherapy situation and piloted to minimise cognitive overload (Sweller, 1998).
5. Pre-brief and debrief	√	√	√	Pre-brief information was provided in advance of the study through the participant information sheet, with respect to the focus, style format, duration and use of assistive technology, and discussed in person on the day of the study. Information was also detailed relating to the debrief procedures in writing and discussed verbally during the pre-brief (format, style, anticipated duration and use of video recording technology required to undertake the video-reflexive interview).
6. Linked learning activities	√	√	√	Following the VRE interview, linked learning activities were discussed with study participants. Participants were provided with a copy of their own video footage (scenario and VRE interview), which they could combine with further written reflexive evidence for their personal e-portfolios. The participants positively valued the video review and provision of digital resources (DVD of the scenario and VRE interview) as opportunities to transform learning from the simulated scenario to practice during their forthcoming (final, elective) practice-based placement.
EVALUATION/RESEARCH 7. Outcomes	√	√	√	Video and thematic analysis was undertaken to explore knowledge, skills (technical and non-technical), attitudes, behaviours, clinical decisions and reasoning, elicited when managing an acutely deteriorating patient. The error frequency, type and independent error recognition abilities were also explored. A priori themes were integrated within the thematic video analysis from the Physiotherapy Framework (CSP, 2013), Non-technical Skills for Surgeons observational behaviour tool (Yule et al., 2008), and the Acute Illness Management rubric (GMCCSI, 2011). Findings indicated that the participants worked within the expected professional standards of physiotherapy practice (CSP, 2013). Video-reflexivity findings relating to error identification, error typology and frequency have provided insights to inform physiotherapy curricular development and the design of STEL interventions and simulation facilities.

8.3.1 The ISTEL Framework components

The ISTEL Framework integrates three distinct but interlinking, essential components to be considered when designing, developing, implementing and evaluating or researching STEL. These include preparation, intervention and evaluation or research. These three components are further divided into seven elements: 1) learner, 2) facilitator, 3) theory and educational practices, 4) learning design characteristics, 5) pre-brief and debrief, 6) linked learning activities and 7) outcomes. The ISTEL Framework was constructed to illustrate the integrated and interlinking considerations required in the preparation, intervention and evaluation or research involving STEL.

Each of the three integrated components of the ISTEL Framework – preparation, intervention and evaluation/research – will now be explored in detail drawing on illustrative examples from the literature.

8.3.2 Preparation component

This component includes three elements: 1) learner, 2) facilitator and 3) theories and educational practices. *Element 1: Learner,* includes consideration of the scenario, course or programme (curriculum) to be developed, learner demographics (e.g. age, level of experience and grade where appropriate), role(s) and composition.

Learners are defined as participants who engage in a STEL activity with the purpose of achieving mastery of knowledge, skills, attitudes and behaviours of professional practice (Gloe et al., 2013). The next step is to explore the demographics of the learners involved in the scenario/course/programme. In the current study, the learners were final year pre-registration BSc (Hons) physiotherapy students from one HEI in the UK. All students undertook active roles within a uni-professional simulation scenario and VRE interview, followed by a debrief. It is important to consider all learners to be involved in the STEL intervention, as considerations of role allocation and scenario composition will need to be decided prior to scenario development. Important considerations also include the total number of individuals and the different professional groups that would be present or involved in a given clinical situation.

The size of the SLE or practice environment in which the intervention will take place may also govern the group size and roles. Online or virtual learning simulation scenarios may afford more flexibility in relation to roles and numbers actively involved in a given scenario or activity. The allocation of learners to active roles within a scenario and allocating specific tasks to others undertaking peer-observer roles provides purpose and direction. In the current study two active roles were identified, the responding emergency on-call physiotherapist and the HCA. In some instances, learners may also be allocated the role of peer-observers. To engage peer observers, it is recommended they are allocated specific tasks such as observing and rating skills and/or behaviours using checklists relevant to the learning objectives that can be integrated within the debrief (Gloe et al., 2013; O'Regan, 2016). Gloe et al. (2013) established standards to ensure professional integrity of all learners involved in SBE. Professional integrity is vital, as a lack of learner professionalism and mutual respect can negatively influence participation and ultimately learning (Gloe et al., 2013). It is achieved through demonstration of mutual respect for learners, recognition of unprofessional and unethical behaviour, and provision of honest, confidential, respectful and constructive feedback during the debrief and linked learning activities (DH, 2011; Gloe et al., 2013).

Element 2: Facilitator, relates to consideration of the skill set requirements, role and team involved in various components of the STEL activities. In Phase 2, a single facilitator (the researcher) was involved in all 12 scenarios. It was important that I had the skill set required to design, facilitate and debrief the intervention within Phase 2 (including knowledge and experience of simulation scenario design, educational theories, debriefing, human factors and patient safety). At the time of the study, no financial funding was available to pay for an additional facilitator and the department did not have a designated simulation technician.

In other organisations, multiple facilitators may be involved at various stages of the STEL activities, each with different roles and skill sets. Boese et al. (2013) recommend that a proficient facilitator is required to manage the complexity of all aspects of STEL activities, who can demonstrate specific simulation educational expertise and continued education. In the instances of course or programme developments there may be multiple facilitators enlisted to participate but there will likely be a designated leader or director (Roberts and Greene, 2010). As the term suggests, the facilitator is responsible for facilitating learners to achieve the desired learning objectives (Meakim et al., 2013; Franklin et al., 2013). The facilitator's role is to provide appropriate guidance, support and facilitation to foster skill development, clinical judgements and clinical reasoning in the pre-brief, STEL intervention, debrief and linked learning activities (Meakim et al., 2013; Boese et al., 2013). This is central to the optimisation of learners achieving the desired objectives (Burton et al., 1996; Gould, 2009; Lioce et al., 2013; Franklin et al., 2013) and fostering professional integrity (Gloe et al., 2013). Boese et al. (2013) established nine criteria for facilitators to enable learners to achieve the desired learning objectives. The criteria establish key roles including clearly communicating objectives and expected outcomes, establishing a safe learning environment, promoting and maintaining fidelity, using appropriate facilitation methods, assessment and evaluation roles, modelling professional integrity, fostering learning and progression, establishing outcomes data and providing constructive feedback to learners.

Boese et al. (2013) and DH (2011) both identify essential facilitator skill set requirements (learning and experience) including possession and demonstration of substantial current knowledge relating to expected outcomes of simulation, as well as understanding theories and principles of experiential and contextual learning, reflective practice and debriefing. Facilitators within the team will also require competent skills in scenario design/modelling, debriefing, development of appropriate assessment strategies and scenario/course/programme evaluation or research, in order to aspire to excellence in educational provision (DH, 2011; Boese et al., 2013; Decker et al., 2013; Franklin et al., 2013; Sando et al., 2013). Thus, to optimise learning, the facilitation team should possess all of these key skill set requirements, knowledge and attributes, to enhance the achievement of the desired learning objectives or intended outcomes (Boese et al., 2013). The DH (2011) also recommend the identification of a strategic lead facilitator, who should ensure staff and learners have access to relevant simulation and technology to meet clearly defined curricula/patient/service needs appropriately. The lead should be able to evidence the appropriate integration of STEL, value for money, equity of access and that provisions are reviewed regularly to ensure they meet the needs of the specific learning objectives (DH, 2011).

Element 3: Theories and educational practices. This element focuses on drawing attention to appropriate learning theories and educational practices applicable to STEL. Theories and educational principles will influence both the design of the intervention (learning design characteristics, pre- and debriefing, linked learning activities) and evaluation or research considerations. Knowles (1968, 1990) described adult learners as self-directed, motivated and orientated towards real-life issues. Theories commonly associated with adult learning include behaviourism, cognitivism, constructivism and humanism (Gould, 2009). Socio-material theories e.g. complexity, cultural historical activity theory and actor network theory (Engeström, 1987; LaTour, 2005; Law, 2007; Mennin, 2010; Fenwick and Edwards, 2013; Fenwick, 2014; Eppich and Cheng, 2015) provide a conceptual lens through which to explore patterns of conformity and unpredictability in educational activities and lifelong learning (see Appendix 1, page 264). In particular, socio-material theories are attractive to both educationalists designing and delivering STEL interventions and those evaluating courses or curricula and researchers alike, to explore struggles, negotiations and accommodations affecting learners, facilitators, educational resources and learning itself (Fenwick and Edwards, 2013; Eppich and Cheng, 2015). Each of these theoretical perspectives offer benefits in their own right, which should be considered in the context of the learning activity to be designed (short course or embedded within a curricula), learning objectives (performance goals) and the learners (uni/multi/interprofessional groups). The selection and utilisation of multiple theories offers opportunities to provide multiple perspectives of learning (Nestel and Bearman, 2015).

In Phase 2, the methodological design was informed by social constructivism (Crotty, 1998; Pritchard, 2008; Rutherford-Hemming, 2012) and socio-material (complexity) theoretical perspectives (Johnson, 2007; Iedema et al., 2013; Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). The scenario and video-reflexive interview embraced social constructivist theories including Vygotsky’s (1968) zone of proximal development and situated and authentic learning (Lave and Wenger, 1991). Educational practices within the existing physiotherapy curriculum included blended learning (DH, 2011), flipped classroom (Roehl et al., 2012), scaffolding (Gould, 2009) with increasing levels of complexity of scenarios and the provision of opportunities for deliberate practice prior to practice (clinical) placements.

Professional educational healthcare programmes (in higher education) are examples of formal learning, which characteristically involve the development of a specific curriculum, designated (specialist teaching) faculty and results in assessment or certification. (In this instance, the term 'programme' refers to a credit-bearing curriculum, for example a pre-registration physiotherapy programme.) Educationalists are required to draw on theories and educational practices to support the development of the holistic curricula, which are driven by current practice and regulatory and statutory requirements (DH, 2004, 2011; CSP, 2015). Key drivers in curriculum development also include statutory and professional bodies' requirements. Examples for UK pre-registration physiotherapy curriculum development include the Chartered Society of Physiotherapy's Physiotherapy Framework: putting physiotherapy behaviours, values, knowledge and skills into practice (CSP, 2013); learning and development principles (DH, 2004); the Health and Care Profession Council standards (HCPC, 2012a, 2012b, 2013), the National Health Service Knowledge and Skills Framework at Band 5 (DH, 2004) and the Quality Assurance Agency Framework for Higher Education Qualification in England, Wales and Northern Ireland (QAA, 2008).

In contrast, informal learning is defined as lacking at least one of the aforementioned formal learning characteristics, and occurs more opportunistically and is part of an ongoing process (Hager and Halliday, 2006). Contemporary STEL activities provide informal learning opportunities for uni/interprofessional groups to develop knowledge and extend understanding of and connection with practice through the facilitation of participation, peer and vicarious learning (DH, 2011; Kelly and Halliday, 2015). Informal learning principles can also be applied to in-situ, ad hoc or impromptu STEL activities in healthcare environments to enrich learning.

Utilisation of educational practices can optimise learning time spent with the facilitator during STEL activities (DH, 2011; Franklin et al., 2013; Lioce et al., 2013). In 2005, McGaghie et al. summarised the 12 best features and educational practices of SBE, these included curriculum integration, outcome measures, simulation fidelity, skill acquisition and maintenance, team training, feedback, deliberate practice, mastery learning, transfer to practice, high-stakes testing, instructor training and educational and professional context. Additional educational practices, which align with the learning and teaching theories, include blended learning (DH, 2011), flipped classroom (Roehl et al., 2013), scaffolding (Gould, 2009; Pritchard and Wollard, 2010) and deliberate practice (Gould, 2009; Clapper and Kardong-Edgren, 2012). A blended learning approach is advocated, which may include SBE, e-learning and other new learning technologies to facilitate achievement of the desired learning objectives across the course or curriculum or clinical needs (DH, 2011; Chiniara et al., 2013; Lioce et al., 2013).

Flipped classroom resources can be designed to support the development of prerequisite knowledge and or skills required within the forthcoming SBE activities, outside of the formal classroom (Roehl et al., 2013). The flipped classroom approach may help prepare learners for the simulated experience, highlighting key topics and achieving baseline knowledge and skills (technical and non-technical). Learning activities can be scaffolded to introduce more complex concepts, skills and procedures incrementally (DH, 2011; the NHET-Sim Monash Team, 2012; Lioce et al., 2013). Learning activity and respective learning objective complexity can be manipulated to enable the learner to move progressively towards achievement of the intended level of development, progress from novice to expert or achieve mastery (Bloom, 1956; Dreyfus and Dreyfus, 1980; Benner, 1984; Pritchard and Wollard, 2010; Clapper and Kardong-Edgren, 2012; Motola et al., 2012; Fenwick and Abrandt Dahlgren, 2015).

8.3.3 Intervention component

The intervention component features three elements: 4) learning design characteristics, 5) pre-brief and debrief and 6) linked learning activities. *Element 4: Learning design characteristics*, includes the integration of learning objectives, design, fidelity, realism, authenticity and cues to optimise learning. The development of learning objectives is a vitally important aspect of developing learning resources (Burton et al., 1996; Gould, 2009: Lioce et al., 2013). Learning objectives should address all domains of learning, be correlated to the learner's level and experience, correspond to the overall course or curricula outcomes, feature evidence-based practice and be achievable within a realistic timeframe (Lioce et al., 2013).

Learning objective development may also differ depending on the purpose of the learning activity and according to different theoretical perspectives. For those adopting a behaviourist approach, the development of learning activities typically starts with the objectives e.g. desired achievement of changes in the cognitive (knowledge), psychomotor (skills) and affective (attitude) domains, which are often written in the SMART format: specific, measurable, achievable, relevant and time-bound (Gould, 2009). In Phase 2, the learning objectives were developed in line with social constructivist principles (Pritchard, 2008; Rutherford-Hemming, 2012), as summarised in Box 4.1 (see page 79). Alternatively, adopting a humanistic (learner-centred and learner-driven) approach involves objectives being established by the learners and not the facilitator (Gould, 2009). In contrast, socio-material learning activities are not usually driven by learning objectives or the learner's individual skills or techniques but on the relationship generated between these and what is produced (Gould, 2009; Fenwick and Abrandt Dahlgren, 2015).

Instructional design principles may be used to facilitate the design of STEL learning activities (Kaakinen and Arwood, 2009; Schaefer et al., 2011; Chiniara et al., 2013; Robinson and Dearmon, 2013). It is important that the most appropriate simulation medium, modality and method of STEL are selected to enable the learners to achieve the desired learning objectives and desired outcomes (DH, 2011). Instructional design terminology (*medium, modality* and *method)* may be used to articulate the design of the STEL intervention. The 'zone of simulation matrix' (Chiniara et al., 2013:e1381-1382) may also help to identify learning events that are most suited to simulation. In Phase 2, the instructional medium (format) included high (equipment, environmental and psychological) fidelity simulation, which featured a computerised human patient simulator. The simulation modality was an immersive clinical simulation scenario featuring an acutely deteriorating medical in-patient (represented by a computerised human patient simulator). The simulation scenario has previously been outlined in Box 4.1 (see page 79). The instructional method included self-directed learning in this instance rather than facilitator-led learning, as it was part of a research study to explore independent management of a deteriorating patient in a simulation context (RQs 3-6, Figure 4.3 on page 74).

Any STEL intervention should then be developed in accordance with technical standards and permit equity of access for all learners (DH, 2011). Articulation of the specific scenario and environmental design considerations required to achieve optimal fidelity, realism and authenticity should be considered within the constraints of the course, programme or individual curriculum (Drescher et al., 2004; Issenberg et al., 2005; Motola et al., 2012; Meakim et al., 2013; Bland et al., 2014).

The literature review highlighted that there is no universally adopted definition of fidelity in healthcare. In this case, I refer to the INACSL standards that define fidelity as the 'believability, or the degree to which a simulated experience approaches reality; as fidelity increases realism increases' (Meakim et al., 2013:S6). Fidelity is further defined into physical (environmental and equipment factors), psychological (emotions, beliefs and learner self-awareness), social (learner and facilitator motivation and goals), culture of the group, degree of openness, trust and modes of thinking (Meakim et al., 2013). Whilst Meakim et al. (2013) report that fidelity is used synonymously with realism and authenticity, Bland et al. (2014) differentiate fidelity and authenticity and their contribution to learning (as discussed in section 8.2.4). Bland et al. (2014) argue that as an individual's interpretation of authenticity can be highly variable, increasing fidelity and realism does not necessarily increase authenticity.

The term cueing (also referred to as cuing) is commonly used in aviation, computer sciences, human factors and, more recently, healthcare literature (Paige and Morin, 2013). The INACSL standard's definition of cueing (Meakim et al., 2013) refers to information provided to enable learner progression through the scenario to achieve the desired learning objectives. Additionally, more specific definitions include antecedent, verbal, written, fiction, conceptual and reality cues (Dieckmann et al., 2007; Paige and Morin, 2013). The term 'antecedent cue' is linked to selectionist and radical behaviourism and refers to objects and events that serve as cues within a given learning activity to signal specific behaviours. In order to enhance the realism of the situation in the current study, authentic artefacts (equipment and environment) and scenario design were carefully selected and piloted (see sections 4.2.2. and 4.2.5 respectively). Antecedent, reality and conceptual cues were incorporated into the scenario (specific details have been provided in Appendix 14 and summarised in Box 4.1 on page 79).

In addition, scenarios may be developed to include overt verbal cues from facilitators or simulated patients and or/written cues to enable learners to discriminate conditions for behaving in a way that returns the desired consequence in a scenario e.g. normalisation of physiological responses to a given intervention. Dieckmann et al. (2007) also referred to fiction cues, which are implausible or artificial artefacts, actions and perceptions. It is reported that when fiction cues are presented artificially, e.g. escalation of physiological responses in relation to a drug intervention, the realism of the scenario is negatively affected. In the current study, fiction cues were avoided in the scenario and responses to intervention were realistic in terms of physiological reactions and timing (Dieckmann et al., 2007). Conceptual cues facilitate learners to achieve the instructional objectives through planned, enacted programmable equipment, environmental or scenario events and to manage anticipated or unanticipated actions or behaviours (Paige and Morin, 2013). Such cues were embedded in the scenario design and notes for the facilitator (Appendix 15: Scenario state overview and programing information, on pages 302-305). Reality cues are referred to as features embedded into the equipment and the environment, which enable offsetting of simulator or equipment limitations, bridging the realism gap in a scenario (Paige and Morin, 2013). The incorporation of conceptual and reality cues within scenario design were considered important to enhance the conceptual dimension of fidelity/realism and aid learner achievement of the overall intended learning objectives (Drescher et al., 2004; Jeffries, 2005; Paige and Morin, 2013). Dieckmann et al. (2010) also refers to scenario life-savers, which can be provided to learners when comprehension or acceptance of a scenario become compromised or unanticipated actions occur, to regain desired behaviours.

Piloting the scenario provided valuable information regarding the nuances that may exist between simulated and actual reality (Burton et al., 1996; Paige and Morin, 2013), which prompted cueing enhancements within the scenario design (section 4.2.5). In the current study, all learners valued the scenario as an opportunity to put the theoretical aspects of physiotherapy into practice (see section 7.5). Participants agreed that the scenario provided an immersive situation, but differences of opinion were raised in relation to the realism of the scenario design (section 7.5, page 143). Examples from the current study included the lack of handwashing equipment and physiological limitations of the manikin affecting the realism of the scenario. Despite the inclusion of cues and prompts within the scenario, to some learners these were still not overt or transparent enough to prompt appropriate responses. Lefroy and Yardley (2015) advocate that where disturbances or breakdown in fiction (loss of reality) occur within a scenario, the feedback/debrief should emphasise these differences to clinical practice. In the current study, this was achieved through the VRE interview and debrief.

Element 5: Pre-brief and debrief refers to the design and implementation considerations relating to the focus, style, format, duration and use of assistive technology. Pre-brief and debrief are presented together as they share common essential design and implementation considerations with respect to the focus, style, format and duration. Pre-brief preparations include defining the focus of the pre-brief (orientating the learners to the prior learning requirements, learning objectives and series of learning activities (Meakim et al., 2013). In Phase 2, the advance provision of the pre-brief information (Appendix 6: Participant information sheet, on page 279) orientated the participants (learners) to the focus, style format, duration and use of assistive technology in the study. This was reinforced prior to commencement of the scenario (see section 4.2.6).

