Evaluation of the training requirements of newly qualified Health and Care Professions Council registered biomedical scientists in the field of Haematology.

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I certify that all material in this thesis which is not my own work has been identified and that any material that has previously been submitted and approved for the award of a degree by this or any other University has been acknowledged

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Abstract

Introduction This project was done to assess current training of biomedical scientists in Haematology laboratories who require a sufficient amount of efficient training before they can be deemed competent. There are guidelines from professional and regulatory bodies to aid training and assess competence for biomedical scientists but there has also been significant NHS organisational change and these new ways of working may affect training.
Aim To determine if current training is sufficient for newly qualified biomedical scientists in the Haematology laboratories.

Method A Delphi study with field experts and a survey with newly qualified scientists were undertaken. Content analysis was performed on the qualitative data and agreement levels for consensus items were performed on the quantitative data for both studies.

Key Findings: These studies identified that NHS organisational change has negatively affected training. Key difficulties include staffing shortages and increased workload. These studies also identified the expert consensus view of the competencies required by a biomedical scientist and how best to train these with respect to technical skill and theoretical knowledge. The studies also identified the consensus of the most relevant qualities for a biomedical scientist as well as the most efficient ways to develop them.

Implications: The conclusions from this research make a contribution to laboratory practice in NHS settings and to the field of Haematology in a laboratory setting by identifying key proficiencies and qualities required by biomedical scientists as well as how to develop them .Suggestions for training practices are also noted.

Key words: Haematology, Biomedical Scientist, laboratory, training,

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List of abbreviations

Health and Care Professions Council (HCPC)

United Kingdom Accreditation Service (UKAS)

Institute of Biomedical Science (IBMS)

National Health Service (NHS)

Department of Health (DOH)

Chapter One- Introduction

Evaluating the training needs of biomedical scientists involves assessing the current training situation in diagnostic Haematology laboratories to identify possible gaps in training as well as discussing with experts and trainees as to how to find solutions to resolve them. Several professional and regulatory bodies have guidelines and legislation regarding the profession yet there is a lack of research in how to train Haematology scientists especially in laboratories which have undergone major organisational changes in the past few years as well as in a discipline in which subject knowledge and technique are constantly evolving.

The aim of the research is to evaluate the current training situation as well as identifying current Haematology competencies, training techniques pertaining to knowledge and practical skill as well as the identification and development of qualities of a biomedical scientist.

This chapter will introduce the research: emphasizing relevant elements of the background and context identified by the research problem, stating the research aims and objectives, noting the purpose of the study, and lastly, describing the limitations.

Biomedical scientists are essential workers in pathology who are required to provide accurate results regarding body specimens that can aid clinical teams with patient diagnosis and treatment. There are several disciplines but this project concerns Haematology. Requiring specific tertiary education, a professional training period as well as suitable health and character checks, biomedical scientists need a fair amount of training to work confidently and competently to adhere to all the responsibilities attributed to them by their employer as well as professional and regulatory bodies. Organisational changes have been happening in the NHS such as the implementation of Agenda for Change (Department of Health [DOH], 2004) and the creation and maintenance of hospital pathology networks as per advice of the Carter review (Carter, 2006). The Carter review was an investigation as to how pathology laboratories worked in the NHS and how they were managed. The aim was to save money as well as improve working practices and management structure to improve efficiency.

Competent and confident scientists are essential for an efficient pathology service and successful training must be in place to enable the development of scientists. Numerous guidelines exist from the National Health Service (Department of Health, 2004b), Institute of Biomedical Science Health (IBMS, 2018a), Care Professions Council (Health and Care Professions Council, 2017) and United Kingdom Accreditation Service (UKAS, 2017) for the use and implementation of training personnel, approaches, assessments and monitoring.