A pre-brief may also include a video or verbal information that signals the start of the scenario. The style of delivery may include face-to-face or online resources and may incorporate a video orientation to the simulation and debrief facilities (if this is the first exposure the SLE for the particular learner group). It is important to orientate learners to the SLE, to establish similarities and differences between simulation and reality. The format of the pre-brief may outline the allocation of roles for both facilitators and learners during the STEL intervention and debrief.

Establishing the duration of the pre-brief is advisable, particularly when this is to be factored into face-to-face timing allocations.

Additional information for facilitators may include pre-brief information for those offering technical support, or simulated patients involved in the learning activity and debrief. Separate briefings may be offered to the simulated patient or simulated people (relatives, carers or other healthcare professionals) involved in a given scenario, so as not to reveal pertinent information ahead of time to the learners. Clarification of the use of assisted technology may include, for example, a) the provision of video podcasts to provide an orientation to the SLE or simulated patient introduction, to set the scene during the pre-brief; b) whether video recordings will be made of the scenario or learning activity and if this will be made available during the debrief or for linked learning activities; and c) establish consent for video use. This information should also be clearly articulated to the learners and documented within simulation briefs and referred to in scenario documentation or lesson plans.

In the current study, the debrief information and procedures were provided in writing and the format was discussed verbally during the pre-brief. The format, style, anticipated duration and use of video recording technology required to undertake the video-reflexive interview was also discussed in the pre-brief, prior to the orientation of the learners (study participants) to the SLE (as detailed in section 4.2.6). The participants in this study positively valued the opportunity to review their simulation video reflexively (Table 7.4: basic theme 14.6, quote 42 and discussed in section 7.5), which afforded the ability to scrutinise their own and each other's behaviour to influence future practice. The focus of this debrief was to resolve any erroneous events or discussions arising from the scenario or VRE interview (further details have been presented in section 4.2.6). Immediately following the VRE interview, all participants participated in a debrief.

The effectiveness of debriefing in healthcare simulation has been widely reported (Issenberg et al., 2005; Rudolph, 2006; Motola et al., 2012; DH, 2011). Debrief preparations include clarification for learners, simulated patients (when applicable) and facilitators relating to the focus, style, format, duration and use of assistive technology that will be involved in the debrief process. In the current study, audio-visual technology was used to record the scenario and replayed (un-edited) within the VRE interview. Similarly, the audio-visual technology can be used to code live scenarios, which can be replayed within a debrief. To date, the approach and impact of using video-assisted technology during debriefing is inconsistent (Levett-Jones and Lapkin, 2014), despite guidelines for its use.

The focus of the debrief is predominantly driven by the learning objectives linked to the STEL intervention (Sando et al., 2013). The objectives may relate to knowledge, technical and non-technical skills, attitudes, behaviours, critical thinking, clinical decision making and clinical reasoning skills (Issenberg et al., 2005; Rudolph et al., 2006; DH, 2011; Motola et al., 2012; Sando et al., 2013), and evidence-based practice (Neill and Wotton, 2011). The style refers to learner or facilitator-led debriefing and this may be influenced by a chosen theoretical perspective or facilitator preference. The format of debriefs can vary from being relatively unstructured to highly structured. Research to date has failed to establish standards in relation to optimal technique, timing and duration of healthcare debriefing (Cant and Cooper, 2010). Innovative models of debriefing have been presented in the literature (Kessler et al., 2015; Kolbe et al., 2015). More recently, Eppich and Cheng (2015) advocated that the theoretical perspectives of cultural historical activity theory provide a suitable lens to view interprofessional team simulation and debrief learning. Structure may be provided through debrief rating tools (Imperial College London, 2012).

Element 6: Linked learning activities, refers to design and implementation considerations relating to post-simulation and debriefing learning activities, including reflection or reflexivity, utilisation of material to demonstrate evidence of personal and professional development using paper or e-portfolios and further clinical experiences (e.g. related scenarios, courses, curricula or clinical activities). These may include reflection or reflectivity activities undertaken individually or in groups to make sense of what happened in the STEL activity. It is important to stimulate the learner to think beyond the simulation practices and debrief, in order to implement learning derived from the feedback (Issenberg et al., 2005; Motola et al., 2012; Meakim et al., 2013). Linked learning activities provide further opportunities to review, practice and embed knowledge, skills and behaviours developed in the SLE and consolidate the learning objectives.

Findings of the current study indicated that the learners (study participants) attributed value to the opportunity to develop action plans based on their existing behaviours and actions within the simulated scenario, which some planned to use as preparation for their forthcoming elective placement and future situations post-graduation. The provision of the digital resources was viewed positively as a linked learning opportunity, by developing action plans derived from the scenario and VRE, to aid preparation for their forthcoming placement (Table 7.4: basic themes 14.6: video review and 14.7: digital video disc on page 144, and discussed in section 7.5).

The facilitator may include specific reference within the debrief to further reflective/reflexivity activities or remediation guidance from which the learners may benefit (Decker et al., 2013). The guidance may be articulated through a managed learning environment (DH, 2011), e.g. Moodle used at the University involved in this study. These activities may be either voluntary or mandatory, depending on the requirements of the current learning activity (e.g. formative or summative assessment). Linked learning activities may relate to clinical experience through placements, in-situ experience or further educational activities via formal or informal courses, simulation-based learning scenarios or in clinical practice. Additionally, learners could be specifically directed to reflect on their own clinical or simulated practice to consolidate learning from the curriculum and other voluntary learning opportunities or courses. The use of VRE, group or self-reflection beyond the debrief may be appropriate and can be used to deepen a learner's reflection and reflexivity. The scenario, debrief and further reflective activities may be used as evidence of performance, achievement or involvement in professional development and documented on paper or in electronic formats, such as an e-portfolio (Sandars, 2009; Gough and Hamshire, 2012). The provision of digital resources arising from STEL has the potential to enhance the learner's educational experiences and facilitate repetitive post-event reflection.

8.3.4 Evaluation and research component

The final component consists of one element. *Element 7: outcomes,* relates to evaluation or research considerations, which may include observation, measurement and/or exploration of knowledge, skills (performance/retention), attitudes, behaviours (e.g. non-technical skills), critical thinking, clinical decision making, clinical reasoning, professional standards, translation to clinical/non-clinical practice outcomes, and programme, course or scenario review. It is essential that an evaluation of the ISTEL preparation and intervention is undertaken to evaluate the effectiveness and/or assess achievement of the desired outcomes (Kernick, 2002, 2003; Kneebone, 2005; Rudolph, 2006; DH, 2011; Meakim et al., 2013; Lioce et al., 2013; Boese et al., 2013) and value for money (Roberts, 1996; Kernick, 2002, 2003; Salas, 2009).

There is no universally accepted approach to evaluation, due to the tensions derived from the diversity of instructional design and application of STEL in healthcare (Kneebone 2005; DH, 2011). The evaluation and research relating to STEL interventions requires thought and careful consideration to ensure that it is meaningful and representational, in order to drive changes in STEL preparation and intervention to ultimately impact on healthcare practice (DH, 2011; Sando et al., 2013). The DH (2011) also recommends the evaluation of the facilitator's abilities to use STEL, equity of access and quality of provision. Maintenance of local or national registers of technology and learning and teaching resources are recommended and may reduce duplication and secure value for money (DH, 2011).

Whether evaluating a scenario, course or entire programme (curriculum), the same principles of evaluation apply. Adamson et al. (2012) outline critical steps in the evaluation of simulation practice and research, including identifying the purpose of the evaluation, determining timeframes, identifying when to evaluate, develop an evaluation plan, select the evaluation instrument and collect and evaluate the data. It is important to establish key timeframes for evaluation and research that are appropriate and will generate meaningful information. The actual timing of evaluation may be determined by the timetabling of formative and summative assessment or identified as an optimal opportunity within a research study (e.g. repeated measures over a period of time). Whether for academic or research purposes, an evaluation plan provides transparency and guidance for all those involved in learning, teaching, researching and evaluating STEL. Academic institutions are now under increasing pressure to provide evidence of course or programme performance metrics, which is increasingly benchmarked against performance standards within their respective sector (for example, the UK performance indicators for higher education providers, Higher Education Statistics Agency, 2015).

In the current research study, video and thematic analysis was undertaken to explore knowledge, skills (technical and non-technical), attitudes, behaviours, clinical decisions and reasoning, elicited when managing an acutely deteriorating patient. The error frequency, type and independent error recognition abilities were also explored using video analysis (presented in section 4.2.7). Specific details of the research design, data analysis and methods have been presented in section 4.2. Thematic analysis included a priori themes relating to physiotherapy knowledge, skills and behaviours (CSP, 2013), non-technical skills (Yule et al., 2008) and acute illness management (GMCCSI, 2011). Findings of the current study indicated that the participants worked within the expected professional standards of physiotherapy practice (CSP, 2013). Video-reflexivity findings relating the error identification, error typology and frequency have provided insights to inform physiotherapy curricular development and the design of STEL interventions and simulation facilities.

Although derived from an alternative domain to healthcare, Kirkpatrick's (1959 and later revised in 1994) four levels of evaluating learning (training) programmes are often reportedly used in the evaluation of STEL (Jeffries, 2012; Adamson et al., 2012). The New World Kirkpatrick Model (Kirkpatrick and Kirkpatrick, 2010) as discussed in section 2.2 includes level 4: results; level 3: behaviour; level 2: learning; and level 1: reaction. One deficit of the New World Kirkpatrick Model is the lack of acknowledgement of the economic costs associated with training evaluation. Both Phillips (1996) and Salas (2009) have previously proposed the addition of level 5: return on investment (the benefits to the organisation or outcomes measured as benefits in relation to the resources invested). Furthermore, there has been a call for health economic cost analysis of SBE in healthcare education and practice (Kernick, 2002, Donaldson, 2002; Kernick, 2003) and more recently by Maloney and Haines (2016). To complement the value that the learners (study participants) attributed to the SBE and VRE interview, cost analysis was undertaken to identify the financial and resource costs of undertaking the current study (see sections 7.5.1 and 8.2.4, and Appendix 17 on pages 146, 172 and 309-310 respectively).

Kneebone (2005) suggested an alternative theoretical framework for evaluating the effectiveness of clinical simulations with respect to procedural skills. Kneebone's four evaluation criteria include allowing for sustained deliberate practice within a safe learning environment; scaffolding of expert facilitator support; simulations should map clinical experience and ensure that learning supports the experience gained within communities of practice; and that simulation-based learning environments should provide a supportive, motivational and learner-centred atmosphere that is conducive to learning (Kneebone, 2005). The four criteria are based on theoretical positions including deliberate practice (Ericsson, 2004), the zone of proximal development (Vygotsky, 1978), self-regulated learning (ten Cate et al., 2004), situated learning (Lave and Wenger, 1991) and communities of practice (Lave and Wenger, 1991; Wenger, 1998).

Alternatively, theoretical frameworks may provide alternative lenses for evaluation/research of all STEL. For example, complexity theory and CHAT provide useful theoretical frameworks (lenses) to explore and evaluate learning (Fenwick, 2010; Fenwick and Abrandt Dahlgren, 2010; Eppich and Cheng, 2015). In particular, socio-material perspectives may help to visualise the materiality of STEL, explore the complexity of learning and healthcare practice and provide alternative ways of expanding and deepening learning (Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). A series of simulation evaluation tools (as detailed in Jeffries et al., 2004; Jeffries, 2012) have been developed, which can be used to improve the STEL preparation and intervention components, although none has been specifically designed for physiotherapy. Further examples of tools specifically designed to measure learning in the cognitive domains, psychomotor domain, critical thinking and behaviours is provided by Adamson et al. (2012). A key feature of the ISTEL Framework is the arrows from the evaluation or research to the other two constructs (preparation and intervention). The arrows in the ISTEL Framework illustrate that evaluation and research cyclically drive changes in all components, leading to potential improvements in the preparation, equity and value of STEL, as well as learning and healthcare outcomes.

8.3.5 ISTEL Framework application and limitations

It is proposed that the ISTEL Framework can be applied to the design, development and evaluation or research of STEL in physiotherapy and other disciplines of education and research. Its use may also help to facilitate structure and transparency when articulating STEL design, intervention and outcomes demonstrated, which, in turn, may facilitate future comparative analysis and replication.

The limitation of the ISTEL Framework refers to its development from the narrative literature review, and findings from Phase 2 in this research study. The ISTEL Framework is currently being utilised and tested by participants of a Masters in a 'simulation in healthcare' unit at the University involved in the current study. Learners enrolled on the units within the 'Postgraduate Certificate in Simulation and Technology Enhanced Learning' at the University, have been invited to use and critically review the Framework within their own areas of practice. Feedback from these participants will also be used to modify the ISTEL Framework accordingly. Therefore, further work is required to test the application of the ISTEL Framework in other HEIs, sectors and domains in healthcare and education.

8.3.6 Framework summary

The ISTEL Framework is intended to support the design, development, implementation and evaluation/research of STEL; whether this be for a scenario, short course or embedded within healthcare programmes (curricula). It emphasises the importance of adopting an integrated approach to the design, development and evaluation of STEL in physiotherapy and other healthcare disciplines. Attention is drawn to the value of outlining theoretical perspectives and educational practices that underpin STEL in education and research. The identification of linked learning activities following the debrief, offers opportunities for further reflection and translation of learning to clinical practice. The key contribution of the Phase 2 research is the development of the ISTEL Framework. It is anticipated that its use will help to facilitate structure and transparency when articulating STEL design, intervention and outcomes, and in turn may facilitate future comparative analysis and replication. Further testing of the Framework is required in other areas of healthcare education and practice.

8.4 Methodological strengths and limitations of Phase 2

The methodological strengths and limitations for Phase 2 are presented in the following two subsections.

8.4.1 Phase 2 Methodological strengths

The findings of Phase 2 highlighted the power of video-reflexivity to explore and uncover the complex realities of managing an acutely deteriorating patient in a simulation context, which are constructed via social, verbal and non-verbal interactions with the patient, others and the environment (Johnson, 2007; Carroll, 2009; Iedema et al., 2013b; Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015). This study demonstrated that the VRE was successfully employed to facilitate error recognition and patient safety awareness. It allowed the participants to question their own knowledge, skills and behaviours in a manner that impacts on themselves and how they relate to patients in a simulated learning environment (Iedema, 2011). The visualisation and narratives provided by the participants during the VRE interview offered the ability to understand the complexity of learning within a simulation context. The findings of this research provide valuable insights to inform future VRE research regarding physiotherapy practice, integration of educational methods to augment patient safety awareness and participant-led innovations in safe healthcare practice. Carefully designed and executed STEL experiences, coupled with video-reflexive methods can offer a safe learning environment to allow learners to explore routine and evolving and complex clinical situations whilst allowing them to learn to be become comfortable with making and exploring errors (mistakes/violations).

Reassuringly, Phase 2 findings have indicated that the participants worked within the expected professional standards of physiotherapy practice (CSP, 2013). The use of VRE allowed participants to openly reflect on their knowledge, skills, attitudes and behaviours as well as identify errors and develop appropriate remedial action.

This study demonstrated that VRE methods were successfully employed to explore the management of a deteriorating patient, facilitate error recognition and patient safety awareness, which may be equally beneficial to exploring medicine, nursing and allied health profession education and practice. It allowed the participants to question their own knowledge, skills and behaviours in a manner that impacts on themselves and how they relate to patients in a simulated learning environment (Iedema, 2011).

The Phase 2 findings have highlighted that learning is highly complex, requires context and continually evolves through social interaction (Fenwick, 2014; Fenwick and Abrandt Dahlgren, 2015), which may be extrapolated to medicine, nursing and allied health professions involved in managing deteriorating patients. One strength of this study is gained through the pragmatic approach, which drew on both qualitative and quantitative methods to explore physiotherapy practice within a simulated environment and to establish the extent to which transformations in learning and/or patient care are realised, or not, by the learner (Drescher et al., 2004). By employing and triangulating qualitative and quantitative approaches, the multiple levels of impact and complexities of learning can be explored, identifying areas of best practice and helping to remedy any deficits between theory and practice (Drescher et al., 2004).

I acknowledge the potential influences an insider-researcher perspective may have on this study. Whilst insider-researchers have the potential to facilitate a greater understanding of the participants' (physiotherapy) practices and social interaction, I also acknowledge the potential effect of acquiescence, owing to my role as an academic on the physiotherapy programme (Hammersley and Atkinson, 1995; Roberts, 2007; Unluer, 2012). Additionally, I acknowledge that being an insider-researcher brings other various disadvantages, including the potential loss of objectivity due to the relative familiarity of physiotherapy practice and introduction of bias through incorrect assumptions based on a researcher's prior knowledge (Unluer, 2012). The participant observer role I adopted during Phase 2 was the foundation of the VRE data collection (Simmons, 2007), allowing me to both learn and explore the management of a deteriorating patient in a simulation context from the multiple perspective of insiders (pre-registration physiotherapy students). I acknowledge the insider-outsider perspective continuum that existed throughout this phase.

As a physiotherapy educator, I was an insider to the profession and an employee of the organisation, bringing insights from both to my study. The insider position allowed me to be sensitive to the student participants' needs, establishing a rapport, building trust and clarifying my role as a non-threatening researcher during the study through self-disclosure and transparency of the research methods and information provided to the participants (Appendix 6: Participant information sheet, page 279). I sought to ensure a balance of power within the student-teacher-researcher relationship within this phase and ensure that I could become what Roberts (2007) describes as an effective ethnographer. This involved being genuine, valuing the contributions of the participants without passing judgement, empowering the participants to be open and honest during the video-reflexive review of their own scenario and empowering the participants to be open and honest. As the student participants already knew me, I was able to understand the norms, differences, values, priorities and physiotherapy intervention, in order to make sense of the ways in which they behaved or performed during the scenarios. This allowed me to collect a rich dataset. However, since I did not practice as a physiotherapist, I was also a relative outsider, enabling me to create some distance to observe the scenarios with researcher objectivity (Simmons, 2007; Roberts, 2007; Unluer, 2012).

8.4.2 Phase 2 Methodological limitations

I acknowledge that the findings of this study are drawn from a BSc (Hons) physiotherapy programme, from one HEI in the UK. The participants were also only exposed to one deteriorating adult patient scenario. An adult scenario was selected as pre-registration students have limited exposure to paediatric patients. The inclusion of both participants within the VRE interview provided multiple perspectives of the same scenario to be explored, without interruption/direction from a facilitator (unlike in a traditional simulation debrief). Alternative findings may have been presented if all 21 students who participated in the VRE were interviewed individually. This may have generated 21 individual narratives with differing or similar perspectives of the same event. Conversely, without both parties being present, the opportunity for the participants to explore each other's perspective would have been lost. For some, pausing and discussing events led to deeper discussion and dual construction of future action plans to aid professional development.

8.5 Educational implications and further research

Healthcare educators have a responsibility to promote student engagement and facilitate students' professional development during their studies. Central to this is fostering the students' progression as autonomous practitioners, who can review their own learning in order to facilitate an understanding and propose developments in their own practice, particularly in relation to professional knowledge, skills, attitudes and behaviours (CSP, 2013). The use of VRE in this study illuminated the multi-layered impact of personal experiences, ethics and behaviours on their practices, clinical reasoning, clinical decisions, dynamics and the complexities and interconnectivity of participants to the SLE (Carroll, 2009; Iedema, 2011; Iedema et al., 2013b; Fenwick and Abrandt Dahlgren 2015). The findings of this study have demonstrated that the combination of SBE and video-reflexivity has the potential to optimise learning and enhance both professional practice, patient safety (Carroll, 2009; Iedema et al., 2013b) and organisational change. Additional benefits of using video-reflexivity included the potential to provide an in-depth exploration of 'learning' and the impact of objects and artefacts embodied within the scenario and SLE (Carroll, 2009; Iedema et al., 2013b).

8.5.1 Impact on the learners

The similarities and differences in patient assessment and management approaches adopted by pre-registration physiotherapy students were identified, despite being enrolled on the same pre-registration physiotherapy programme. The students' assessment approaches were generally unstructured despite students trying to use a standardised assessment and management approach. Management approaches also varied in relation to a specific intervention, order and timing of events/actions. During the VRE interview, students explored the content of their respective simulation video, attempting to make sense of what occurred and highlighting the impact of personal experiences that they perceived may have been central to their actions, clinical decisions and the cause or mitigation of errors in their practice.