However, all these guidelines are based on generic training and are not focused on each specific biomedical science discipline. A scientist training in one discipline might be able to work in a different one as they would have all the relevant qualifications. Each discipline has its own skills and knowledge attached to it and it is up to the hospital in which the trainee is in to make sure that the trainees have all the current knowledge and skills. As a result, the existing guidelines lack guidance on imparting essential discipline specific knowledge and skills. During major service upheaval due to the changes made by the Carter report (Carter, 2006) and the Agenda for Change, with staff being relocated and staff more involved with ISO 15189 (ISO, 2012), training may not be as robust unless a hospital has a strong training programme with allocated trainers and aids and protects time of both trainer and trainee. Poor training means a weak workforce which can lead to a decline in quality which can negatively impact patient care.

Given the lack of guidelines for training for specific disciplines in biomedical sciences this study will aim to identify the current training requirements of newly qualified scientists in Haematology to enable them to work competently and confidently.

The objectives of this study are as follows:

To assess the current training situation,

To identify key competencies required,

To determine what training methods are the most efficient for imparting scientific knowledge and developing practical skill and

The most crucial qualities of a biomedical scientist are to be identified as well as the methods of developing said qualities.

The structural outline is:

In Chapter One, a brief overview of the study is described.

In Chapter Two, the background of the study including the evolution of the profession of biomedical scientists and Haematology is put forward. The roles of the regulatory and professional bodies are also described.

In Chapter Three the current literature will be reviewed to identify training methods in diagnostic Haematology laboratories as well as the current training situation due to Agenda for Change and the recommendations of the Carter report (Carter, 2006).

In Chapter Four, a CASP analysis is performed.

In Chapter Five, a critical analysis of the methods and the justification of the chosen methods will be presented. Two studies will be done, each being described with protocols, participants' details and user consultations.

In Chapter Six, the results from both studies will be presented with tables and corresponding graphical representations.

In Chapter Seven, the current training situation is assessed. Key competencies required to work the 24 hour shift are identified, what training methods are deemed the most efficient for imparting scientific knowledge and developing practical skill, the most crucial qualities of a biomedical scientist are to be identified as well as the methods of developing said qualities.

This study will contribute to the body of research done on training in diagnostic Haematology in UK hospitals, an area in which research is lacking. This study will provide training guidance in the form of current and practical solutions and suggestions for those responsible for training management in a haematology laboratory.

The limitations of this study are the time commitment required by participants of the Delphi method, as well as attrition of the participants. In Study One, a selection of views may also not adequately represent the profession. In Study Two there were not as many participants that were recruited as in Study One. This could have created bias.

Chapter Two– Haematology and the Role, Statutory and Policy Context Of the Biomedical Scientist

In this chapter I explain what a biomedical scientist is as well as the discipline in which the study is conducted. I explain how I came to the research question.

I also present the role of the Health and Care Professions Council (HCPC) and United Kingdom Accreditation Service (UKAS) as regulatory bodies involved in the development and training of biomedical scientists. The regulatory responsibility of the HCPC covers both the scientist as well as the laboratory through the standards of conduct, proficiency and ethics. In respect to this thesis, the training aspects of the HCPC and UKAS are also explored.

In this chapter, I investigate the IBMS degree and Registration portfolio with respect to training. The role of the IBMS in training programmes is also explored. In this chapter the current changes of NHS organizational change are noted for their impact on training. The importance of qualities and conduct are also acknowledged in respect to the NHS, IBMS and HCPC.

2.1 The role of a biomedical scientist and the evolution of the profession

A biomedical scientist is a scientist working in healthcare and is responsible for analysing patients' specimens and clinical data to provide information to assist the medical team to diagnose and treat disease. Analysis leads to identification of the source, diagnosis and management of pathological disease. Pathology is comprised of several disciplines including Haematology, Microbiology, Biochemistry, Histology, Cytology, Immunology and Blood Transfusion. Biomedical scientists are therefore essential to healthcare by providing crucial information relevant to patient care.