The participants in this study demonstrated a capacity for openness and observation, working within the uncertainty and complexity of a deteriorating scenario and offering known or alternative solutions. They demonstrated mindfulness as they vocalised being aware of themselves, demonstrating a shared interest in what they and others did. Participants questioned their own knowledge, technical and non-technical skills (strengths and deficits), professionalism, errors encountered and realism of the simulated experience in a manner that impacted on themselves and how they related to the patient and each other within the SLE (Carroll, 2009; Iedema, 2011; Fenwick and Abrandt Dahlgren, 2015). The impact of academic, clinical placement and personal experiences were highlighted as positive influential factors on their subject knowledge (physiotherapy management of a deteriorating patient), skill acquisition and behaviours. Participants also reflected on lack of respiratory-related placements or practical opportunities (e.g. suctioning or moving and handling patients) and limited experience of immersive scenarios, which may have negatively impacted on their ability to manage the patient in the simulation context. The learner (participant) interactions elicited through the combination of simulation and video-reflexive methods and considerations for educational programmes have been presented in Table 8.3. Key interactions included the complexities of learning within the simulated environment, eliciting collective competency and enhanced intelligence, and identifying learner insight.

8.5.2 Further research

Findings from the video analysis and VRE interviews provide valuable inferences for scenario design in relation to fostering a) emergence, acknowledging diverse ways of thinking, acting and being responsive to change; b) materiality, consideration of the effects of equipment and environment; c) attunement, proving opportunities to enhance non-technical skills such as situational awareness in order to sense what is unfolding; d) disturbance, introducing interruptions to routine practices; and e) experimentation, providing diverse learning and feedback opportunities (Fenwick and Abrandt Dahlgren, 2015).

Carefully planned and executed simulation scenarios and video-reflexive methods can offer a safe learning environment to allow students to explore routine, evolving and complex situations whilst allowing them to learn to become comfortable with making and exploring errors (mistakes/violations).

Table 8.3: Interactions and considerations for educational programmes when using simulation and video-reflexive methods

Interactions identified through simulation and video-reflexivity	Considerations for educational programmes
Complexities of learning within the simulated environment Video-reflexivity illustrated the multi-layered impact of personal experiences, codes of practice, conformity/non-conformity, errors, dynamics and the complexities of interconnectivity of students and the SLE.	• SBE design requires complex thought and preparation to construct optimal learning experiences carefully. Drawing on learning (adult, social and cognitive) theories and educational practices aligned to SBE, may help to optimise learning. • The identification of routine/non-routine actions, relevant codes of professional practice, conformity and creativity highlights the need to increase the focus on different types of thinking when designing and debriefing scenarios. • Simulation provides opportunities for students to take managed risks in a safe learning environment; however, such risks and potential/actual errors should be appropriately discussed during the debrief (feedback). • Complexity theory raises key considerations for scenario and SLE design in relation to the effects of '*emergence*', diverse ways of thinking, acting and being responsive to change; '*materiality*', equipment and environment; '*attunement*', listening and touching to sense what is unfolding; '*disturbance*', fostering/amplifying the disturbance of routine practices; and '*experimentation*', providing multiple, diverse learning and feedback opportunities (Fenwick and Abrandt Dahlgren, 2015).
Collective competency and enhanced intelligence Students interact together to manage a deteriorating patient, communicating decisions to reach a shared level of understanding (collective competence) and explore how they enacted the process of knowing together (enhanced intelligence).	• Video-reflexive methods and facilitator-led debriefing strategies may be used to explore the development of collective competence and enhanced intelligence, which may help to understand how these skills can be translated to healthcare practice. • Facilitating opportunities to explore the process of 'knowing' with and alongside each other, potentially equips students to engage with complexity, influence professionalism and impact on patient safety (Iedema, 2011).
Learner insight Students lacked insight into some errors encountered during the scenario, predominantly relating to knowledge and skills (relating to physiotherapy assessment components, intervention and moving and handling/infection control violations).	• The use of simulation and video-reflexive methods provide potential opportunities for facilitators to identify students who lack insight into their own knowledge, skills, attitudes and behaviours. A structured facilitator-led debrief can provide an opportunity to regain balanced discussion between achievements, creativity, the need to appreciate professional boundaries, codes of conduct, policies and procedures, whilst raising learner awareness of deficits in knowledge, skills, attitudes and desired behaviours. Considerations for further remediation opportunities may be required.

Table 8.3 also highlights potential opportunities afforded when combining SBE and video-reflexive methods, drawing on interactions identified in this study and poses considerations for other educational programmes. This study highlighted the benefits of exploring dimensions of learning beyond metrics to make sense of the dynamics within the simulated environment.

Table 8.4 summarises the educational implications for each research question addressed in Phase 2 in accordance with RQs 3-6. I propose that further research combining SBE and VRE could be undertaken to explore other areas of physiotherapy education and practice including other specialties of physiotherapy and different healthcare settings. Longitudinal mixed methods studies could be undertaken to determine the impact of integrating SBE within EOC training and physiotherapy curricula with regards to improving educational outcomes, impact on skill performance, competency, retention and patient safety. Additionally, video-observation and video-reflexive methods may be used to explore essential components of simulation design e.g. instructional design aspects (relating to the most effective medium, modality and method), equipment, environmental and psychological fidelity, scenario complexity, cognitive load and the most effective feedback/debrief style is yet to be determined.

Further research is warranted to explore the multi-faceted value and associated economic costs of embedding SBE within physiotherapy education and practice. In the current climate of ever-increasing drivers to reduce costs and increase effectiveness and efficiency in physiotherapy education and practice, we are faced with the challenge of maximising learning objective achievement within finite financial and human resource constraints. Thus, the effectiveness and value associated with the combination of SBE and VRE warrants further exploration across multiple HEIs, including different academic pre-registration and postgraduate curricula to establish the viability and sustainability within physiotherapy education and practice.

Table 8.4: Educational implications and areas for further research

Research question	Educational implications
3	a) The combination of the scenario and VRE provided an opportunity for transformational learning to occur, as the participants engaged in the uncertain and unfamiliar context of managing an acutely deteriorating patient that replicated the complexities of an EOC situation
	b) Scenarios can be designed to challenge learners to draw on their problem-solving skills and technical and non-technical skills to integrate diverse ranges of information in order to appraise the situation, prioritise and then implement interventions
	c) Video-reflexivity provides an opportunity for participants to develop attunement by openly discussing their assessment strategies, mental models and suggesting modifications to future practice, and to explore the impact of personal experiences that may influence their actions, clinical reasoning decisions and patient management
4	d) The range of errors identified by this study highlights the complexity of managing an acutely deteriorating patient in a simulation context. These findings have implications for the types of SBE intervention required to increase the awareness of error recognition and recovery by pre-registration physiotherapists in order to minimise the impact on patient safety
	e) The use of VRE has the potential to facilitate the identification of participants who lack insight into their knowledge, skills and behaviours and has the potential to play an important part in improving patient safety
	f) The combination of SBE and video-reflexivity has the potential to optimise learning by exploring error recognition and defences erected to mitigate errors and their impact on patient safety
5	g) Participants perceived that the diversity and complexity of pre-registration physiotherapy academic and placement learning were influential factors on their performance within SBE
	h) VRE can be used to illuminate the multi-layered impact of personal experiences, ethics and behaviours on practices, clinical reasoning, clinical decisions, dynamics, and the complexities and interconnectivity of participants to the simulation environment
6	i) From the pre-registration physiotherapy students' perspectives, the combination of SBE and video-reflexivity provides a valuable opportunity to promote skills development, increase self-awareness, provide placement preparation and has the potential to influence patient safety
	j) The combination of the scenario and video-reflexivity may be beneficial in physiotherapy to enable learners to develop not only competency prior to placement exposure, but capability for the transition to practice upon graduation
7	k) The full economic cost of designing and delivering SBE provides valuable information for planning and scaling learning and teaching activities within physiotherapy curricular
Research question	**Areas for further research relating to the existing research questions**
3	a) Exploration of the physiotherapy management of patients with simple and complex musculoskeletal, neurology and oncology conditions within the simulation context by pre-registration and qualified physiotherapists
4	b) Evaluation of the independent error recognition abilities of pre-registration and qualified physiotherapists, including participants from multiple cohorts and multiple institutions
	c) Investigation of the transfer and retention of clinical skills taught within the SLE and transfer to clinical practice
	d) Investigation of physiotherapy technical and non-technical skills is warranted featuring larger sample sizes, including multiple scenarios and involving multiple institutions across healthcare and education
5	e) Analysis of the elements of prior learning and practice experience that pre-registration and qualified physiotherapists perceive may influence their performance within a simulation context, including participants from multiple cohorts and multiple institutions
6	f) Exploration of the economic costs of embedding different mediums, modalities and methods of simulation within the pre-registration physiotherapy curricula in the UK and transfer of learning to the practice environment
	g) Analysis of the impact of integrating SBE in EOC training, on improving educational outcomes, skill performance, competency achievement and retention and patient safety is yet to be determined
	h) Evaluation of the impact and value of scenario design components is yet to be determined in relation to instructional design (medium, modality and method), equipment, environmental and psychological fidelity, scenario complexity, cognitive load and feedback/debrief style
	i) Economic evaluations are warranted to inform decisions of the viability and sustainability of SBE in physiotherapy education and practice
7	j) Further research is warranted to explore the multi-faceted value and associated economic costs of embedding SBE and VRE within physiotherapy education and practice

The findings of this thesis emphasise the importance of scenario design, considering the learner's level of experience, prior knowledge and sequencing of abstract skills before requiring contextualisation within scenarios increasing in complexity (Lefroy and Yardley, 2015). Consideration of the complexity of the agents (people) and artefacts embodied within the scenario to enhance realism and authenticity is required to ensure balance and optimise learning without cognitively overloading the learners (Sweller, 1998). As educationalists, we need to be mindful that learning is highly complex, always contextual and continually evolves through social interaction (Fenwick and Abrandt Dahlgren, 2015). It is therefore essential that evaluation can reflect this multiplicity and complexity when designing and evaluating healthcare curricula. Holistic evaluation methods that draw on both qualitative and quantitative approaches may help to establish the extent to which transformations in learning and/or patient care are realised, or not, by the learner (Drescher et al., 2004). Such approaches offer greater enlightenment regarding the links between educational interventions and outcomes. By employing and triangulating qualitative and quantitative approaches to explore multiple levels of impact, the complexities of learning can be explored, identifying areas of best practice and helping to remedy any deficits to enhance the transformation between theory and practice (Drescher et al., 2004).

8.6 Conclusion

This study has presented a unique insight into the experiences, skills, attitudes, behaviours and error recognition abilities of pre-registration physiotherapy students managing an acutely deteriorating simulated patient. This study has demonstrated that the combination of SBE and video-reflexive methods has the potential to facilitate the identification of participants who lack insight into their knowledge, skills and behaviours, and has the potential to play an important part in improving patient safety. SBE and VRE could be employed to explore the complexities of healthcare professional learning and practice beyond cardio-respiratory physiotherapy, in particular to highlight key gaps in the curricula, as well as the existence/deficits in learner knowledge, skills and behaviours. The findings of this research provide valuable insights to inform physiotherapy practice, integration of educational methods to augment patient safety awareness and participant-led innovations in safe healthcare practice.

Chapter 9: Conclusion

9.1 Introduction

This chapter provides an overview of the achievement of this thesis. The overall methodological strengths and limitations and novel aspects of the thesis are discussed. Finally, the local, national and international impact of my doctoral study to date is presented.

9.2 Overall strengths and limitations

This thesis has reported the comprehensive exploration of the use of SBE within cardio-respiratory physiotherapy. The pragmatic design of a two-phased mixed methods study has enabled me to address all seven research questions and to present a comprehensive exploration by combining information from complementary kinds of data or sources and avoiding biases that are intrinsic to single-method approaches (Morgan, 2007; Denscombe, 2008). The methods utilised were selected to capture multiple perspectives (approaches and understandings) and the complexity of using SBE within cardio-respiratory physiotherapy in the UK. The design of the questionnaires in Phase 1 permitted exploration of both RQs 1 and 2, and all of the supplementary research questions. The methodological strengths and limitations of the national surveys have previously been discussed in section 6.3. Phase 2 featured the use of VRE methodology to address RQs 3-7. The methodological strengths and limitations have been similarly addressed in section 8.4. In sections 6.4 and 8.5, I have also presented the educational implications and future research implications for all seven research questions (originally stated on pages 7-8).

This thesis has highlighted the complexities of designing, developing and exploring SBE within physiotherapy, including the challenges of development, delivery and evaluation, alongside the benefits that SBE and VRE have to offer the future of healthcare education and practice. Perhaps the most challenging aspect of further research will be to explore the costs associated with embedding SBE within physiotherapy and other healthcare disciplines.

9.3 Novel aspects of this thesis

The novel aspects of my thesis are discussed and the impact of the findings and recommendations are made for further research. The novel aspects of my thesis are summarised in Box 9.1.

Box 9.1: Novel aspects of this thesis

To the best of my knowledge, this is the first study to:

- Investigate the spectrum of SBE utilised in EOC physiotherapy training in both pre- and postgraduate cardio-respiratory physiotherapy education within the UK (RQs 1 & 2)
- Explore pre-registration physiotherapy students' experiences of managing a deteriorating cardio-respiratory patient using SBE and VRE (RQ3)
- Explore both technical and non-technical skills utilised by pre-registration physiotherapy students when managing a deteriorating patient in the simulation context (RQ3)
- Investigate pre-registration physiotherapy students' abilities to independently recognise errors encountered in their own simulated practice (RQ4)
- Apply incident analysis to explore error types committed or recovered by physiotherapists/pre-registration physiotherapy students in the SLE (RQ4)
- Explore pre-registration physiotherapy students' perceptions of factors that may influence their performance within the SLE (RQ5)
- Explore pre-registration physiotherapy students' perceptions of the value of a simulation-based learning experience (RQ6)
- Cost consequence analysis of using SBE and VRE (RQ7)
- Develop an evidence-based ISTEL Framework to inform the design, development, implementation and evaluation or research

9.3.1.1 Local impact

The findings of this thesis have already influenced BSc (Hons) and MSc pre-registration physiotherapy curricular developments and design of the new SLE facilities at the University. The ISTEL Framework has been adopted within the physiotherapy programmes at the University. To date, implementation of this Framework has focused on improving scenario design, formalising debriefing practices and ensuring linked learning activities are overtly articulated to students. The findings from the video analysis and VRE interviews have influenced scenario design in relation to fostering emergence, materiality, attunement, disturbance and experimentation (Fenwick and Abrandt Dahlgren, 2015). Staff teaching briefs now include acknowledging and facilitating emergence of diverse ways of thinking, acting and promoting responsiveness to change within a scenario. Staff development sessions have embraced materiality considerations when designing simulation scenarios, acknowledging the potential effects of the equipment and environment and potential impact on the achievement of the learning objectives. Additional opportunities for learners to develop/enhance attunement have been integrated within the individual units in the pre-registration physiotherapy curricula, to enhance non-technical skills such as situational awareness. Facilitators also increasingly prompt the learners to review their simulation videos reflexively to develop and explore a sense of what is unfolding throughout a given scenario. The combination of simulation and video-reflexive methods is being integrated within the final year of the pre-registration physiotherapy curricula for multiple reasons: to allow facilitators to identify students who lack insight into their own knowledge, skills, attitudes and behaviours, and to allow learners to develop reflexivity skills prior to graduation.

Further opportunities are being considered to foster disturbance within the more complex scenarios in the final year of the curriculum, by introducing interruptions to routine practices. The physiotherapy programme staff at the University have continued to explore opportunities for experimentation with methods of providing diverse learning and feedback, including debriefing practices. Structured facilitator-led debriefing is currently providing opportunities to promote balanced discussion on achievements, creativity, the need to appreciate professional boundaries, codes of conduct and policies and procedures, whilst raising learner awareness of deficits in knowledge, skills, attitudes and desired behaviours (Iedema et al., 2013b). Some of the immediate changes that have already materialised include placing an increased emphasis on human factors and their effect on patient safety. Simulation scenario learning objectives have been reviewed to explicitly relate to human factors and patient safety, and additional flipped classroom learning resources have been created.

The thesis identified a gap between learning and actual practice of knowledge and skills gained from the pre-registration (BSc Hons) physiotherapy curriculum, in particular relating to error producing factors such as knowledge and skill deficits (Reason, 1999). The provision of additional 'flipped classroom' (Roehl et al., 2013) resources (educational videos and podcasts) have already been introduced to support repetitive practice of essential technical and non-technical skills required to manage cardio-respiratory and acutely deteriorating patients. Multiple policies around oxygen therapy (*a latent error*) have been replaced with a single guideline to minimise confusion and error (Reason, 1999; Vincent 2012). The combination of a lack of hand-washing facilities (*an error producing factor*) in the previous SLE and identification of active failures including infection control and moving and handling violations (Reason, 1999; Vincent 2012) have also contributed to the design of the new SLE facilities at the University involved in Phase 2.

The specific issues relating to the latent error (multiple oxygen therapy policies) and error-producing factors highlighted in Phase 2, have also been raised to pre-registration physiotherapy cardio-respiratory unit teams and are being addressed within the teaching resources. Additionally, the findings of Phase 2 are currently being used to review technical and NTS within cardio-respiratory physiotherapy units at the University. A review of the integration of human factors within the BSc and MSc pre-registration physiotherapy curricula at the University is currently being undertaken. This is in preparation for the mandatory requirement by the HCPC that all pre-registration healthcare programmes overtly embed human factors within their curricula (NQB, 2013). Whilst the physiotherapy staff regularly embraces change, progress can sometimes be slow to materialise due to internal constraints on curricula modifications, staffing and cost implications. The cost of all academic units featuring SBE are currently being evaluated in light of bursary changes and students being required to self-fund their academic studies at university (DH, 2015).

9.3.1.2 Scenario developments

The scenario resources developed for use in Phase 2 have since been extensively used across many physiotherapy units within the BSc (Hons), MSc pre-registration and MSc post-registration physiotherapy and MSc nursing programmes at the University involved in Phase 2. The scenario has been extended to incorporate role profile development of both the SPs (real people trained to portray Levi) and computerised manikins. Several new scenarios featuring Levi Williams have been created to represent different clinical situations in a patient's journey from admission to discharge, including a community scenario, further deterioration following admission to the general medical ward, admission to ICU where Levi later requires mechanical ventilation, post-ICU rehabilitation and a home visit scenario following discharge from hospital. More recently, the Levi Williams role profile has been further developed and integrated as an example within the learning and teaching resources for two recent projects funded by Health Education England North West (Gough et al., 2015; Green and Gough 2015). The purpose of the Simulated Patient projects was to design, develop and evaluate a standardised, quality assured approach to training-the-trainers of SPs and training SPs. Further information on the SP projects is located via the following hyperlink: http://www.mmu.ac.uk/simulatedpatient.

The scenario and resources (summarised in Appendices 14-16, on pages 304-311) have also been made accessible to NHS trusts and HEIs through the NWSEN scenario library. This allows NWSEN members access to peer reviewed SBE scenarios and associated SP role profiles. The resources will also be made accessible via the 'interactive CSP' website (iCSP, http://www.csp.org.uk/icsp) within the networks for cardio-respiratory, education and managers.

9.3.1.3 National and international impact of the doctoral study

Several aspects of this thesis' findings have already been subjected to peer review and contributed to the body of knowledge in the field of SBE. The research findings arising from both Phases 1 and 2 have been disseminated via two peer reviewed journal articles, two forthcoming book chapters, three published abstracts/conference proceedings and eight unpublished abstracts from platform presentations at national and international physiotherapy and simulation conferences. Full details of the aforementioned dissemination of different aspects of this study have been previously outlined in section 1.4. Additionally, in 2013 I was invited to co-author the CSP simulated practice guidance paper (CSP, 2014a). Excerpts from my literature review (Chapter 2) were used to develop the guidance and my substantial input has been acknowledged (CSP, 2014a).