I am currently a specialist biomedical scientist working in Blood Transfusion and Haematology and the research question came from my own experiences. In order to become a biomedical scientist I needed a biological degree and a training period with an associated portfolio of evidence. My degree was a Biomedical Sciences BSc and my training period was in a Mycology (the study of yeasts and fungi) laboratory. On becoming a biomedical scientist I was able to apply for band 5 biomedical scientist roles in any discipline and was successful in receiving a position for a Haematology and Blood Transfusion laboratory working in a 24 hour shift rota. Working in the laboratory I felt the training to be rushed and I felt there was a lack of training resources, staff, and organization. I felt I was at a disadvantage as I had trained in one discipline and was working in another. It occurred to me that I was new to the discipline and was put on shift work relatively quickly. I was deemed competent for the tasks I was performing and I felt confident but there were aspects in which I had not trained and once I went on the shift system it was difficult to find time and trainers so these gaps remained for a long time. This led to my development as a scientist being halted and I felt like a partially trained scientist working in the laboratory.

As I continued in my career I found this to be a common theme with trainees not getting what they needed to be competent and confident, trainer scientists not being able to provide them with effective training as well as a general lack of staff and resources. I wondered if this was happening in most laboratories and if so, why these issues were prevalent and what the possible solution is. I felt that training should be more efficient and more in sync with what trainees needed currently .In my career I was confronted with a variety of knowledge content, training techniques and trainer styles. I was curious as to what were the most crucial knowledge and skills needed by a biomedical scientist and how best to impart this expertise. Due to the rushed nature of training in laboratories I felt that some attributes such as confidence, communication and organisation may not be as advanced as they could have been and I felt that with proper training these could be developed in a more efficient way. I was keen to see the best way to develop these personal skills.

This thesis is a means to assess the needs of trainee scientists and how they can be met.

Despite having a critical role in healthcare, it can be argued the relevance of biomedical scientists is not known. The importance of the biomedical scientists was not always acknowledged in the past either and this led to the creation of the Pathological and Bacteriological Laboratory Assistants' Association (PBLAA) by the Pathological Society of Great Britain and Ireland in 1912 and the aim of it was to "form a means of communication amongst the assistants; to supply information regarding appointments and to assist in the general advancement of its members" (Holman, 2012, p.17).The PBLAA changes names several times over the years but is known today as the Institute of Biomedical Science (IBMS). Holman (2012) notes that throughout the years this organization has worked in accordance to workforce demands to create qualifications and assess learning outcomes with one of the first aims being to recognize and establish the standing of laboratory assistants through an examination-based certificate of competence . The author stated that in 1919 finances were available to introduce such an accreditation scheme and described how an Examination Council was created with the Pathological Society of Great Britain and Ireland in the following year with examinations being held the next with the latter involving a written assignment, an oral test as well as a laboratory practical. This was a milestone for the profession with the value of laboratory staff being acknowledged by employers and therefore demanding it when seeking staff for senior posts (Holman, 2012). In 1942 the PBLAA was renamed the Institute of Medical Laboratory Technology (IMLT) (IBMS, 2012).

Another milestone relevant to the profession was the creation of the National Health Service by the British Government in 1944 (Ministry of Health, 1944). The Minister of Health

declared that the Institute of Medical Laboratory Technology would be a recognized body for tutorials, consultations and qualifications for medical laboratory staff (Holman, 2012).
In 1978 the IMLT changed its name to the Institute of Medical Laboratory Sciences (IMLS) (IBMS, 2012). Holman (2012) described the changes throughout the years; the IMLS created and improved upon education and training standards, adding more accredited schemes as well as a programme for continuing professional development with the latter eventually being recommended for all professions in the NHS. In the late 80's the IMLS liaised with the Department of Health and the Royal College of Pathologists to establish laboratory accreditation to assure the reliability of the laboratories (Holman, 2012). In 1994 the IMLS changed its name to the Institute of Biomedical Science (IBMS, 2012). The reliability of the laboratory personnel was confirmed with the Certificate of Competence being awarded on the completion of a successful laboratory logbook (Holman, 2012).