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Appendix 1: Theoretical perspectives, views, considerations and examples of integration

Theoretical perspective	View of learning	Considerations when planning simulation-based education (SBE)	Examples of theoretical perspective application in SBE activities
Behaviourism **Behaviourism** draws on the works of theorists such as Burrhus Skinner, Ivan Pavlov, Edward Thorndike and John Watson, who referred to learning as the objectively observable acquisition of behaviour(s).	***Behaviourism*** view of learning is permanent change in behaviour as a direct result of activity or experience, e.g. positive/negative or as a result of reward/punishment (Gould, 2009). Three major types of behaviour include respondent learning, operant conditioning and observational learning, each relying on building associations. Variants of behaviourism include: ***methodological behaviourism,*** (all habits are formed from conditioned reflexes, drawing on the work of Watson), ***radical behaviourism*** (learning occurs in relation to past and present through the effect they have on human beings, based on earlier work by Skinner) and ***selectionist behaviourism*** whereby all learning is a result of the experienced consequences of the organisms' behaviour based on Skinner's later work, (Burton et al., 1996). Three major considerations of behaviourism that are directly relevant to simulation design include the role of the learner (learners learn by doing), the nature of learning (building associations between the stimulus event, the response and results or consequences) and the generality of the learning processes and instructional procedures (Burton et al., 1996).	• Learning is based on behavioural objectives. Learning outcomes are commonly formulated as 'SMART' (specific, measurable, achievable, relevant and timed) • Learning activities are formal and didactic e.g. lectures and formal tutorials to facilitator led clinical skill demonstrations or e-learning activities • The facilitator is dominant and learners are passive and respond to given stimuli • Standard routines and expectations can be reinforced through repetition • Practice opportunities for learners should follow faculty-led demonstrations • Deliberate practice (Ericsson, 2004; Ericsson et al., 2007), can be integrated which includes repetition of a skill/task for the acquisition of expert performance. This can, however, be affected by constraints of resources, effort and motivation • Assessment of learning is formal and summative and often involves objective testing of knowledge and skills and often relate to the lower levels of Bloom's (1956) taxonomy of learning (knowledge, comprehension and application; however, multiple response/viva options can be used to demonstrate a learner's ability to analyse, synthesize and evaluate information).	• Parker and Myrick (2009) provide a critical examination of behaviourist and constructivist theories applied to high-fidelity scenario-based simulation • Kaakinen and Arwood (2009) identified behaviourism principles applied to nursing simulation education, in addition to other learning theories in their systematic review • Harvey et al. (2012) utilised behaviourist principles of learning, teaching and assessment in the development of a peer-led training and assessment programme in Basic Life Support (BLS) • Mardegan et al. (2015) undertook a quasi-experimental post-test study to compare the effectiveness of interactive CD-based and traditional instructor-led BLS skills training. The traditional instructor-led BLS training featured behaviourist principles including presentation, demonstration, supervised practice and assessment.

Theoretical perspective	View of learning	Considerations when planning simulation-based education (SBE)	Examples of theoretical perspective application in SBE activities
Cognitive Cognitivism is concerned with how individual learners process, creating associations and knowledge, creating associations and understanding relationships between information. Cognitive theories include constructivism, cognitive load, discovery learning, situated learning and cognitive load. Cognitivism draws on works by Piaget, Gagne and Vygotsky.	***Cognitivism* –** refers to learning as a change in the cognitive structures including the way an individual perceives events, organises experiences and solves problems, integrating new learning with and transforming previous learning (Gould, 2009). Learning is generally regarded as active and can lead to multiple representations of reality (Pritchard, 2008). ***Constructivism*** – refers to learning as an active process in which the learners construct new ideas or concepts through knowledge, social interactions and motivation (Pritchard, 2008). ***Personal constructivism*** refers to meaning attached by the learner based on individual and prior knowledge and experience (Pritchard, 2008; Rutherford-Hemming, 2012), *whereas* ***Social constructivism*** refers to learning occurring through dialogue about problems in a social context (Pritchard, 2008; Rutherford-Hemming, 2012). In contrast ***social constructionism*** focuses on the collective generation and transmission of meaning and emphasises the influence of culture on humans (Crotty, 1998). ***Situated learning/situated cognition*** considers the primary focus of learning as social participation, creating social identity through contribution to communities of practice (Lave and Wenger, 1991; Wenger, 1998). Other constructivist learning perspectives include transformational learning (Dewey, 1910; Rutherford-Hemming, 2012), experiential learning (Kolb, 1984; Schôn, 1983; Gibbs, 1998), and reflective practice (Schôn, 1983; Gibbs, 1998). ***Cognitive load theory*** refers to the total amount of mental effort used in working memory (Sweller, 1998).	• Activities focus on the learning process rather than the content, with an emphasis on understanding the learning objectives • Encourage learners to think, process and organise information. The introduction to the principles of self-regulated learning may be of benefit to learners (Zimmerman, 2000) • Deductive (Ausbel, 1963), inductive (Bruner, 1967) and problem solving approaches can be integrated (e.g. following an inductive sequence: introducing a concept/principle, providing specific context and then moving to general applications) • Scaffolding learning (Vygotsky, 1968; Pritchard, 2008) throughout a course/curriculum can be achieved through the provision of learning resources, tasks and face-to-face activities. Blended learning (DH, 2011) and flipped classroom (Roehl et al., 2013) approaches can be adopted to facilitate scaffolding • Reflection on prior experience, collaboration with peers and autonomous learning are encouraged • Extraneous, germane and intrinsic cognitive load should be examined when designing SBE activities to optimise learning (Reedy, 2015) • The need for situated and authentic learning activities/scenarios may facilitate deeper level of learner engagement, information and relative ideas (Pritchard, 2008). • Assessments of learning are predominantly designed to test understanding and whether learners can identify relationships and generate reasoned arguments	• Woo and Reeves (2007) outline social constructivist principles to design authentic web-based learning tasks to facilitate meaningful interaction • Cognitive theoretical principles applied to nursing simulation identified by a systematic review by Kaakinen and Arwood (2009) • Clapper and Kardong-Edgren (2012) discuss using deliberate practice, scaffolding and simulation to improve skills • Onda (2012) exemplifies the constructivist theory of learning through experience, situated cognition, skill development and clinical reasoning in nursing simulation-based education • Using cognitive load theory to inform simulation design and practice is presented by Reedy (2015) • Key issues relating to measuring cognitive load effect on performance, mental effort and simulation task complexity are detailed by Haji et al. (2015)

Theoretical perspective	View of learning	Considerations when planning simulation-based education (SBE)	Examples of theoretical perspective application in SBE activities
Humanistic Humanism provides an optimistic view on humanity, where learners strive within their individual limitations to achieve maximum potential (Gould, 2009).	***Humanism*** refers to learning through which learners strive to achieve maximum personal growth within their own limits. Learners are self-determining and have the ability to freely make their own choices, which influence learning. Essentially, learning is learner-centred and learner driven. Humanism was developed in the 1960s and includes works by Maslow, Carl Rogers and more recently Jennifer Rogers, in response to the dominant behaviourist and psychoanalytical perspectives which ignored the learner's free will (Gould, 2009).	• The learner is considered to have a natural potential of learning and will only learn what he/she perceives to be necessary to maintain or enhance him/herself • Learning is optimised when learners participate responsibly • Learning objectives are not set by the faculty but generated by the learner(s) • The facilitator's role is to empower learners to take control and responsibility for their own learning by promoting realness/genuineness, acceptance (non-judgmental) and empathetic understanding. The relationship between learner(s) and the facilitator(s) is crucial to optimising learning • Self-criticism and self-evaluation are encouraged to foster independence, creativity and self-reliance. This is perceived as more important than the assessment of learning by others (Gould, 2009) • Humanistic assessments relate to the uniqueness of the individual learner(s) and do not seek reference points against which to measure performance. Performance is referenced to as self-actualisation (referenced to previous or usual performance of the individual learner) to demonstrate progression/stationary/regression (Gould, 2009)	• Ziv et al. (2005) advocate humanistic principles to simulation-based medical education as a means to provide opportunities to learn from errors • Hanna and Fins (2006) propose humanistic reflections may illuminate some of the fundamental differences between the learner–doctor/simulated patient/patient interactions practiced in simulation encounters and real doctor–patient relationships • Murphy et al. (2007) explore current simulation-based education strategies including formalised and experiential learning. They propose that simulation may enhance humanistic training in medical education

Theoretical perspective	View of learning	Considerations when planning simulation-based education (SBE)	Examples of theoretical perspective application in SBE activities
Socio-material Socio-material perspectives question the acceptance of differential categories (individual/organisation and binaries of subject/object, knower/known), and also challenge the givenness of fundamental distinctions between human and non-human (Fenwick, 2010) Multiple worlds and ontologies, which are enacted through diverse forms of material assembling are central to socio-materiality (Fenwick and Edwards, 2013)	***Actor network theory (ANT)*** refers to learning as ways of being, acting, feeling, interacting, representing as well as knowing, which emerge through materialising networks and practices in which people are involved (Fenwick and Edwards, 2013). ANT draws on the work by Latour (2005) and Law (2007) Three generations of ***cultural historical activity theory (CHAT)*** have been developed; the first by Vygotsky, the second by Leontyev and more recently, the third by Engeström (1987). In CHAT the 'activity system' (elements related to managing goal–oriented tasks such as the subject, rules, tools/mediating artefacts, objective, community and divisions of labour) are central to the learning activity or experience and not the individual learner (Eppich and Cheng, 2015). ***Complexity Theory*** applied to learning is associated with the emergent, co-participatory and co-evolutionary process rather than a person's accumulation of knowledge and competency (Mennin, 2010). Complexity theory is a heterogeneous body of theories, which originated from biology, mathematics, systems theory and cybernetics (Drescher et al., 2004). Complexity concepts include emergence, attunement, disturbance and nested systems, experimentation.	• The emphasis is not on the learners' individual skills or technologies but on the relationships between these and what is produced • Learning objectives are not usually established prior and do not drive scenario development • Faculty roles include prompting learners to attune to the setting, tools and technologies and act on the emerging action within a given scenario/simulation and technology enhanced learning activity • Uncertainty and unpredictability are assumed in socio-material approaches. Scenarios can be designed that encourage mess, complexity and unpredictability, mirroring clinical practice • Structured reflection activities may be incorporated during a simulation scenario by stopping the action mid-flow and encouraging learner metacognition. Stopping and alternating learners into existing scenario roles provide opportunities to share perspectives (Fenwick and Dahlgren, 2013) • Multiple feedback loops may be required to enable learners to recognise, prioritise and make meaning of and respond to feedback (Fenwick and Dahlgren, 2013) • CHAT and Complexity (emergence, attunement, disturbance and nested systems and experimentation) concepts can be integrated into debrief schedules to explore the complexity of interactions, (Fenwick and Dahlgren, 2013) and contextual factors which may promote or impede safe and effective patient care (Eppich and Cheng, 2015) • The complexities of learning can be explored by employing and triangulating qualitative and quantitative approaches (Drescher, 2004)	• Reflective practice and its role in simulation and debriefing are discussed by Wang (2011) and Husebo et al. (2015) • White (2010) outlines a socio-cultural approach to practice-based learning in healthcare • Fenwick and Dahlgren (2015) outline essential implications in socio-material approaches and their applications for scenario design and enhancing deepening learning • Socio-material approaches (complexity and ANT) relevancy to lifelong learning are discussed by Fenwick and Edwards (2013) • Eppich and Cheng (2015) provide examples of how CHAT can facilitate interprofessional debriefing strategies and explore contextual factors which may promote or impede safe and effective patient care • LeFroy and Yardley (2015) embrace complexity theory to clarify best practice framework for SBE

Appendix 2: Ethical approval

Wrightington, Wigan & Leigh Research Ethics Committee
Room 181
1st Floor
Gateway House
Piccadilly South
Manchester
M60 7LP

Tel: 0161 237 2166
Fax: 0161 237 2383

04 August 2009

Mrs Suzanne Gough
Senior Lecturer
Physiotherapy Programme
Faculty of Health, Psychology and Social Care
Department of Health Professions
Manchester Metropolitan University
T410 Elizabeth Gaskell Campus
Hathersage Road
Manchester
M13 0JA

Dear Mrs Gough,

Title of project: **The application of Simulation-Based Education (SBE) within Cardio-respiratory and Emergency On-call Physiotherapy Education**

Thank you for seeking the Committee's advice about the above project.

You provided the following documents for consideration:

- Email (29 July 2009)
- Cover letter (28 July 2009)
- Appendix 1 - Ethical Checklist (28 July 2009)
- Appendix 2 - Full Protocol dated (28 July 2009)
- Appendix 3a - Letter inviting participation in the pilot study – NHS SBE Questionnaire (28 July 2009)
- Appendix 3b - Letter to accompany the NHS SBE Questionnaire (28 July 2009)
- Appendix 3c - Reminder letter to accompany the NHS SBE Questionnaire (28 July 2009)
- Appendix 3d - Covering letter to accompany SBE HEI Questionnaire (28 July 2009)
- Appendix 3e - Letter to accompany HEI SBE Questionnaire (28 July 2009)
- Appendix 3f - Reminder letter to accompany HEI SBE Questionnaire (28 July 2009)
- Appendix 4 - Information sheet with consent form
- Appendix 5a - SBE NHS Utilisation National Questionnaire Draft v2.1 (28 July 2009)
- Appendix 5b - HEI SBE Utilisation National Questionnaire Draft v2.1 (28 July 2009)
- Appendix 6 - Pilot Feedback Sheet (28 July 2009)
- MMU Application for Ethical Approval (28 July 2009)

These documents have been considered by the Chair.

I enclose a copy of our leaflet, "Defining Research", which explains how we differentiate research from other activities. The Chair has advised that the project is not considered to be research according to this guidance. Therefore it does not require ethical review by a NHS Research Ethics Committee.

You should check with the R & D Department what other review arrangements or sources of advice apply to projects of this type. Guidance may be available from the clinical governance office.

You may wish to check whether the project should be reviewed by the ethics committee within your own institution.

This letter should not be interpreted as giving a form of ethical approval to the project or any endorsement of the project, but it may be provided to a journal or other body as evidence that ethical approval is not required under NHS research governance arrangements.

However, if you, your sponsor/funder or any NHS organisation feels that the project should be managed as research and/or that ethical review by a NHS REC is essential, please write setting out your reasons and we will be pleased to consider further.

Where NHS organisations have clarified that a project is not to be managed as research, the Research Governance Framework states that it should not be presented as research within the NHS.

Yours sincerely

Stephen Tebbutt
Committee Co-ordinator

E-mail: stephen.tebbutt@northwest.nhs.uk

Copy to: Professor Val Edwards-Jones, R & D, MMU

Enclosure: NRES leaflet – "Defining Research"

Phase 1

MEMORANDUM
THE MANCHESTER METROPOLITAN UNIVERSITY
FACULTY OF HEALTH, PSYCHOLOGY AND SOCIAL CARE

FACULTY ACADEMIC ETHICS COMMITTEE
To: Suzanne Gough
Health Professions Department
From: Dr Bill Campbell
Date: 30 September 2009
Subject: Ethics Application 0921
The application of Simulation-Based Education (SBE) within Cardio-respiratory and Emergency On-call Physiotherapy Education

Thank you for your detailed response to the issues raised in the review process of your ethics application

The Faculty Academic Ethics Committee is now able to approve your application.

I would like to wish you every success with your project.

Many thanks

Dr Bill Campbell

Phase 2

MEMORANDUM
THE MANCHESTER METROPOLITAN UNIVERSITY
FACULTY OF HEALTH, PSYCHOLOGY AND SOCIAL CARE
FACULTY ACADEMIC ETHICS COMMITTEE

To: Suzanne Gough
From: Prof Carol Haigh cc Deirdre Connor
Date: 15 December 2010
Subject: Ethics Application 1102
Title: Exploring the experiences of final year pre-registration physiotherapists participating in high fidelity simulation

Thank you for your application for ethical approval.

The Faculty Academic Ethics Committee review process has recommended approval of your ethics application.

We wish you every success with your project.

Prof Carol Haigh

Appendix 3: Phase 1 NHS and HEI survey cover letters

Manchester Metropolitan University

T401, Elizabeth Gaskell Building
Hathersage Road
Manchester
M13 0JA

Mrs XXXXXX
Physiotherapy Department
XXXXXX NHS Trust
XXXX Lane
City
Postcode

12th October 2009

Dear Colleague,

Re: Invitation for participation

I am writing to ask if you would be willing to participate in the first part of my PhD study entitled:

"The application of Simulation-Based Education within Cardio-respiratory and Emergency On-call Physiotherapy Education"

I currently work as a Senior Lecturer in Physiotherapy at Manchester Metropolitan University and formerly as Senior I ICU and Surgery Physiotherapist, at Wrightington, Wigan and Leigh NHS Trust. I am currently engaged in a doctoral research project to explore the extent to which simulation-based education is being utilised within acute respiratory and on-call physiotherapy services within the UK.

The questionnaire enclosed has been devised in respect to the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Acute Respiratory/On Call Physiotherapy Self-Evaluation of Competency questionnaire and the current range of simulation technology.

I would be most grateful if you could complete and return the enclosed questionnaire. Completion should take no longer than 10 minutes. If your Trust *does use* simulation technology within on-call training, please answer *all sections 1-4*. However, if your Trust *does not currently use* simulation technology within on-call training, you will only be required to answer *sections 1 and 2*.

All data provided will be treated confidentially and your anonymity will be preserved throughout the study. Data provided by this study will be included within the PhD thesis, and potentially future publication and/or conference presentations.

I would be very grateful if you could return the questionnaire and consent form in the enclosed pre-paid envelope provided, **before *Monday 26th October 2009*.** I would finally like to thank you for taking the time to read this letter and considering participation.

Yours Sincerely

Mrs Suzanne Gough
Principal Investigator
PhD Student, MA Education, PGC-AP,
BSC (Hons) Physiotherapy, FHEA
Email: s.gough@mmu.ac.uk

Dr Abebaw Yohannes
Director of Studies
Reader in Physiotherapy
Manchester Metropolitan University

MANCHESTER METROPOLITAN UNIVERSITY

T401, Elizabeth Gaskell Building
Hathersage Road
Manchester
M13 0JA

10th November 2009

Dear Colleague,

Re: Invitation for participation

I am writing to ask if you would be willing to participate in the first part of my PhD study entitled:

"The application of Simulation-Based Education within Cardio-respiratory and Emergency On-call Physiotherapy Education"

I am currently engaged in a doctoral research project to explore the extent to which simulation-based education is being utilised within Higher Education Institution Physiotherapy Programmes within the UK.

The questionnaire to be piloted is enclosed and has been devised by the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Acute Respiratory/On Call Physiotherapy Self Evaluation of Competency questionnaire and the current range of simulation technology. I would be most grateful if you could complete and return the enclosed questionnaire. Completion should take no longer than 15 minutes. If your University *currently uses* simulation technology within the cardio-respiratory or Evidence Based Practice Modules, please answer *all sections 1-4*. However, if your University *does not currently use* simulation technology, you will only be required to answer *sections 1 and 2*.

All data provided will be treated confidentially and your anonymity will be preserved throughout the study. Data provided by this study will be included within the PhD thesis, and potentially future publication and/or conference presentations. Further details of the study have been outlined in the Information Sheet enclosed.

I would be very grateful if you could return the questionnaire and consent form in the enclosed pre-paid envelope provided, **before *Tuesday 24th November 2009.*** I would finally like to thank you for taking the time to read this letter and considering participation.

Yours Sincerely

Mrs Suzanne Gough
Principal Investigator
PhD Student, MA Education, PGC-AP,
BSc (Hons) Physiotherapy, FHEA
Email: s.gough@mmu.ac.uk

Dr Abebaw Yohannes
Director of Studies
Reader in Physiotherapy
Manchester Metropolitan University

Appendix 4: Phase 2 cover letter

Manchester Metropolitan University

T401, Elizabeth Gaskell B
Hathersage Road
Manchester
M13 0JA

28th January 2011

Dear Student,

Re: Invitation for participation

I am writing to ask if you would be willing to participate in my PhD study entitled:
"Exploring the experiences of final year pre-registration physiotherapists participating in high-fidelity simulation"

I currently work as a Senior Lecturer in Physiotherapy at Manchester Metropolitan University and formerly as Senior I ICU and Surgery Physiotherapist, at Wrightington, Wigan and Leigh NHS Trust.

The aim of this doctoral study is explore the experiences of final year pre-registration Physiotherapists participating in high-fidelity cardio-respiratory physiotherapy simulation at Manchester Metropolitan University.

The standardised simulation experience would take place in the Simulated Learning Environment at Manchester Metropolitan University. In return you will be provided with personal copies of the Digital Versatile Disc (DVD) of your participation in the simulation, simulation learning outcomes and a certificate of participation. The DVD, learning outcomes and certificate can be used as evidence of personal and professional development. This can be presented in your Personal Development Portfolio.

What will participation involve?
If you would like to participate in the study this would involve:

1) You will be required to complete one cardio-respiratory simulation scenario in the Simulated Learning Environment (CM5 and CM6 within the Clinical Skills Laboratory), at MMU. The simulation scenario has been developed using a clinical incident from another study. Guidance from the National Patient Safety Agency and the simulation evidence base has also been used to design the simulation scenario. The scenario has already been piloted and will take you approximately 20-30 minutes to complete a physiotherapy assessment and management of the patient.
2) After the simulation has ended you will be required to view your personal simulation video and provide any comments on your activities. This is called the 'Think Aloud' review technique. The Principal Investigator will not prompt you to concentrate on any topic specifically. Key prompt questions will be used to enable you describe your thoughts and actions as you review your own video of the simulation you have just undertaken. You will also be able to provide any additional information that you feel relevant at this stage. This may take approximately 30-40 minutes depending on the duration of your simulation.

If you are asked to participate in the pilot phase you would also be asked to complete a short pilot review sheet which would be given to you following completion of all the pilot activities. This will aim to evaluate the process from a participant view point. Information that you provide will be utilised to refine the main study procedures. It is anticipated that this should take no more than 5 minutes to complete.

The overall anticipated participation time will be 60-90 minutes. Participation is voluntary and no monetary payments will be made. Participation/non-participation will have no effect your current or future education at Manchester Metropolitan University. All completed pilot data and documentation will be dated and maintained by the Principal Investigator and stored alongside the entire study paper documents (in the Principal Investigator's locked filing cabinet in her office at MMU). Results from the pilot will be excluded from the main study. All data provided will be treated confidentially and your anonymity will be preserved throughout the study. Data provided by this study will be included within the PhD thesis, and potentially future publication and/or conference presentations.

Deciding to participate, what is the next step?
A full description of the study, aims and procedures has been provided in the information sheet attached to this letter. Please read this carefully before deciding whether to participate in the study. If you would like to participate, please complete the intention to participate slip and return this in the self-addressed envelope provided by 14th February 2011. If you have any further questions I can be contacted by telephone (0161 247 2942) or email s.gough@mmu.ac.uk

What if I do not wish to participate?
If, however, you have chosen not to participate, please return the intention to participate slip provided below. It can be returned in the self-addressed envelope provided and no further contact will be made.

When will I know if I have been selected to participate in the study?
You will be informed of whether you have been selected to participate in the pilot/main study in writing and/or email (depending on which you select on the intention to participate slip). The Principal Investigator will contact you to arrange a convenient time for you to undertake the standardised simulation. The pilot phase is due to commence in March 2011 and the main study between March and May 2011.

I would finally like to thank you for taking the time to read this letter and considering participation.

Yours Sincerely

Mrs Suzanne Gough
Principal Investigator
PhD Student, MA Education, PGC-AP, BSC (Hons) Physiotherapy, FHEA
Manchester Metropolitan University
Email: s.gough@mmu.ac.uk

Dr Abebaw Yohannes
Director of Studies
Reader in Physiotherapy
Email: a.yohannes@mmu.ac.uk

Please turn over to complete the intention to/not participate slip

INTENTION TO PARTICIPATE RELP SLIP **Version 1.0** **28 January 2011**

Please read and tick the boxes that you agree to and sign below:

☐ ***I would like*** to participate in the cardio-respiratory simulation scenario

☐ ***I DO NOT*** want to participate in the cardio-respiratory simulation scenario

Please provide a current postal address/email address so that the Principal Investigator can contact you to arrange participation at a convenient time for you

Address:...
....
....
....
Email address: ....

Please detach this slip and return to the Principal Investigator
in the self-addressed envelope provided to:

Mrs Suzanne Gough,
T401 Elizabeth Gaskell Campus,
Manchester Metropolitan University,
Hathersage Road,
Manchester, M13 0JA
Telephone: 0161 274 2942
Email: s.gough@mmu.ac.uk

Before Monday 14th February 2011

Appendix 5: Phase 1 NHS and HEI participant information sheets

NB: The exact format was replicated for the HEI participant information sheet, thus it has not been duplicated in the appendix.

FACULTY OF HEALTH, PSYCHOLOGY AND SOCIAL CARE
Department of Health Professions
Elizabeth Gaskell Campus
Hathersage Road
MANCHESTER
M13 0JA

Manchester Metropolitan University

Information Sheet for NHS Trusts

(Version 2.0, 21/09/09)

Study title

The application of Simulation-Based Education (SBE) within Cardio-respiratory and Emergency On-call Physiotherapy Education

Invitation

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part.

What is the purpose of the study?

Despite the wealth of evidence relating to the use of simulation-based education (SBE) within healthcare postgraduate training; its potential use with respect to physiotherapy clinical skill development, cardio-respiratory and on-call physiotherapy remains unknown. The application and extent of SBE use within cardio-respiratory physiotherapy education (undergraduate and /or postgraduate) and emergency on-call services has not yet been defined.

Specifically, the objectives of this survey are to:

i) Determine how on-call physiotherapy leads perceive the application of SBE within induction (initial) and update emergency on-call physiotherapy.
ii) Determine to what extent SBE is currently being utilised within Trust-specific/Regional acute respiratory/on-call/basic life support training.
iii) Identify whether simulation is currently being utilised by Physiotherapy Departments in relation to physiotherapy training.
iv) Determine how the available simulation technology being utilised within current physiotherapy on-call training in relation to the ACPRC, (2007) Emergency On-call Physiotherapy Assessment and Treatment Matrix.
v) Determine whether there are any additional simulation-product specifications that would further enhance human simulator use within cardio-respiratory physiotherapy education.

Why have I been chosen?

You have been chosen because you have the designation of On-call Physiotherapy Lead for your Trust. Your Trust has been chosen because, according to data that is in the public domain (CMA Data (2008) Directory of Critical Care), your Trust has open and staffed critical care beds, thus your Trust is likely to provide cardio-respiratory/emergency on-call physiotherapy continued education for employees.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part, you are still free to withdraw yourself and any information that you have provided at any time and without giving a reason.

For this reason you should include on your questionnaire a unique code that will allow the research team to recognise your questionnaire and remove it, and the data it contains from the study. A decision to withdraw at any time or a decision not to take part, will not affect you in any aspect of your relationship with Manchester Metropolitan University.

What will happen to me if I take part?

You will be required to complete one postal questionnaire and this consent form. Following completion, please return both of the documents in the enveloped self-addressed envelope. The questionnaire will consist of a questions relating to use of simulation within education and cardiorespiratory/emergency on-call assessment and treatment skills (as outlined in the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Acute Respiratory/On Call Physiotherapy Self Evaluation of Competency questionnaire.

The questionnaire will take no more than 15 minutes to complete. The cover letter indicates that if your NHS Trust does not currently use simulation, that only the initial 2 sections are required to be completed.

Participation is voluntary and no monetary payments will be made. Participation/non-participation will have no effect your current or future employment.

What are the possible disadvantages of taking part

The research team does not anticipate that any respondent will be disadvantaged by participating in this study.

What are the possible benefits of taking part?

It may be that you as an individual do not benefit directly from having participated in the study. However, findings of this study shall be used to inform the development of a cardiorespiratory/emergency on-call physiotherapy simulation tool and generate further research.

Will my taking part in this study be kept confidential?

You will not be required to identify yourself on the questionnaire. You will not be required to identify which Trust you work for on the questionnaire. In this way, your confidentiality will be protected.

No coding of actual questionnaires will be made to ensure confidentiality and anonymity of respondents. Each questionnaire envelope will be coded and a register shall be kept of those numbers (1-280 NHS Hospitals) returned. Only when the final date specified on the questionnaire/cover letter has passed, will the outstanding number/codes (corresponding to Trusts) be re-issued with a reminder letter and additional copy of the questionnaire. Once the initial deadline has passed, returned questionnaire envelope codes will be cross-referenced. Envelopes will then be destroyed and non-respondents will be issued with a reminder questionnaire. The list that allows links to be made between any Trust and a code will be then be destroyed.

You may, if you wish provide a unique identification number on the final page of the questionnaire, so that if you wish to withdraw the data that you have provided at any time the research team can identify your questionnaire and either return it to you or destroy it. You are free to withdraw your questionnaire at any time until the data is to be analysed, without any threat to your future employment or the study.

What will happen to the results of the research study?

Data provided by this study will be analysed and included within the Principle Investigator's PhD thesis, and potentially in future peer-reviewed publication and/or conference presentations.

The results will also inform the development of future work, specifically a cardio-respiratory simulation tool suitable for both cardio-respiratory/on-call undergraduate and postgraduate education.

Who is organising and funding the research?

This study is organised by the Principle Investigator, Suzanne Gough as part-fulfilment of her PhD and the Supervisory Team (Dr Abebaw Yohannes, Professor Judith Sixsmith and Ms Catharine Thomas, Consultant Physiotherapist) from Manchester Metropolitan University.

Who has reviewed the study?

Ethical approval has been sought and gained from Manchester Metropolitan University internal ethics committee (Ref no: 0921).

Contact for Further Information

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Department of Health Professions
Faculty of Health, Psychology and Social Care
Manchester Metropolitan University
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Email: s.gough@mmu.ac.uk

Dr Abebaw Yohannes
Director of Studies and Reader in Physiotherapy
Department of Health Professions
Faculty of Health, Psychology and Social Care
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Appendix 6: Phase 2 Participant information sheet

Version 1.2 3 March 2011

FACULTY OF HEALTH, PSYCHOLOGY AND SOCIAL CARE
Department of Health Professions
Elizabeth Gaskell Campus
Hathersage Road
MANCHESTER
M13 0JA

Manchester Metropolitan University

Study title
An exploration of pre-registration physiotherapy students' experiences of participation in a cardio-respiratory simulation-based education scenario.

Invitation
You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part.

What is the purpose of the study?
The purpose of this study is to better understand the application of simulation-based education (SBE) within physiotherapy. The student experiences will be explored using videos of the simulation experience and participant review of the simulation video (using a method called 'Think Aloud'). The findings will be utilised to inform future development and evaluation of physiotherapy cardio-respiratory simulation scenarios and inform Physiotherapy curricula development.

Aim of the study
To explore the application of a standardised cardio-respiratory physiotherapy (high-fidelity) simulation scenario with final year pre-registration physiotherapy students.

Study Objectives
To develop a suitable methodology to allow the participants to reflexively engage with their own experience within a standardised (high-fidelity) cardio-respiratory simulation scenario.
To develop a standardised simulation scenario (using key findings from Phase 1) to permit an exploration of the pre-registration physiotherapy students' responses to the management of a deteriorating cardio-respiratory patient.
To develop a video reflexive interview schedule to facilitate the exploration of the pre-registration physiotherapy students' ability to:
Identify any errors encountered within the management of a standardised cardio-respiratory patient.
Explore any errors encountered within the management of a standardised cardio-respiratory patient.
Explore potential elements of prior learning that may have assisted the pre-registration physiotherapy students' actions within the simulated scenario.
Ascertain the value that the pre-registration students attributed to the simulated learning experience.

Why have I been chosen?
You have been invited to take part as you are currently a member of the (BSc (Hons)/MSc Pre-registration Physiotherapy Programme which is currently using simulation. All current final year pre-registration Physiotherapy students at Manchester Metropolitan University will be invited to take part.

Do I have to take part?
It is up to you to decide whether or not to take part. If you decide to take part, you are still free to withdraw yourself and any information that you have provided at any time and without giving a

reason. For this reason you should include a unique code on the consent form that will allow the research team to recognise you and remove all data associated with your participation in the study. A decision to withdraw at any time or a decision not to take part, will not affect you in any aspect of your education within Manchester Metropolitan University. Once all expression of interest forms have been completed, the Principal Investigator will randomly select 15 participants (3 to take part in the pilot and 12 for the main study). Participants will be contacted by the Principal Investigator to arrange a suitably convenient time for you to undertake the simulation.

What will happen to me if I take part?
The following information is provided to clearly indicate the level of involvement required by each participant. In return for participation you will be provided with personal copies of the Digital Versatile Disc (DVD) of your participation in the simulation, simulation learning outcomes and a certificate of participation. The DVD, learning outcomes and certificate can be used as evidence of personal and professional development. This can be presented in your Personal Development Portfolio.

Outline of participant involvement:
You will be required to complete one cardio-respiratory simulation scenario in the simulation suite (CM5 and CM6) of the Clinical Skills Laboratory at MMU. The simulation scenario has been developed using a clinical incident from another study. Guidance from the National Patient Safety Agency and the simulation evidence base has also been used to design the simulation scenario. The scenario has already been piloted and will take you approximately 20-30 minutes to complete a physiotherapy assessment and management of the patient. After the simulation has ended you will be required to view your personal simulation video and provide any comments on your activities. This is called the ‘Think Aloud’ method. Key prompt questions will be used to enable you to describe your thoughts and actions as you review your own video of the simulation you have just undertaken. You will also be able to provide any additional information that you feel relevant at this stage. This may take approximately 30-40 minutes depending on the duration of your simulation). The overall anticipated participation time will be 60-90 minutes. Participation is voluntary and no monetary payments will be made. Participation/non-participation will have no effect your current or future education at Manchester Metropolitan University.

What are the possible disadvantages of taking part?
The research team does not anticipate that any respondent will be disadvantaged by participating in this study.

What are the possible benefits of taking part?
It is anticipated that by undertaking the simulation scenario, Think Aloud Review of your performance and receiving a personalised simulation debrief (from the Principal Investigator), you will have developed in some way. The simulation scenario is standardised; however, as you are able to independently assess the ‘simulated patient’ you inevitably learn from your participation. The DVD provided by the Principal Investigator will enable you to reflect on your own learning immediately after the simulation (during the Think Aloud Review and in your own time). The simulation learning outcomes have been mapped to key skills within the National Health Service (NHS) Knowledge and Skills Framework (KSF). Therefore, you may wish to use the DVD and/or personal reflection activities as supporting evidence of achievement of these KSF components. The simulation, any future personal reflection activities and certificate of participation can all be used within your own Personal Development Portfolio, to demonstrate your experiences and achievements. You may also choose to discuss or use any evidence generated as a result of participation within future job applications or interviews.
Findings of this study will also be used to inform the development of simulation, reflection and electronic portfolio activities within pre- and postgraduate programmes at Manchester Metropolitan University.

Will my taking part in this study be kept confidential?
You will not be required to identify your name or which cohort you are registered to on any of the videos. In this way, your confidentiality will be protected. All video files will be coded using your unique identifying code, which only you will design. This will be completed on the study consent

form. The Principal Investigator will transfer this to all digital and paper-based copies of data pertaining to your participation. This will ensure that all information relating to your participation could be withdrawn at any time, prior to data analysis. The use of a unique identifying code designed by you is to ensure the confidentiality and anonymity of participants. This number will bear no reference to your individual student number. The Principal Investigator will maintain all consent forms in a separate folder as these will contain the unique identification codes and personal contact details. This will be kept in a locked cabinet and the Principal Investigator's locked office. All paper documents will be kept in a locked filing cabinet, computer records will be password protected. The completed questionnaires and the data generated from them will be kept for 10 years and then destroyed (cross-shredded). All simulation videos will be recorded using the MMU simulation equipment located in C5 and C6 simulation rooms within the Clinical Skills laboratory. After each simulation has been completed the videos will be removed from the MMU simulation equipment and transferred to the Principal Investigator's password protected Apple MacBook and external hard-drive. This is because the computer software used to run the scenario and analyse the videos requires Apple hardware (MacBook/iMac). All files will then be password protected to prevent unauthorised viewing of raw data by others outside of the Supervisory Team. The external hard-drive will be password protected, locked to the desk (with a Kensington lock) in the Principal Investigator's locked office. All storage shall comply with the data Protection Act (OPSI 1998 and MRC 2000). Computerised data storage considerations are in line with the Medical Research Council recommendations (MRC 2000). All printouts will be retained in a separated locked filing cabinet and identified by date of collection and participant's generated unique identifying code. All data shall be maintained for 10 years, in line with the Data Protection Act recommendations. If you wish to withdraw the data that you have provided the research team can identify your questionnaires and simulation DVD and either return it to you or destroy it. You are free to withdraw your data at any time until the data is to be analysed, without any threat to your education at Manchester Metropolitan University, future employment or the study.

What will happen to the results of the research study?
Data provided by this study will be analysed and included within the Principle Investigator's PhD thesis, and potentially in future peer-reviewed publication and/or conference presentations.
The results will also inform the development of future work, specifically a cardio-respiratory simulation evaluation tool potentially suitable for both cardio-respiratory pre-registration and postgraduate education. If you wish to withdraw yourself or your data from the study, you can do so at any point until data analysis has commenced. To withdraw your data, please contact the Principal Investigator in writing, indicating your unique identification number (which you will personally generate on the consent form).

Who is organising and funding the research?
This study is organised by the Principle Investigator, Suzanne Gough, as part-fulfilment of her PhD and the Supervisory Team (Dr Abebaw Yohannes, Professor Judith Sixsmith, Dr Pennie Roberts and Miss Catharine Thomas, Consultant Physiotherapist) from Manchester Metropolitan University.

Who has reviewed the study?
Ethical approval has been sought and gained from Manchester Metropolitan University Faculty of Health Ethics Committee (Ref no: 1102).

Contact for Further Information

Mrs Suzanne Gough
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Dr Abebaw Yohannes
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Appendix 7: Phase 1 NHS and HEI survey consent forms

NHS Written Consent Form

Version 2.0, 21/09/09

After reading the information sheet, I would be very grateful if you could indicate with a tick, whether you wish to participate in the questionnaire survey:

☐ **I wish** to participate in this study. *Please return this form with the questionnaire, in the self-addressed envelope provided.*

☐ **I do not wish** to participate in this study. *Please return this form in the self-addressed envelope provided, so that your wishes will be honoured and you will not receive a reminder letter and further copy of the questionnaire.*

Signature……………………………………………

Please print your full name…………………………..

Date ………………………….

Contact Information:
Mrs Suzanne Gough, Principal Investigator,
T401, Elizabeth Gaskell Building, Hathersage Road, Manchester M13 0JA.
Email: **s.gough@mmu.ac.uk**

HEI Written Consent Form

Version 2.0, 21/09/09

If after reading the information sheet, I would be very grateful if you could indicate with a tick, whether you wish to participate in the questionnaire survey:

☐ **I wish** to participate in this study. *Please return this form with the questionnaire, in the self-addressed envelope provided.*

☐ **I do not wish** to participate in this study. *Please return this form in the self-addressed envelope provided, so that your wishes will be honoured and you will not receive a reminder letter and further copy of the questionnaire.*

Signature……………………………………………

Please print your full name…………………………..

Date ………………………….

Contact Information:
Mrs Suzanne Gough, Principal Investigator,
T401, Elizabeth Gaskell Building, Hathersage Road, Manchester M13 0JA.
Email: **s.gough@mmu.ac.uk**

Appendix 8: Phase 2 Consent form

Manchester Metropolitan University

Exploring the experiences of final year pre-registration physiotherapists participating in high-fidelity simulation

Simulation-Based Education Consent Form

Version 1.0 **11 March 2011**

The cardio-respiratory simulation-based education scenario shall consist of an immersive experience where you will participate individually in a simulated scenario to undertake an assessment and management of a patient. In order to provide you with a Digital Versatile Disc (DVD) of the experience, the simulation will be recorded using the simulation suite video equipment at Manchester Metropolitan University (MMU).