In 2004 Agenda for Change was introduced which was a change of NHS working noted in the following sections: Principles and Partnership, Pay, Terms and Conditions of Service, Employee Relations, Equal Opportunities, Operating the System and Transitional Arrangements (Department of Health [DOH] , 2004).The IBMS, in response to these changes created more qualifications that could be used as continuing professional development with these taking the form of standardized laboratory-based learning, portfolios and self-study (Holman, 2012). Qualifications can be discipline specific or they can be targeted at the practice of biomedical sciences as a whole. The IBMS today has a repertoire of courses and tools that aid biomedical scientists in their professional careers and also provide indemnity insurance to its members (IBMS, 2020b).

2.2 Haematology

The discipline of Biomedical Science in which this thesis is based is Haematology. Haematology is the specialist subject of blood, including its diseases which often involve the production and destruction of its components. Haematology also involves diagnosis, treatment and prevention of blood related conditions. Blood is the primary transport fluid of the body consisting of platelets, erythrocytes and leucocytes (mass portion) in plasma (fluid portion). This transport fluid is responsible for presenting oxygen and nutrition and eliminating waste products. Haematology also includes Coagulation. This is the study of the clotting mechanism of blood, commonly called the coagulation cascade and is related to bleeding disorders such as haemophilia as well as thrombotic conditions such as deep vein thrombosis and pulmonary embolisms. Haematology laboratory work is often performed by a biomedical scientist.

2.2.1 Evolution of Haematology

As well as the profession, the field of Haematology has expanded with huge developments, changing understanding and techniques throughout the years. Coller (2015) noted some of the many achievements in the field of Haematology, like when Ehrlich established the technique of blood cell staining before classifying different granulocytes in 1878 or when Wintrobe clarified the Haematocrit Technique which enabled him to define other relevant red blood cell indices including the mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration in 1929.

The evolution of diagnostic Haematology and Coagulation from these events has led to specialised automation being standard now in UK laboratories. In the past, a scientist would use time-consuming and manual techniques to count white blood cells, red blood cells and platelets as well as blood clotting times for each individual patient. Now with the discipline being highly automated, analysers can process several samples at a time. Test kits have also developed significantly producing results in a matter of minutes, examples being the immunochromatographic tests for Malaria and Infectious Mononucleosis. Making and staining blood films can be manual or automated depending on the workload of the laboratory. In the Coagulation laboratory, Prothrombin Time measuring the Intrinsic Pathway and the Kaolin clotting time measuring the Extrinsic Pathway were done manually in the past. Now these tests are performed by highly specialised analysers which are also able to perform Fibrinogen, D-dimer, Factor, Van Willebrands and Inhibitor assays as a matter of routine. Health and Safety as well as Quality Control has also become more robust in the past years with the development of the Control of Substances Hazardous to Health Regulations 2002 (COSHH) (Health and Safety Executive, 2002) and International Organization for Standardisation (ISO) 15189 Medical laboratories — Requirements for quality and competence (ISO, 2012)

The Control of Substances Hazardous to Health Regulations 2002 is a law with specifications to protect workplace staff and personnel from the potential danger of substances or equipment (Health and Safety Executive, 2002). It does this by identifying hazards, assessing risk, controlling exposure as well as monitoring and maintaining staff health (Health and Safety Executive, 2012). ISO 15189 is an international standard concerning medical laboratories quality management system specifications (ISO, 2012).This standard has several sections to provide thorough instruction as to how to maintain quality in medical laboratory working in order to produce a safe learning environment for staff while producing accurate results for patients.

With the changes in the profession, further discoveries taking place and more theories being developed in science, it is essential for those working as biomedical scientists to keep their knowledge and skills up to date. The Continuing Professional Development scheme by the IBMS involves journal-based learning, reflective learning and professional activities (IBMS, 2020a).It is also important that biomedical scientists keep up to date so they can pass on their knowledge to newly trained scientists.

The training needs for the profession are also constantly evolving as is the way we train and pass on knowledge. If the techniques that were used in the past are no longer feasible then new ways must be developed to ensure competence and quality patient care.

2.3 IBMS Undergraduate degree accreditation

In order to assess the needs of biomedical scientists I wanted to assess the two components that are essential to create a HCPC biomedical scientist. The first is the IBMS Undergraduate accredited degree and the second is the IBMS Registration portfolio.

The IBMS accredits its degrees against the Quality Assurance Agency Benchmarks from 2002 with the exception of clinical genetics, though this has changed since 2008 and the standards have been refreshed in 2014 (IBMS, 2021a) .The Quality Assurance Agency (QAA) sets the UK code for higher education for the UK Standing Committee for Quality Assessment and has developed the Quality Code which includes expectations, core and common practices and guidance with the first two aspects are mandatory for all UK providers (QAA, 2018). The Subject Benchmark Statements is set guidance used in the creating, administrating and evaluating academic programmes to enable successful learning outcomes (QAA, 2019).They are written by experts and describe several relevant aspects of the academic programme as well as the academic standards one is to achieve if successful (QAA, 2019). These standards encompass subject-specific and core knowledge, understanding and skills as well as key and graduate skills (QAA, 2019). I was keen to investigate what the subject benchmark statement contained for biomedical sciences and how relevant it was to a biomedical scientist working in a laboratory today. With respect to Haematology, the standards state that a biomedical science graduate will have knowledge of blood cell anatomy, activity and generation. The standards also note that graduates will have knowledge of modulation of blood clotting mechanisms. The standards also state that graduates should be aware of descriptions of common haematological disorders and investigative laboratory methods. However one of the shortcomings is that these definitions and standards are broad and each university is free to interpret this as they see fit. The depth of knowledge is not defined as they do not have subsections noting what exact knowledge is to be learnt. However during the validation of the degree by the IBMS this would be addressed to adhere to the QAA benchmarks (Quality Assurance Agency, 2019).

For each discipline it would be useful to have a syllabus that is in aligned to current practice in the laboratories. The IBMS Specialist Diploma portfolio (IBMS, 2019b) offers more specific requirements. It contains competency and knowledge criteria for the scientist to achieve in their development to a Specialist Biomedical scientist. These benchmarks could be assessed against the knowledge criteria of the IBMS Specialist Diploma portfolio so that the knowledge would be against current practice. The competence criteria would be challenging to implement due to the analysers and equipment and the technical side might be better in the laboratory, but the university would be ideal for theoretical knowledge.

Having looked at three accredited degrees I reviewed the subject specific areas and for haematology and blood transfusion around 20-30 hours (equivalent to 1 module) work is required including practicals and lectures (University of Derby, 2021; University of Gloucestershire, 2021; University of Kent, 2021). A full time course takes around 650 hours is so this is 1/32 of the time needed. There are common topics to the IBMS Specialist Diploma. There is no time limit on the IBMS Haematology Specialist Diploma which also incorporates blood transfusion. The subject specific area for Haematology is small in comparison to the entire degree so retention of such knowledge might be challenging. However other topics like cell biology and the other disciplines are essential for comprehension and knowing about the other disciplines like biochemistry and microbiology is beneficial for multidisciplinary working and cultivating a respect for the other disciplines. Palmer *et al* .(2018) noted that in their Australian study that 20% of science graduates went on to have careers in their field with the rest having employment in other fields so it was essential to address wider knowledge and skills as well as specialised knowledge and skills. To include broader scientific knowledge and skills is also an advantage for those who would not become biomedical scientists at all and would prefer to work in academia, research and industry. The specialised knowledge and skills included, is beneficial to those becoming biomedical scientists in the future.