Please read and tick the boxes that you agree to and sign below:

☐ I wish to participate in the cardio-respiratory simulation scenario

☐ I agree that the high-fidelity simulation scenario(s) can be video-recorded

☐ I agree that the information that I provide may be utilised by MMU for educational or marketing purposes, future publication, conference presentations and as partial fulfilment of the Principal Investigators PhD

In the case of publication, the material will be published without my name attached and every attempt will be made to ensure my anonymity. I understand, however, that complete anonymity cannot be guaranteed. It is possible that somebody somewhere may identify me. The material may be published in peer reviewed journals or presented at conferences relating to physiotherapy, technology, education, simulation, mixed methodology

☐ I give consent for the material to be used in other publications as long as the following criteria are met:

The material will not be used out of context - for example, a picture will not be used to illustrate an article that is unrelated to the subject of the photograph.

☐ I agree that on receipt of my copy of the DVD/podcast, that I will not share this in any format (upload to the worldwide web or any other unlawful copying). By accepting the DVD of the simulation, I accept that copyright belongs to MMU.

Student signature:…………………………………………………………………………..
Print name:……………………………………………………………………………..

Course facilitator signature:…………………......…………………………………..
Print name:………………………...

Date:……………………………………………………………………………………….

Please enter your unique identifier here:___________________
This is to allow you to identify your scenario data. It can be numbers and/or letters. You should keep a note of this code should you wish to withdraw your simulation recording.

Principal Investigator Contact Address:

Mrs Suzanne Gough,
PhD Student,
Principal Investigator
T401 Elizabeth Gaskell Campus,
Manchester Metropolitan University,
Hathersage Road,
Manchester, M13 0JA

T: 0161 274 2942
Email: s.gough@mmu.ac.uk

Please provide a current postal address so that the DVD file can be forwarded on to you:

....
....
....
....

Office Information:
Copy 1 to be retained by the participant
Copy 2 to be retained by the Principal Investigator

Appendix 9: Phase 2 Confidentiality agreement

Confidentiality Agreement

Version 1.0 **28 January 2011**

As a patron of the simulation equipment at Manchester Metropolitan University, I understand the significance of confidentiality with respect to information concerning simulated patient.

I will uphold the requirements of the Data Protection Act and any other laws regarding confidentiality. I agree to report any violations of confidentiality that I become aware of to the Principal Investigator (Mrs Suzanne Gough).

Please tick that you have read and agree to adhere to the following guidelines:

- [ ] All information generated during the cardio-respiratory simulation-based education experience is confidential and any inappropriate viewing, discussion or disclosure of this information is a violation of Manchester Metropolitan University policy.
- [ ] This information is privileged and confidential regardless of format: electronic, written, video overheard or observed.
- [ ] Any inappropriate viewing, discussion or disclosure of this information is a violation of Manchester Metropolitan University policy and may be a violation of the Data Protection Act and other laws.
- [ ] The cardio-respiratory simulation-based education experience is a learning environment. Participation in the simulation, regardless of the outcome, should be treated in a professional manner. Actions undertaken as part of the simulation should be undertaken with utmost respect and practice within the scope of practice of your profession (Physiotherapy).
- [ ] All participants will have the opportunity to participate in a debrief following the simulation as a part of self-reflection. This debrief will conclude the cardio-respiratory simulation-based education.
- [ ] No food or drink should be consumed in the simulation room or within the vicinity of the simulation or computer equipment.
- [ ] On receipt of my copy of the Digital Versatile Disc (DVD), I agree that I will not share this in any format (upload to the worldwide web or any other unlawful copying). By accepting the DVD of the simulation, I accept that copyright belongs to MMU.

Participant signature: ______________________________

Printed name: ______________________________

Date: ______________________________

Principal Investigator: ______________________________

Appendix 10: Phase 2 Risk assessment

Simulation Risk Assessment

Manchester Metropolitan University

Version 1.0 **28 January 2011**

Physiotherapy simulation participants will be required to comply with contractual requirements for health and safety of themselves and others, in accordance with their employment by Manchester Metropolitan University.

Please tick in each box that you have read and understood the following potential hazards and control measures relating to simulation participation

Hazards

☐ Risk of slip/trip in work environment.

☐ Risks associated with moving and handling of SimMan/METIman simulator.

Control

☐ Participants are reminded to ensure that they are to maintain a healthy and safe working environment

☐ Participants are reminded of the principles for safe moving and handling.

☐ Participants are to declare to tutors/others if unable to participate in the study due to health or any other reasons.

Participant signature: ______________________________

Printed name: ______________________________

Date: ______________________________

Principal Investigator: ______________________________

Simulation Code of Conduct

Manchester Metropolitan University

Version 1.0 **28 January 2011**

As a patron of the Simulation Equipment at Manchester Metropolitan University, I understand the significance of confidentiality with respect to information concerning simulated patients and fellow students. I will uphold the requirements of the Data Protection Act and any other laws regarding confidentiality. I agree to report any violations of confidentiality that I become aware of to my assessor (Principal Investigator of the research study, Suzanne Gough).

I agree to adhere to the following guidelines - please tick all that you have read and agree each of the points below)

☐ All information generated during the standardised cardio-respiratory simulation scenario and Think Aloud Review (TAR) is confidential

☐ Any inappropriate viewing, discussion or disclosure of this information is a violation of Manchester Metropolitan University policy Institute policy.

☐ This information is privileged and confidential regardless of format: electronic, written, video overheard or observed.

☐ Any inappropriate viewing, discussion or disclosure of this information is a violation of Manchester Metropolitan University policy and may be a violation of Data Protection Act (OPSI, 1998).

☐ The Simulation Experience and TAR have been designed to replicate as near as possible the real clinical environment. Thus can be classified as a high-fidelity simulated learning environment. Participation in the simulation and TAR, regardless of the outcome, should be treated in a professional manner.

☐ Engagement within discussions in the TAR should be undertaken with utmost respect and respecting professional code of conduct defined by the Chartered Society of Physiotherapy and Health Professions Council.

Participant signature: ______________________________

Printed name: ______________________________

Date: ______________________________

Principal Investigator: ______________________________

Appendix 12: Phase 1 NHS survey questionnaire

The use of Simulation-Based Education for Emergency On-Call Training in the United Kingdom

Emergency on-call physiotherapy is defined as 'the provision of respiratory/cardiorespiratory/cardiothoracic or combinations of respiratory and orthopaedic physiotherapy, out of working hours' (Gough and Doherty, 2007).

For the purpose of this questionnaire simulation-based education is defined as the use of part-task trainers (e.g. suction mannequin or Resusci® Anne mannequin) or full body human patient simulators (e.g. SimMan) within education, training sessions or courses.

The following questionnaire has been devised in-conjunction with the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Acute Respiratory/On Call Physiotherapy Self Evaluation of Competency questionnaire.

Any comments noted will be treated as confidential and will be anonymised
Thank you for your participation.

Section 1: Demographics

For Office use only

Q1) Please state your Professional title, e.g. Clinical Specialist Physiotherapist, Team Leader: D1

....

Q2) Please state your age .... **Q3) Gender:** Male/Female **(Delete as appropriate)** D2

Q4) Have you personally participated in any general/on-call training using simulation technology *(e.g. part task trainers such as suction heads or medium/high fidelity human patient simulators)?* ***(Please tick 1 box)*** D3

Simulation experience	Tick 1box	For Office use only
NO *If NO, Please continue to Section 1 Question 6 on page 2*		[2]
YES *(please provide brief details of the type of training e.g. On-call, Basic Life Support)*		[1]

Q5) Please indicate the number of times you have participated in simulation education in the past 2 years. ***(Please tick 1 box)***

Number of times	0	1	2	3	4	≥ 5

D6

Q6) Please indicate your level of agreement with each statement below:

Simulation-based education in relation to on-call physiotherapy	Strongly Agree [1]	Agree [2]	Neither [3]	Disagree [4]	Strongly Disagree [5]	For Office use only
Simulation-based education has a place in physiotherapy on-call training?						E1
Simulation-based education has a place in physiotherapy acute respiratory training						E2
I am sceptical about the usefulness of simulation-based education in physiotherapy						E3
Simulation-based education may contribute to increased patient safety						E4
Simulation equipment is suitable for use within on-call training						E5
Simulation-based education is suitable to develop on-call competencies						E6
Simulation-based education is *not* suitable for the assessment on-call competencies						E7
Simulation-based education could provide opportunities to practice/manage critical events						E8

Section 2: On-call Training

Q7) Where do physiotherapists on your Trust's emergency on-call rota receive their on-call *induction* training? *(Please Tick 1all that apply)*

Emergency on-call induction training delivery location	**Tick**	
In-house		[1]
Regional training		[2]
Other: Please specify		[99]

Q8) Where do physiotherapists on your Trust's emergency on-call rota receive their on-call *update* training? *(Please Tick 1 box)*

Emergency on-call update training delivery location	**Tick 1 box**	
In-house		[1]
Regional training		[2]
Other Please specify		[99]

For Office use only

Section 2 Continued: On-call Training

Q9) In relation to the on-call *induction* training (in-house/regional) – does the delivery involve using any form of simulation technology? *(Please Tick 1 box)*

Emergency on-call *induction* training using simulation	**Tick 1 box**	
YES		[1]
NO		[2]

Q10) In relation to the on-call *update* training (in-house/regional) – does the delivery involve using any form of simulation technology? *(Please Tick 1 box)*

Emergency on-call *update* training using simulation	**Tick 1 box**	
YES		[1]
NO		[2]

Q11) Does your Trust currently use simulation technology for on-call competency assessment? *(Please Tick 1 box)*

Simulation technology for on-call competency assessment	**Tick 1 box**	
YES		[1]
NO		[2]

Q12) Does your Physiotherapy service currently use simulation technology for acute respiratory physiotherapy staff training? *(Please Tick 1 box)*

Simulation technology for acute respiratory training	**Tick 1 box**	
YES *Please go to Q13*		[1]
NO *If No, you have now completed the questionnaire*		[2]

Q13) In which of the following situations does your Trust use simulation technology for induction/update on-call staff training? (Please Tick all that apply)

Emergency On-call Training situations	**Tick**	
On-call assessment skills		OC15
On-call treatment skills		OC16
On-call scenarios		OC17
Other Please specify		OC99

For Office use only

Section 3: Simulation Technology:

Q14) What type of simulation equipment is available within your Trust? (Please tick <u>either</u> YES or NO for all statements)

Simulation equipment	YES [1]	NO [2]	For Office use only
Laerdal SimMan			Q1
Laerdal SimMan 3G			Q2
Laerdal SimBaby			Q3
Laerdal Resusci®Anne (CPR equipment)			Q4
METI iStan			Q5
METI Human Patient Simulator (HPS)			Q6
METI Babi/Pedia SIM			Q7
Guamard Medical Hal			Q8
Guamard Paediatric/Newborn Hal			Q9
Simulaids Stat Man			Q10
Simulaids Stat Baby			Q11
Part-task trainers (e.g. human simulated head for suction skills)			Q12
Other: *Please specify*			QE99

Q15) Which of the following simulation features have you used within your Trust's emergency on-call training (initial or updates)? (Please tick <u>either</u> YES or NO for all statements)

Simulation features	YES [1]	NO [2]	For Office use only
Normal lung sounds			Q12
Abnormal lung sounds			Q13
Interactive voice (pre-set on simulator or microphone)			Q14
Ability to simulate pneumothorax			Q15
Pulses (manual record of Heart Rate)			Q16
Normal airway sounds			Q17
Abnormal airway sounds			Q18
Other: *Please specify*			QF99

Section 4: Current use of simulation within on-call training (induction/update)

For Office use only

Q16) Please indicate the type of scenarios that are currently undertaken using simulation technology within on-call training in your Trust:
(Please tick <u>either</u> YES or NO for all statements)

Scenario - Range of Competency (ACPRC, 2007 competency statements: Range of Competency)	YES [1]	NO [2]	
Adults following abdominal surgery			R1
Adults following cardiothoracic surgery			R2
Adults on ventilators			R3
Adults with chronic respiratory disease			R4
Adults multiple trauma			R5
Adults with acute medical disease			R6
Adults with unstable spine			R7
Adults with neurological deficits			R8
Adults who are unstable (e.g. cardiovascular instability)			R9
Adults with a tracheostomy			R10
Adults with raised head trauma/raised intra cranial pressure			R11
Adults in 'end of life situations'			R12
Other: *Please specify*			R99

Q17) Please indicate the type of assessment skills that are currently undertaken using simulation technology within on-call training in your Trust:
(Please tick <u>either</u> YES or NO for all statements)

Patient Assessment (ACPRC, 2007 competency statements: Patient Assessment)	YES [1]	NO [2]	
Interpret patient records, notes and charts (& monitors)			A1
Use a stethoscope to interpret auscultation findings			A4
Observe the patients breathing and general status and identify significant findings			A6
Collects accurate and appropriate information			A9
Identify the patients main problems			A10
Select appropriate outcome measures			A11
Interpret arterial blood gases			A12
Interpret chest x-ray findings of relevance to physiotherapy			A13
Analyse assessment findings			A14
Identify a patient who is deteriorating or becoming critically ill			A15
Other: *Please specify*			A99

Section 4: Current use of simulation within on-call training (induction/update)

For Office use only

Q18) Please indicate the type of treatment skills that are currently undertaken using simulation technology within on-call training in your Trust (Please tick either YES or NO for all statements)

Patient Treatment (ACPRC, 2007 Treatment Skills Matrix)	YES [1]	NO [2]	
Percussion			MX2
Vibrations			MX3A
Shaking			MX3B
Humidifiers and Nebulisers			MX4
Postural Drainage Positioning			MX5
Positioning and breathing exercises for control of breathlessness			MX6
Nasopharyngeal suction			MX10
Oro-pharangeal suction			MX11
Closed Suction			MX12
Endotracheal/Tracheostomy suction			MX13
Inserting an airway			MX16
Tracheostomy Management			MX17
Other: *Please specify*			MX99

Q19) Are there any additional simulation product specifications that would further enhance human patient simulator use within cardio-respiratory education? Please use the space provided below to provide details

ASP

Q20) If you would like to provide any further comments regarding on-call training, use of simulation or competencies, that has not been addressed by questions within this questionnaire: please use the space below.

AC

Thank you very much for your participation, your time and comments are greatly appreciated. Please return the questionnaire in the self-addressed envelope provided by *Friday 27th November 2010*

Please enter your unique identifier here:________________

This is to allow you to identify your questionnaire. It can be numbers and/or letters. You should keep a note of this code and only share it with the investigator should you wish to withdraw.

Appendix 13: Phase 1 HEI survey questionnaire

The use of Simulation-Based Education for Cardio-respiratory Education within the United Kingdom

For the purpose of this questionnaire simulation-based education is defined as the use of part-task trainers (e.g. suction mannequin or Resusci® Anne mannequin) or full body human patient simulators (e.g. SimMan) within education, training sessions or courses.

The following questionnaire has been devised in-conjunction with current simulation technology literature and the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) Acute Respiratory/On Call Physiotherapy Self-Evaluation of Competency questionnaire (ACPRC, 2007).

**Any comments noted will be treated as confidential and will be anonymised.
Thank you for your participation.**

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Section 1: Demographics

Q1) Please state your Professional title, e.g. Lecturer, Senior Lecturer, Principle Lecturer, Head of Department: D1

....

Q2) Please state your age .... **Q3) Gender:** Male/Female **(Delete as appropriate)** D2 D3

Q4) Have you personally undertaken any education using simulation technology? *(e.g. part task trainers such as suction heads or medium/high fidelity human patient simulators)? **(Please tick 1 box)***

Simulation experience	Tick 1box	
NO *If NO, Please continue to Section 1 Question 6 on page 2*		[2]
YES *(please provide brief details of the type of training e.g. On-call, Basic Life Support)*		[1]

Q5) Please indicate the number of times you have participated in simulation-based education in the past 2 years. ***(Please tick 1 box)***

Number of times	0	1	2	3	4	≥ 5

D6

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Q6) Please indicate your level of agreement with each statement below:

Simulation-based education in relation to on-call physiotherapy	Strongly Agree [1]	Agree [2]	Neither [3]	Disagree [4]	Strongly Disagree [5]	
Simulation based education has a place in cardio-respiratory education						E1
Simulation-based education has a place in physiotherapy acute respiratory training						E2
I am sceptical about the usefulness of simulation-based education in physiotherapy						E3
Simulation-based education may contribute to increased patient safety						E4
Simulation equipment is suitable for use within emergency on-call training						E5
Simulation-based education is suitable for use within cardio-respiratory education						E6
Simulation-based education is *not* suitable to develop cardio-respiratory skills						E7
Simulation-based education could provide opportunities to practice critical events						E8

Section 2: Undergraduate Cardio-respiratory Education

Q7) Does your Physiotherapy Programme have access to human patient simulators (e.g. SimMan / METI HPS)? *(Please Tick 1 box)*

Human Patient Simulator Access (e.g. SimMan / METI)	**Tick**	
NO		HPC2
YES		HP1

If YES please provide details the following details:

a) How many? HP1A

b) Were they purchased for sole use of the Physiotherapy Programmes? HP1B

c) Where are the simulators situated (e.g. mock ward set-up)? HP1C

d) Do you have access to a simulation centre? HP1D

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Section 2 Continued: Undergraduate Cardio-respiratory Education

Q9) In relation to undergraduate cardio-respiratory physiotherapy education – does the delivery involve using any form of simulation technology? *(Please Tick 1 box)*

Cardio-respiratory undergraduate education	Tick 1 box	
YES		[1]
NO		[2]

Q10) In relation to postgraduate cardio-respiratory physiotherapy education– does the delivery involve using any form of simulation technology? *(Please Tick 1 box)*

Cardio-respiratory postgraduate education	Tick 1 box	
YES		[1]
NO		[2]

Q11) Does your Physiotherapy Programme currently use simulation technology within formative assessment of cardio-respiratory skills?

Simulation technology for formative assessment	Tick 1 box	
NO		[2]
YES, If yes, please provide brief details below		[1]

Q12) Does your Physiotherapy Programme currently use simulation technology within summative assessment of cardio-respiratory skills?

Simulation technology for summative assessment	Tick 1 box	
NO		[2]
YES, If yes, please provide brief details below		[1]

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Q13) In which of the following situations does your *Undergraduate* Physiotherapy Programme utilise any form of simulation technology. Please answer all statements (Please Tick either YES or NO)

Undergraduate situations	**YES [1]**	**NO [2]**	
Basic Life Support (BLS)			UG1
Advanced Life Support (ALS)			UG2
Cardio-respiratory assessment skills (e.g. auscultation)			UG3
Cardio-respiratory treatment skills (e.g. airway management/suction)			UG4
Mock emergency on-call scenarios			UG5
Acute Illness Management Scenarios			UG6
Acute Illness Management (AIM) Course (ALERT®/Greater Manchester AIM® or equivalent)			UG7
Other Please specify			UG99

Q14) In which of the following situations does your *Postgraduate* Physiotherapy Programme utilise any form of simulation technology. Please answer all statements (Please Tick either YES or NO)

Postgraduate situations	**YES [1]**	**NO [2]**	
Basic Life Support (BLS)			PG1
Advanced Life Support (ALS)			PG2
Cardio-respiratory assessment skills (e.g. auscultation)			PG3
Cardio-respiratory treatment skills (e.g. airway management/suction)			PG4
Mock emergency on-call scenarios			PG5
Acute Illness Management Scenarios			PG6
Acute Illness Management (AIM) Course (ALERT®/Greater Manchester AIM® or equivalent)			PG7
Other Please specify			PG99

Q15) Does your Physiotherapy Programme currently use simulation technology (human patient simulators or part task trainers, e.g. human simulated head for suction or airway management skills) within any current cardio-respiratory modules/units?