Other relevant aspects of the standards are core biomedical sciences knowledge, understanding and skills which are also part of the degree and a thorough knowledge of the subject is expected (QAA, 2019).Biomedical sciences are a broad topic and can contain all the disciplines noted as well as the building blocks of biology cell biology and human physiology. Key and graduate skills include intellectual skills that a graduate is expected to possess such as to know subject specific theories and ideas in practice as well as applying knowledge on issues that need solving in the laboratory (QAA, 2019).Practical and professional skills are also essential key skills and the graduate should be competent in standard experimental abilities (QAA, 2019). For biomedical scientists, large amounts of work are done by automation, but this cannot do everything and requires constant monitoring and troubleshooting; some tests are still performed manually. They should also have knowledge of the use and nature of components of a quality management system (QAA, 2019).This is a crucial aspect that is a part of the IBMS Registration portfolio. They should also have knowledge of how to plan a hypothesis based experiment as well as ethics and health and safety (QAA, 2019).In the laboratory health and safety is also a major part of the IBMS Registration portfolio. Graduates should be able to have analytical, data interpretation and problem solving skills as well as have knowledge of quantitative and qualitative analysis (QAA, 2019).A variety of techniques used in the laboratory such as morphology can be considered both qualitative and quantitative. This is also helpful for validation of full blood counts and coagulation screens.

The next three aspects for the benchmarks are" communication, presentation and information technology, interpersonal and teamwork skills and self-management and professional development skills" (QAA, 2019, p. 8) which are all also crucial aspects of both the IBMS and HCPC code of conduct and also feature in the IBMS Registration Portfolio.

A variety of learning and teaching methods including self- directed and peer learning, work placements, case studies, reflective exercises, research, computer simulations and laboratory practicals are recommended in the standards (QAA, 2019). The variety of styles is beneficial as Ganyaupfu (2013) suggests learning is more effective when the students are actively analysing and applying solutions to problems rather than memorising information. Bonner (1999) notes that one teaching style cannot me*et al* l the requirements of a learning aim and that active learning and passive learning must be given for complicated learning and relatively easier learning goals respectively. The assessments include dissertations, observed practice by a competent person, data interpretation tests, investigations of case-studies and work experience (QAA, 2019).

There are many biomedical sciences degree programmes that are suitable as an IBMS accredited degree and include the following programmes (QAA, 2019):

- Collective biomedical sciences degrees and associated degrees with human biology
- HCPC approved and IBMS accredited integrated degrees with laboratory-based training in an IBMS accredited pathology laboratory on a full time or part time basis
- IBMS accredited degree with a laboratory placement in industry or pathology.

One aspect of some of the degrees is the sandwich year. The sandwich year might be helpful as the student would be working in the laboratory. The structure for this is reliant on the hospital and university. The student may be in a multidisciplinary department or just one discipline which may depend on the university and discipline availability. It could be that the student does not get the discipline they work in later down their career path, but if they do then this would be a real life experience of being a biomedical scientist as well as firsthand experience of using analysers and various techniques that would benefit them in their actual career. This would be something that would not be easy to learn in a traditional lecture setting as troubleshooting analysers, and maintaining quality and health and safety are more laboratory based activities.

The key takeaway is there is no comprehensive guideline for haematology and the inclusion of haematology is only in some degrees. However even the inclusion compared to the whole course is quite small. However the content seems to be relevant to what is learnt in the laboratory but the depth may vary from university to university and retention may be difficult as there is no time line when the student may get a job in a haematology field. Speaking just for haematology the most crucial side to be learnt is the theoretical side of science. Analysers are constantly changing and Standard Operational Procedures are always updating so undergraduates would not be expected to have technical knowledge. Validation and even morphology might be challenging but actual theoretical science would be relatively easy to teach in a traditional setting. Another aspect to consider for the training in the technical side is not just the competence but capability of the graduates. Capability is different from competence and O'Connell *et al* . (2014) describes educating for capability is a process with learners using reflection, group work feedback and self-setting goals. Stephenson (1998) suggests it is part of specialist knowledge and comes from learning from experiences, relating knowledge and skills to different situations and being responsible for own learning. Stephenson (1998) notes that capability education is becoming popular with graduates being involved with " learning society, work-based learning, guidance and learner autonomy and more recently, key skills, creativity and high level skills for lifelong learning" (p.10) suggesting these are all ways for building capability.