Simulation technology within any cardio-respiratory modules/units?	**Tick 1 box**	
YES *Please go to Q16*		STU2
NO *Questionnaire completed (Thank you for your time. Please return the questionnaire in the Self-addressed envelope provided).*		STU1

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Section 3: Simulation Technology:

Q16) Which type of simulation equipment is available within your University? (Please tick <u>either</u> YES or NO for all statements)

Simulation equipment	YES [1]	NO [2]	
Laerdal SimMan			Q1
Laerdal SimMan 3G			Q2
Laerdal SimBaby			Q3
Laerdal Resusci®Anne (CPR equipment)			Q4
METI iStan			Q5
METI Human Patient Simulator (HPS)			Q6
METI Babi/Pedia SIM			Q7
Guamard Medical Hal			Q8
Guamard Paediatric/Newborn Hal			Q9
Simulaids Stat Man			Q10
Simulaids Stat Baby			
Part-task trainers (e.g. human simulated head for suction skills)			
Other: *Please specify*			QE99

Q17) Which of the following simulation features have you used within the cardio-respiratory modules/units (undergraduate or postgraduate)? (Please tick <u>either</u> YES or NO for all statements)

Simulation features	YES [1]	NO [2]	
Normal lung sounds			Q12
Abnormal lung sounds			Q13
Interactive voice (pre-set on simulator or microphone)			Q14
Ability to simulate pneumothorax			Q15
Pulses (manual record of Heart Rate)			Q16
Normal airway sounds			Q17
Abnormal airway sounds			
Other: *Please specify*			QF99

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Section 4: Current use of simulation within cardio-respiratory education

Q18) Please indicate the type of scenarios that are currently undertaken using simulation technology within cardio-respiratory modules/units within your Physiotherapy Programme:

Scenario - Range of Competency **(ACPRC, 2007 competency statements: Range of Competency)**	**YES** [1]	**NO** [2]	
Adults following abdominal surgery			R1
Adults following cardiothoracic surgery			R2
Adults on ventilators			R3
Adults with chronic respiratory disease			R4
Adults multiple trauma			R5
Adults with acute medical disease			R6
Adults with unstable spine			R7
Adults with neurological deficits			R8
Adults who are unstable (e.g. cardiovascular instability)			R9
Adults with a tracheostomy			R10
Adults with raised head trauma/raised intra cranial pressure			R11
Adults in 'end of life situations'			R12
Other: *Please specify*			R99

Q18) Please indicate the type of assessment skills that are currently undertaken using simulation technology within cardio-respiratory modules/units within your Physiotherapy Programme:

Patient Assessment **(ACPRC, 2007 competency statements: Patient Assessment)**	**YES** [1]	**NO** [2]	
Interpret patient records, notes and charts (& monitors)			A1
Use a stethoscope to interpret auscultation findings			A4
Observe the patients breathing and general status and identify significant findings			A6
Collects accurate and appropriate information			A9
Identify the patients main problems			A10
Select appropriate outcome measures			A11
Interpret arterial blood gases			A12
Interpret chest x-ray findings of relevance to physiotherapy			A13
Analyse assessment findings			A14
Identify a patient who is deteriorating or becoming critically ill			A15
Other: *Please specify*			A99

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Section 4: Current use of simulation within cardio-respiratory education

Q20) Please indicate the type of treatment skills that are currently undertaken using simulation technology within cardio-respiratory modules/units within your Physiotherapy Programme: **(Please tick <u>either</u> YES or NO for all statements)**

Patient Treatment (ACPRC, 2007 Treatment Skills Matrix)	**YES** [1]	**NO** [2]	
Percussion			MX2
Vibrations			MX3A
Shaking			MX3B
Humidifiers and Nebulisers			MX4
Postural Drainage Positioning			MX5
Positioning and breathing exercises for control of breathlessness			MX6
Nasopharyngeal suction			MX10
Oro-pharangeal suction			MX11
Closed Suction			MX12
Endotracheal/Tracheostomy suction			MX13
Inserting an airway			MX16
Tracheostomy Management			MX17
Other: *Please specify*			MX99

Q21) Are there any additional simulation product specifications that would further enhance human patient simulator use within cardio-respiratory education? Please use the space provided below to provide details

ASP

Q22) If you would like to provide any further comments regarding cardio-respiratory education, use of simulation, which has not been addressed by questions within this questionnaire: please use the space below.

AC

Thank you very much for your participation, your time and comments are greatly appreciated. Please return the questionnaire in the self-addressed envelope provided by *<u>Friday 11th December 2009</u>*

Please enter your unique identifier here:__________________

This is to allow you to identify your questionnaire. It can be numbers and/or letters. You should keep a note of this code and only share it with the investigator should you wish to withdraw

Appendix 14: Scenario assessment and treatment skills overview

The high frequency assessment and treatment skills identified within the UK surveys undertaken in Phase 1 were integrated in the EOC scenario (Table A1).

Table A1: Scenario assessment and treatment skills

ACPRC (2007) Matrices	High frequency statements identified in Phase 1 NHS and HEI surveys, which were relevant to the case history (ACPRC, 2007 matrix statement in parenthesis)
Range of Competency Statements (Scenario)	Adults with acute medical disease (AR6) Adults with neurological deficits (R8)
Patient Assessment Skills Matrix	Interpret patient records, notes, charts and monitors (A1) Use a stethoscope to interpret auscultation findings (A4) Observe the patient's breathing and general status and identify significant findings (A6) Collects accurate and appropriate information (A9) Identify the patient's main problems (A10) Select appropriate outcome measures (A11) Interpret arterial blood gases (A12) Interpret chest x-ray findings of relevance to physiotherapy (A13) Analyse assessment findings (A14) Identify a patient who is deteriorating/becoming critically ill (A15)
Patient Treatment Skills Matrix	Percussion (MX2) Vibrations (MX3A) Shaking (MX3B) Humidifiers/Nebulisers (MX4) Postural Drainage Positioning (MX5) Positioning and breathing exercises for control of breathlessness (MX6) Nasopharyngeal suction (MX10) Oropharyngeal suction (MX11)
NHS KSF Core Dimension (DH, 2004)	**Description**
HWB6	Assessment and treatment planning
HWB7	Interventions and treatments
HWB8	Biomedical investigation and intervention
IK2	Information collection and analysis
IK3	Knowledge and information resources
G1	Learning and development

Key: ACPRC (2007) acute respiratory/emergency on-call physiotherapy self-evaluation of competence questionnaire and NHS Knowledge and Skills Framework (KSF) core dimensions (DH, 2004)

Appendix 15: Scenario state overview and programming information

Table A2: Scenario states, minimal behaviours and prompts

State 1	Minimal Behaviours expected from the physiotherapist	Prompts for the Healthcare Assistant
Initial Physiotherapy Assessment (25/05/2010 1635 hours)	• Identifies the patient appropriately by checking name band/with nurse • Undertakes subjective respiratory assessment – ascertains airway patency (via patient verbal response and Nurse/Support Worker), ascertains trends in patient condition from the Nurse/Support Worker • Nurse/Support Worker to supply the medical notes, PARS sheet and drug kardex on request (kept initially on the ward desk) • Physiotherapist to undertake an objective respiratory assessment – this may include: o Respiratory status including rate, rhythm and depth of respirations, assessing lung sounds, interpreting chest x-ray(s) o Cardiovascular status including heart rate, blood pressure, capillary refill time, urine output o Disability –AVPU/GCS o Head-to-toe examination • Interpret findings and document – Identify normal and abnormal values (with/without assistance from the Support Worker/Facilitator)	**Provide brief patient information when requested** • **Moving and handling** =requires red slide sheet due to patient being unable to assist in any repositioning (AVPU = Voice) • **Infection control**=MRSA precautions as documented protocol in the notes available to physiotherapist on request written or verbally – **Gloves** for direct contact with body fluids, and /or non-intact skin, or infected tissue. **Aprons** for activities involving patient contact necessary, **Mask**-not necessary • **Laboratory results** = provide on request from physiotherapist, refer the physiotherapist to the medical notes • **Chest x-ray**= Interpretation assistance if learner unable to identify problem. Prompt learner to identify normal and abnormal findings • Interpretation of normal/abnormal vital signs **MEWS:** 3 at 0845hrs and 1635hrs **You can prompt from this information if requested or if asked to help (other info available from simulator/monitors):** **Airway** =patent, self-ventilating, Cyanosis=none; **Breathing**= Apical, no accessory muscle use, increased work of breathing, coarse crackles= RUL, RLL, > LLL, LUL normal breath sounds. Cough=poor minimal effort; **Circulation**= Skin pale, cool, CRT 3 secs, UO 1135 yesterday, 50mls in last hour; **Disability**=responds to voice, agitated, PEARL, Blood Glucose 6.2; **Exposure**= Low tone in upper & lower limbs and around trunk.
Healthcare Assistant Instructions: Spend time looking through case notes at the desk until requested by the physiotherapist for assistance/information.		• Provide (previous and recent) ABG (Found in the patients file), Laboratory results and call for Chest x-ray (on the screen). • Provide assistance in moving and handling/repositioning of the patient. The physiotherapist must lead the physiotherapy

State 2	Minimal Behaviours expected from the physiotherapist	Prompts for the Healthcare Assistant

Physiotherapy Intervention
 	
(25/05/2010 1635 hours)
	• Initiates physiotherapy intervention including:
	  o Oxygen therapy – increase to HCO2 mask (optimal) or consider humidification
	  o Positioning of the patient – Left side lying for chest clearance (adhering to health & safety guidelines, infection control)
	  o Chest wall vibrations – Percussion/shaking/ vibrations – Right upper, mid and lower lobes, Left base
	  o Considers physiotherapy adjuncts – IPPB, Cough assist, suction via nasal airway
	• Reassesses respiratory status following physiotherapy intervention
	• Completes a structured handover to the Nurse/HCA
	You can prompt from the SBAR sheet on your AIM card (copy available in the Patient's Notes)
		• Provide brief patient information when requested (from event column)
		• **Moving and handling** =requires red slide sheet due to patient being unable to assist in any repositioning (AVPU = Voice) *NB: Assistance must be provided to* physiotherapist *for any repositioning due to simulator weight.*
		• **Infection control**=MRSA precautions 9 as documented protocol in the notes available to physiotherapist on request written or verbally **Gloves** for direct contact with body fluids, and /or non-intact skin, or infected tissue. **Aprons** for activities involving patient contact necessary, **Mask**-not necessary
		• **Chest x-ray**= Displayed on the screen throughout the scenario
		• **Intervention preparation**= provide assistance with setup of suction equipment, airway insertion (nasal preferred versus oral) or suction if requested by physiotherapist
		
		You can prompt from this information if requested or if asked to help (other information is available to the physiotherapist from simulator/monitors):
		Airway =patent, self-ventilating, Cyanosis=none
		Breathing= Apical, no accessory muscle use, increased work of breathing, coarse crackles= RUL, RLL, > LLL, LUL normal breath sounds. Cough=poor minimal effort **Circulation**= Skin pale, cool, CRT 3 secs, UO 1009, 50mls in last hour **Disability=**responds to voice, agitated, PEARL, Blood Glucose 6.2
		Exposure=Abdominal=distended and in pain when touch, tone low in upper and lower limbs and around trunk

Healthcare Assistant Instructions:

- Spend time looking through case notes at the desk until requested by the physiotherapist for assistance/information
- Provide assistance in moving and handling/repositioning of the patient. The physiotherapist must lead these interventions unless you are requested otherwise

<table>
<tr><th>State 3</th><th>Minimal Behaviours expected from the Physiotherapist</th><th>Prompts for the Healthcare Assistant</th></tr>
<tr><td>Physiotherapy Reassessment and Handover

(25/05/2010 1635 hours)</td><td>• Reassesses respiratory status following physiotherapy intervention including: respiratory (rate depth and symmetry of breathing, auscultation, oxygen saturations) and cardiovascular parameters (heart rate, non-invasive blood pressure, cyanosis)

• Ascertains current cardiovascular status – acute deterioration

• Identification of the cause of the recent deterioration = able to suggest the cause of the recent deterioration

Basic interpretation = aspiration pneumonia,
Optimal = potential of developing sepsis secondary to recent aspiration

• Completes a structured handover to the Nurse/Support Worker (e.g. SBAR format) including plan of action, when a physio is likely to return</td><td>• Provide brief patient information when requested

• Handover = Prompt for structured approach Situation, Background, Assessment, Recommendations (SBAR) – on the AIM card and within the patient's folder

• Physiotherapy Plan= Prompt for information relating to next physiotherapy intervention and physiotherapy plan if not offered in the (SBAR) handover</td></tr>
<tr><td colspan="3">Healthcare Assistant Instructions:
• Provide vital sign information assistance to recognise trends or re-cap values at the request of the learner
• Request a handover from the physiotherapist when the intervention has been provided</td></tr>
</table>

Table A3: Simulator pre-programmed events according to the position of the patient and physiotherapy interventions administered

Event	Physiotherapy Intervention	Simulator (Patient's) Reaction
Initial desaturation	N/A	Baseline vital signs: SaO_2 92% on 40% (Oxygen via a red venturi face mask), HR=93, BP 115/82, RR 29.
Remains in supine lying position	With or without • Manual chest physiotherapy techniques use • Suction • Increased concentration of oxygen	The vital signs demonstrate that the patient had deteriorated further as this position would indicate a ventilation perfusion mismatch in the lungs. This was designed to stimulate the participants to reconsider their choice of position and utilise appropriate physiotherapy interventions. Vital signs: SaO_2 86%, HR 93, BP 115/82, RR 28
Repositioned in upright sitting position	With or without variants • Manual chest physiotherapy techniques used • Suction • Increased concentration of oxygen	The vital signs demonstrate that the patient had deteriorated further as this position would indicate a ventilation perfusion mismatch in the lungs. This was designed to stimulate the participants to reconsider their choice of position and utilise appropriate physiotherapy interventions. Vital signs: SaO_2 88%, HR 93, BP 115/82, RR 28
Repositioned right side lying position	With or without variants • Manual chest physiotherapy techniques used • Suction • Increases concentration of oxygen	The vital signs demonstrate that the patient had deteriorated further as this position would indicate a ventilation perfusion mismatch in the lungs. This was designed to stimulate the participants to reconsider their choice of position. Vital signs: SaO_2 80% HR 96, BP115/84, RR29
Repositioned left side lying position	With or without variants • Manual chest physiotherapy techniques used • Suction • Increased concentration of oxygen	The vital signs demonstrate that the patient had improved in left side lying SaO_2 94%, HR 90, BP 115/82, RR 27 They did not reach the following levels unless further physiotherapy interventions were added. Vital signs: SaO_2 94%, HR 90, BP 115/82, RR 27
Effective (optimal) treatment	To include all of the following: • Left side lying • Active cycle of breathing techniques • Manual chest physiotherapy techniques • Suction • High concentration oxygen therapy (15L/minute) administered	Optimal resolution of the patient's condition and vital signs. The timing to achieve the final parameters will be determine on the length of time the patient deteriorated before the appropriate interventions were administered. Vital signs: SaO_2 97%, HR 87, BP 115/82, RR 23
Allows patient to stabilise	N/A	The patient still exhibits signs of acute deterioration. This was designed to portray that optimal treatment has not been achieved. Vital signs: SaO_2 92%, HR 90, BP 115/82, RR 24

Key: SaO2, oxygen saturations; HR, Heart Rate; BP, Blood Pressure; RR, Respiratory Rate

Appendix 16: Scenario resources

Examples of the case notes used during the scenario include the Modified Early Warning Tool, Medical Notes and Chest X-ray (NB: Fictitious Trust name applied)

Figure A1: Modified Early Warning Chart

MANCHESTER METROPOLITAN FOUNDATION HOSPITAL TRUST

MODIFIED EARLY WARNING OBSERVATION CHART

Forename: LEVI		Surname: WILLIAMS
Consultant: GEORGE		Hospital Number: 1361 2100
Ward: HAIGH	D.O.B.: 11.01.68	Age: 43

FREQUENCY OF OBSERVATIONS

The frequency of observation recording will depend on the patient's condition. It is the responsibility of the Health Professional to assess each individual patient and make an appropriate decision about the frequency of observations required.

Modified Early Warning Score – Intervention Required			
0-1	2	3 to 4	>5
Stable	*Potential for deterioration*	*Deteriorating*	*Acute/ Critically Ill*
Normal Observations	Extra Vigilance	Assess and Alert	Senior Medical Review
Minimum 12 Hourly Observations	Minimum 4 hourly observations	Minimum 2 Hourly observations	Minimum 1 Hourly Observations
		FY1-FY2 medical staff to review within 30 minutes	FY1-FY2 to be alerted and reviewed by SPR within 30 minutes

MODIFIED EARLY WARNING SCORE

	3	2	1	0	1	2	3
Airway	Threatened						
RR	<6	6-8		9-17	18-20	21-29	>30
SBP	<70	71-80	81-100	101-199		>200	
HR		<40	40-50	51-100	101-110	111-129	>130
AVPU				Alert/Sleeping	Verbal Stimulus	Pain Response	Unresponsive
TEMP		<35.0		35.0-38.0	38.1 - 38.5	>38.6	
U.O. for 2 Hours	<10ml/hr	<35mlhr+2hr					

AVPU	Pain Score	Nausea/ Vomiting Score
A = 0 Awake and Responsive	0 = no pain	0 = No Nausea/Vomiting
V = 1 Responds to verbal commands	1 = Mild Pain	1 = Nausea/Vomiting
P = 2 Responds to painful stimulus	2 = Moderate Pain	
U = 3 Unresponsive	3 = Severe Pain	

Figure A2: Scenario medical notes

MANCHESTER FOUNDATION HOSPITAL TRUST

Manchester Metropolitan University

PATIENTS NAME: LEVI WILLIAMS	A&E NUMBER 13612100	NHS NUMBER 644 323 1100
ADMITING DOCTOR/ENP (Print Name & Bleep Number) RA Weston 2241		

DATE & TIME	CLINICAL NOTES HAIGH WARD (continued)	Name Signature & Bleep
17.10.13 0845	A – Pt self ventilating 40% O_2 via fm B – RR 28 ↓ expansion Coarse crackles (R) > (L) upper lobes > LL Equal expansion (R) = (L) C – BP 120/57 HR 104 UO 50mls in last hour D – AVPU Drowsy unsedated. Intermittently follows instructions. Temp 38.0°C °(P) E – °rashes / °cuts / °swelling / °bruises °NG feed / ✓jaundice. IV fluids NACL Give 1L in 4–6hrs Imp Pneumonia 2° to end stage liver failure. Recent deterioration type II RF. Requires review in 4 hours. Plan (1) Repeat CXR (2) Chase notes from MAU (3) Call physio for RV.	

RA Weston 2241

MANCHESTER FOUNDATION HOSPITAL TRUST

Manchester Metropolitan University

PATIENTS NAME: Levi Williams	A&E NUMBER 13612100	NHS NUMBER 644 323 1100
ADMITING DOCTOR/ENP (Print Name & Bleep Number) DR R A Weston 2241		

DATE & TIME	CLINICAL NOTES HAIGH	Name Signature & Bleep
17.10.13 0810	41 yr old male transferred from MAU with alcoholic hepatitis and end-stage liver failure. H/o Pneumonia 1/52 Previously managed by his GP – oral ABx for past 1/52. Mr Williams c/o little improvement and ↑ difficulty of expectoration, with ↑ SOBOE. Admitted to ward via A&E → MAU 1/7 ago. ↑ expectoration of green thick sputum q0 (P) to (R) chest on coughing. O/E HR 104 BP 115/58 RR 28 ABGs on admission pH 7.33 pCO_2 8.37 KPa PaO_2 6.44 kPa HCO_3 31.3 mmol/L BE 4.3 SaO_2 95% on 40% O_2 fm coarse crackles upper lobes (R) > (L) tactile fremitus (R) > (L)	

RA Weston

0810 2241

Figure A3: Simulation environment and equipment

Room set up:

- Human patient simulator (METIman) with oxygen and intravenous fluids attached to the drip-stand with infusion pump and slide sheet hung from the head of the bed
- Chest x-ray (displayed on left-hand monitor)
- Equipment trolleys with aprons, gloves, hand gel, airways, oxygen therapy masks, suction equipment, tympanic, blood sample tubes, cannulas, disposable sharps box, sphygmomanometer
- Oxygen therapy protocol (on the whiteboard)
- Patient vital signs (displayed on the right-hand monitor)
- Telephone on the table

Appendix 17: Transparent approach to costing (TRAC) analysis of combining a scenario and VRE

Item	Description	Full economic Cost (£ ex. VAT)
Non-staff directly incurred equipment costs		
Scenario consumables	• Consumable items as specific in scenario template (Appendix 14)	164.28
QuickTime	• Free software application for Apple and Windows • (to record audio and screen recordings during the VRE interview)	0.00
QuickTime Broadcaster	• Free software application for Apple and Windows • (to broadcast audio and video recording of the scenario to a lecture room)	0.00
Directly incurred costs – staff costs for the scenario design		
Senior Lecturer (Grade 9, point 43)	• 5 days allocated for scenario *scripting, programming, piloting and revision*	1319.00
Direct incurred costs – staff costs for the pre-brief, scenario, VRE interview and debrief		
Scenario as delivered in Phase 2 1 Facilitator: 2 learners per scenario	• 1 Simulation Facilitator (Senior Lecturer*, controlling the manikin and providing the verbal interaction for the manikin or other required telephone verbal interactions as required). Total of 36 hours of staff time for 12 sessions: 2 hours set up and pack away on 6 days, 2 hours per simulation intervention, total of 12 sessions.* • *Non-staff directly incurred costs (overheads calculated including specialist laboratory costs which consider heating, lighting, specialist simulation equipment, service level contracts and repairs)* *Key: [a] Cost per 24 learners (12 scenarios, 2 learners per scenario)*	1305.00[a]
TRAC based costs – estates and directly allocated technicians for the use of specialist laboratory-based rooms		
	• Specialist laboratory estate costs	280.00
	• Directly allocated technicians costs for maintenance and updates of specialist facilities	19.00
Indirect costs	• Overheads e.g. office and telephone expenses and utilities	782.00
	Total PhD delivery cost for 12 scenarios	3706.00
	Cost per learner	154.42

Alternative delivery costs for comparison and future investigation			Full Economic Cost (£ ex. VAT)
Original 1 Facilitator : 2 learners per scenario	• 1 Simulation Facilitator (Senior Lecturer, *controlling the manikin and providing the verbal interaction for the manikin or other required telephone verbal interactions as required*) ***Total time allocation: 36 hours.*** *This includes staff time for 12 sessions: 2 hours set up and pack away on 6 days, 2 hours per simulation intervention, total of 12 sessions for 24 learners*		
	Cost per 24 learners (12 scenarios, 2 learners per scenario[a])	**Cost per 24 learners[a]**	**3706.00**
		Cost per learner	**154.42**
	Future replication for a cohort of 86 learners, (42 scenarios, 2 learners per scenario, excluding staff costs for the scenario design)	**Total cost per cohort [a]**	**8553.56**
Option 1 1 Facilitator & 1 Technician: 2 learners per scenario	• 1 Simulation Facilitator (Senior Lecturer Grade 9, Point 43) • 1 Technician *(Controlling the manikin and providing the verbal interaction for the manikin)* ***Total time allocation: 36 hours.*** *This includes staff time for 12 sessions: 2 hours set up and pack away on 6 days, 2 hours per simulation intervention, total of 12 sessions for 24 learners*		
(Includes scenario design costs as in original option)	**Cost as outlined in original delivery costs plus**		3706.00
	Direct incurred staffing cost – Technician (Grade 6, Point 26)		738.00
	Cost per 24 learners (12 scenarios, 2 learners per scenario)	**Cost per 24 learners[a]**	**4444.00**
	Cost per cohort of 86 learners	**Cost per learner**	**185.17**
	(42 scenarios, 2 learners per scenario, excluding staff costs for the scenario design)	**Total cost per cohort[a]**	**11,197.92**
		Cost increase per cohort based on the original option	**2644.36**

*Key: £, British Pounds; ex., excluding; VAT, value added tax; VRE, video-reflexive ethnography; [a] The opportunity for a total of 24 learners actively participating in the scenario, video-reflexive review of the scenario (VRE interview) and debrief, as per the original PhD delivery method; [b] Total learners from 2 actively participating in the scenario, whilst the remainder of the cohort undertake pre-defined observer roles prior to the VRE review of the video footage of the scenario. All 86 learners participate in a debrief; *, this option would also require broadcasting equipment (QuickTime Broadcaster), a free software application for Apple and Windows (to broadcast audio and video recording of the scenario to a lecture room) or more sophisticated audio-visual solutions; TRAC, Transparent Approach to Costing; Staff costs are calculated for the specific grade and point and includes basic salary with the additional national insurance and employer pension contributions. Using activity based costing methodology and principles TRAC aims to provide a transparent approach to the costing of teaching, research and other costs within Higher Education. The staff cost model is based on the assumption of 1650 hours per year, in line with the University workload planning.*

Appendix 18: Video-reflexive interview schedule outline

11 March 2011 **Version 1.2**

Video-reflexive interview aim
The aim of the video-reflexive interview is to establish participant verification of events undertaken within the individual standardised simulation. Each participant will be asked a series of questions to understand the participants' views, critical thinking and clinical decision-making process undertaken with respect to the assessment, physiotherapy intervention and management of the standardise simulation scenario (Levi Williams). A series of prompt questions are also presented to explore the simulation in detail from the individual participant's perspective and gain a greater insight into the actual events that occurred within the simulation.

Standardised introduction
The purpose of the video-reflexive interview is to provide a greater understanding with respect to the clinical reasoning and clinical decision making you have undertaken when completing the simulated assessment and management of Levi Williams. I will shortly ask a series of questions to prompt you to describe your simulation and actions which you will see on the replay video of your simulation.

Please feel free to verbalise your actions, which may relate to assessment components, treatment or decisions that you made during the simulation. If the interviewer feels that prompts are required in order for you to explain anything that occurs, she will use a series of standardised questions to prompt you.

Prompt Questions
Please review the following video and feel free to provide a running commentary with respect to your assessment, physiotherapy intervention and clinical decision-making processes.

NB: Questions 1-21 have been outlined in Table 4.3 in the thesis.

That will now conclude the interview. Thank you for your time.

Conclusion:
We will now undertake the simulation debrief to assist in your personal reflection activities. This part of the simulation will not be video-recorded. This is an individual peer review, which is undertaken by the participant, yourself and the Principal Investigator.

Following the simulation debrief you may like to create a written reflective account of the simulation and video-reflexive interview activities. The Principal Investigator will now provide you with the following simulation reflection sheets. A personalised DVD copy will also be generated from the simulation video. This will be posted to the address that you have provided on your consent form.

If you have any outstanding questions after the simulation activities, please do not hesitate to contact the Principal Investigator (see your copy of the consent form for details). All further discussions will remain confidential unless there is a serious breach in professional code of conduct. Only in the case of professional misconduct would the Physiotherapy Programme Leader be contacted.

Appendix 19: Transcription convention

All simulation videos and VRE interviews were transcribed verbatim. Guidance for transcribing video data was sought from Heath et al. (2010). It was intended that the verbatim transcriptions would not be analysed independently of the video data, since the text from the transcriptions were reinserted into the StudioCode software video file to enable the data in its entirety to be subjected to thematic analysis (Ritchie and Spencer, 1994). Thus, details of the participants entering/leaving the room were not transcribed at the time. Typical transcription conventions were used as featured in VRE literature (Iedema and Carroll, 2010; Iedema et al., 2013a-d). The transcription conventions included pauses in conversation are denoted by numbers in parenthesis, indicating silence in tenths of a second, for example (0.02), empty parentheses were used to indicate the inability to hear what was said, square brackets used for interruptions e.g. [Everyone interrupting], further explanation and to anonymise names, and (Sic.) is presented in a quotation when words may appear erroneous or unusual, since the text replicates the spoken word during the interview.

Quotations and excerpts presented are single spaced and indented to make a clear distinction from the main text. Where direct quotations have been presented, the participant's anonymised reference name is provided in parenthesis following the quotation e.g. Male Physio 1 (MP1) and Female HCA 1 (FHCA1). Where an excerpt of a conversation is used, the participant's anonymised reference name is provided at the start of their respective dialogue (Iedema and Carroll, 2010; Iedema et al., 2013a-d):

> FHCA5: *Yeah and we should have been a lot more focused and safety conscious.*
> FP7: *Yeah for us as well because the way my back was moving and bending was not great.*

Three full stops (…) have been used to indicate where parts of the conversation have been omitted. Where abbreviations have been made by the participants in their response, the context is provided in brackets within the quotation, in italics:

> FHCA5: *His sats [*referring to oxygen saturations*] deteriorated…*

Bold text is used to highlight the key text within longer excerpts from the VRE interview.

Appendix 20: Non-parametric data analysis of attitudinal statements

Statement	**Survey**	**Category**	**Frequency (percentage)** **None**	 **Some** **(1 to ≥5)**	**Chi-square analysis frequency of participation versus gender**
Frequency of participation	NHS	Male	6 (4)	13 (9)	χ2 (1) =0.679[a], p=0.410
		Female	56 (36)	79 (60)	
		Age	60 (41)	87 (59)	U=2426.5 W=4256.5 Z= -0.744 p=0.469
Frequency of participation	HEI	Male	0 (0)	2 (12)	χ2 (1) =0.327[b], p=0.568
		Female	2 (12)	12 (76)	
		Age	2 (12)	12 (88)	U=11.0 W=14.0 Z= -0.183 p=0.855
Statement	**Survey**	**Category**	**Frequency (percentage)** **Agree***	 **Disagree†**	**Analysis attitudinal statement**
SBE has a place in physiotherapy *EOC training*	NHS	Male	16 (12)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	115 (88)	0 (0)	Mann Whitney U Test cannot be performed due to empty cells
		Age	127 (100)	0 (0)	
SBE has a place in physiotherapy cardio-respiratory education	HEI	Male	2 (12)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	12 (88)	0 (0)	
		Age	14 (100)	0 (0)	Mann Whitney U Test cannot be performed due to empty cells
SBE has a place in physiotherapy acute respiratory training	NHS	Male	15 (12)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	114 (88)	0 (0)	
		Age	124 (99)	1 (1)	U= 9.00 W=10.00 Z= -1.471 p=0.141
	HEI	Male	2 (14)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	14 (88)	0 (0)	
		Age	14 (100)	0 (0)	Mann Whitney U Test cannot be performed due to empty cells
SBE could provide opportunities to practise critical events	NHS	Male	17 (13)	0 (0)	χ2 (1) = 0442[b], p=0.506
		Female	115 (85)	3 (2)	
		Age	127 (98)	2 (2)	U=83.50 W=86.50 Z= -0.830 p=0.438
	HEI	Male	2 (12)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	14 (88)	0 (0)	
		Age	14 (100)	0 (0)	Mann Whitney U Test cannot be performed due to empty cells (n=14)
SBE may contribute to increased patient safety	NHS	Male	13 (11)	1 (1)	χ2 (1) = 0320 p=0.572[c]
		Female	99 (85)	4 (3)	
		Age	109 (97)	4 (3)	U= 157.5 W=6152.0 Z= -0.941 p=0.346
	HEI	Male	2 (15)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	11 (85)	0 (0)	
		Age	11 (100)	0 (0)	Mann Whitney U Test cannot be performed due to empty cells
SBE equipment is suitable for use *within EOC training*	NHS	Male	18 (14)	0 (0)	χ2 (1) = 0.318[c] p=0.573
		Female	113 (85)	2 (1)	
		Age	125 (98)	2 (2)	U=116.0 W=119.0 Z= -0.175 p=0.861
SBE equipment is suitable for use *within cardio-respiratory education*	HEI	Male	2 (13)	0 (0)	χ2 (1) = 0.152[b], p=0.696 (n=15)
		Female	13 (87)	0 (0)	
		Age	13 (93)	1 (7)	U = 5.500, W=96.5 Z= -2.49 p=0.803
SBE equipment is suitable to *develop EOC competencies*	NHS	Male	14 (11)	1 (1)	χ2 (1) = 0.049[a] p=0.825
		Female	99 (80)	9 (8)	
		Age	107 (91)	10 (9)	U=412.50 W=467.50 Z= -1.196 p=0.232
SBE equipment is suitable to develop *cardio-respiratory skills*	HEI	Male	2 (12)	0 (0)	Unable to report χ2 due to 2 cells with 0 values[b]
		Female	10 (62)	0 (0)	
		Age	11 (100)	0 (0)	Mann Whitney U Test cannot be performed due to empty cells
I am sceptical about the usefulness of SBE in physiotherapy	NHS	Male	2 (2)	12 (10)	χ2 (1) = 0.974[a] p=0.324
		Female	7 (6)	96 (82)	
		Age	7 (6)	105 (94)	U = 283.50 W=311.50 Z= -1.011 p=0.312
	HEI	Male	0 (0)	2 (12)	χ2 (1) = 0.179[b], p=0.672 (n=14)
		Female	1 (12)	11 (76)	
		Age	1 (7)	11 (93)	U = 0.000, W= 66.00 Z= -1.599 p=0.110

*Key: 'None' responses or 'neither' responses to each statement in the 'neither' category were removed before analysis. * Agree includes strongly agree and agree responses, †, Not agree includes disagree and strongly disagree response; [a], 1 cell with a count less than 5; [b], 3 cells with a count less than 5; [c], 2 cells with a count less than 5*

Statement	Survey	Category	Frequency (percentage) Agree*	Disagree†	Analysis attitudinal statement
SBE is <u>*not*</u> suitable for the *assessment of EOC competencies*	NHS	Male	4 (3)	11 (9)	$\chi 2$ (1) = 0.002[a], p=0.966
		Female	28 (24)	75 (64)	
		Age	31 (27)	83 (73)	U=1119.0 W=1615.0 Z= -1.068 p=0.285
SBE is <u>*not*</u> suitable for the assessment *of cardio-respiratory skills*	HEI	Male	0 (0)	2 (14)	$\chi 2$ (1) = 0.327[c], p= 0.568 (n=14)
		Female	1 (7)	11 (79)	
		Age	1 (7)	12 (93)	U = 5.500 W=83.50 Z= -0.134 p=0.893
Statements common to both surveys		**Category**	**Frequency (Percentage) Never**	**Some (1 to ≥5)**	**Analysis of attitudinal statement**
Frequency of participation in SBE in the last 2 years		Male	6 (4)	15 (9)	$\chi 2$ (1) = 0.841, p=0.359
		Female	58 (34)	91 (53)	
		Age	62 (39)	99 (61)	U=2782.00 W=4735.00 Z= -0.998 p=0.318
			Agree*	**Disagree†**	
SBE has a place in physiotherapy acute respiratory training		Male	17 (11)	0 (0)	$\chi 2$ (1) = 0,133[a] p=0.716
		Female	128(88)	1 (1)	
		Age	138 (99)	1 (1)	U=9.00 W=10.00 Z= -1.497 p=0.134
SBE may contribute to increased patient safety		Male	15 (12)	1 (1)	$\chi 2$ (1) = 0.285[c] p=0.593
		Female	110 (84)	4 (3)	
		Age	120 (97)	4 (3)	U=183.00 W=7443.00, Z=_0.807 p=0.420
SBE could provide opportunities to practise critical events		Male	19 (13)	0 (0)	$\chi 2$ (1) = 0.441[c] p=0.507
		Female	129 (85)	3 (2)	
		Age	141 (98)	2 (2)	U=89.00 W=92.00 Z=-0.895 p=0.371
I am sceptical about the usefulness of SBE in physiotherapy		Male	2 (2)	14 (11)	$\chi 2$ (1) = 0.612[a] p=0.434
		Female	8 (6)	107 (81)	
		Age	8 (6)	116 (94)	U=420.500 W=456.500, Z=-0.443 p=0.658

*Key: 'None' responses or 'neither' responses to each statement in the 'neither' category were removed before analysis. * Agree includes strongly agree and agree responses, †, Not agree includes disagree and strongly disagree response; [a], 1 cell with a count less than 5; [b], 3 cells with a count less than 5 ; [c], 2 cells with a count less than 5*

Appendix 21: Demonstration of key physiotherapy knowledge, skills and behaviours

CSP framework domain (CSP, 2013)	**Elicited during the scenario**	**Examples from the simulation scenario** *mapped to the graduate entry-level descriptors* (CSP, 2013)	**Elicited during the VRE interview**	**Examples from the video-reflexive ethnography interview** *mapped to the graduate entry-level descriptors* (CSP, 2013)
Physiotherapy values	✓	Responsible for own actions, behaves ethically, undertakes an effective assessment.	✓	Reflexive review of their own actions, behaviours and professionalism evident within the simulation scenario.
Knowledge and understanding of physiotherapy	✓	Practice within complex generally predictable conditions which required the application of current physiotherapy knowledge.	✓	Reflexive review of their own knowledge relating to the management of an acutely ill patient.
Self-awareness	✓	Reflection-in-action of the limitation of knowledge and skills. Requesting help from an appropriate member of the multi-disciplinary team.	✓	Demonstration of self-awareness during the reflexive review of personal practice, incorporating feedback from others to identify and articulate their personal values, ways of working, then analysing how these may influence their behaviour and practice.
Physiotherapy practice skills	✓	Assessment and management of the acutely deteriorating patient including the modification of techniques in response to patient feedback and physiological changes in the patient's condition. Process and critically analyse information in complex & predictable situations where data/information comes from a range of sources or is incomplete.	✓	Reflexive review of physiotherapy and generic AIM skills in the management of an acutely deteriorating patient. Demonstration of the ability to evaluate their own and others' performance. By reflecting on clinical decisions and evaluating the outcome of intervention and the overall scenario, participant recognised this may inform their future practice *(Advanced graduate level).*
Communicating	✓	Demonstration of sharing information, advice and ideas with others using a variety of media (including spoken, non-verbal, written). Modification of communication to meet individuals' preferences and needs.	✓	Evidence of self-awareness and ability to modify their communication in response to feedback (e.g. from the patient and peer) to meet the needs of others involved in the simulation scenario.
Promoting integration and teamwork	✓	Demonstration of the ability to work effectively with others to meet the responsibilities of professional practice.	✓	Reflexive review of their own practice within the scenario including working effectively with others to meet the responsibilities of professional practice, and identifying situations where collaborative approaches could add value to practice and improve patient safety (in particular moving and handling and infection control).

CSP framework domain (CSP, 2013)	**Elicited during the scenario**	**Examples from the simulation scenario** *mapped to the graduate entry-level descriptors* (CSP, 2013)	**Elicited during the VRE interview**	**Examples from the video-reflexive ethnography interview** *mapped to the graduate entry-level descriptors* (CSP, 2013)
Helping others learn and develop	x		✓	Demonstration of self-awareness of learning preferences and started to independently identify some personal learning and development needs relating to assessment and physiotherapy intervention options. *(Advanced graduate level).*
Managing self and others	✓	Actively takes some responsibility for the work of others (e.g. delegation of tasks within the scenario). Modification of personal behaviour and actions in response to peer/patient feedback to meet the demands of the situation.	✓	Reflexive review of the ability to take some responsibility for the work of others (e.g. delegation of tasks within the scenario). Demonstration of an ability to suggest modification of their personal behaviour and actions in response to peer feedback, to meet the demands of similar situation in the future, in order to enhance own performance.
Putting the person at the centre of practice	✓	Demonstration of respect for the HCA and simulated patient by acknowledging their unique needs, preferences and values, autonomy and independence in accordance with legislation, policies, procedures and best practice.	✓	Acknowledging the unique needs and preferences of the patient and peer in accordance with legislation (e.g. moving and handling or infection control policies, procedures and best practice).
Respecting and promoting diversity	✓	Demonstration of respect for the ability to work constructively with people of all backgrounds and orientations by recognising and responding to individuals' expressed beliefs, preferences and choices.	✓	Reflexively reviewed their own practice within the scenario including working constructively with others (physiotherapist, HCA, patient) and recognising and responding to individuals' expressed beliefs, preferences and choices (e.g. treatment preferences and subjective comments relating to fatigue or requiring a rest from treatment).
Ensuring quality	✓	Recognised situations where the effectiveness, efficiency of intervention are compromised, and take appropriate action.	✓	Reflection on personal performance & with guidance, projects that this evaluation can be used to enhance the effectiveness, efficiency & quality of future practice *(advanced graduate level).*
Lifelong learning	✓	Identified knowledge/skill deficits, request assistance and identify further personal development requirements (in particular relating to physiotherapy intervention and suction).	✓	Assessed own personal learning and development needs and preferences. Reflection on the learning process.
Practice decision making	✓	Effective use of a wide range of routine and some specialised approaches (AIM) and techniques to systematically collect information from a variety of sources relevant to the situation.	✓	Reflexively reviewed the effectiveness of a routine and specialised AIM approach and techniques to systematically collect information from a variety of sources relevant to the situation.

Key: VRE: Video reflexive ethnography; HCA: Healthcare assistant; AIM: Acute illness management