Fraser and Greenhalgh (2001) note the relevance of educating for capability means traditional education and training must give way to new methods and thinking such as changing from an instructive model to a constructive model. The authors describe the first model as information being given to students whist the second focuses on discussion and active learning. The authors also note that assessments should not be on facts being memorized but "analysis, synthesis, and problem solving" whilst the curriculum should be based on competences needed for employment and not on topics that were included historically.

Satran *et al*. (2020) suggest techniques of building mentalization capabilities through group work over the training period for nurses, which spans years, and is led by experienced staff and focuses on real life clinical scenarios. This involves sharing experiences and imparting relevant knowledge, practical and mental techniques to deal with these situations to promote efficient working and improved patient care. The effectiveness of this program has not been assessed and the authors suggest monitoring behaviours of students.

Building capability as outlined by Satran *et al* . (2020) noted would be more beneficial in a laboratory rather than the university as not all students will be biomedical scientists. As mentioned before there are not as many scientists as nurses so a group of trainees may not be possible in a laboratory unless it was virtual and therefore available to all trainees in the UK. One of the key training members providing by the IBMS is the mentor and this is noted in the next section. This is a voluntary and supportive role and this person does not assess competence or train in theoretical knowledge or specialist skill. This person could be responsible for building capability. The mentorship however can take the form of what the mentee and mentor want it to be and there is no capability framework to follow.

2.4 IBMS Registration Training Portfolio

In order to become HCPC registered, an IBMS Certificate of Competence must be presented as well as having an IBMS accredited degree, satisfactory character references and acceptable health declarations. However, assessments are available for all degrees which are not on the IBMS accreditation list to ensure they cover all academic standards (IBMS, 2021a). Top-up courses and supplementary courses may be required to reach the academic standard. The IBMS Certificate of Competence is awarded on the successful completion of the IBMS Registration portfolio and successful subsequent viva. A period of training in a laboratory (which has IBMS pre-registration training approval) is essential in which to complete the IBMS Registration portfolio. The IBMS Registration portfolio is a collection of evidence that covers all standards and competencies using reflective learning, research, tutorials, and set assignments.

2.4.1 Achieving HCPC registration through the IBMS Registration Portfolio

The portfolio has some specific scientific discipline sections but also covers a range of generic topics like quality control, health and safety and professional conduct. It is undertaken under the supervision of an IBMS training officer who is based in the laboratory. Although the training officer is officially in charge of training and signing off assignments, it is common for all competent members of the laboratory to assist in training (IBMS, 2018b).

Table 2.4.1

Summary table of IBMS Registration portfolio (IBMS, 2019a)

Professional Conduct	Professional Skills and Standards
Personal Responsibility and Development	Professional Knowledge
This module involves being aware of how to conduct oneself as a biomedical scientist as well as recognising and understanding their duties and responsibilities. The scientist must be aware of how to use sound reasoning while working as well as being able to perform autonomously with regards to fitness to practice. Self development, which may be undertaken in the form of many learning activities, is essential. The	The biomedical scientist must be able to exhibit the current knowledge that underlies required skills. This knowledge is about both disease and technical investigations in clinical and research settings. They must be able to work in accordance of Standard Operating Procedures.

Institute of Biomedical Science's 'Code of Conduct' and 'Guide to Good Professional Practice' is to be followed as well as the HCPC standards of performance, conduct and ethics and any other organisational, national and international standards which are reference guides to registered scientists.	
Equality and Diversity The biomedical scientist must be able to acknowledge and value the equality and diversity of everyone as well as their duties and rights.	Health and Safety The biomedical scientist must be compliant with national and organisational policies like COSHH as well as seeking to assess and enhance operations with regards to Health and Safety. They must consider it a duty to safeguard themselves and others.
Communication Skills The biomedical scientist must be competent in written and oral communication in a professional environment. The biomedical scientist must be able to effectively and appropriately use suitable communications in different situations including complicated and sensitive points. The scientist must be able to troubleshoot communication obstacles effectively.	Quality The biomedical scientist must be able to manage their quality of work as well as the organisations. This includes being aware of actions if standards of quality are not met.

Patient Records and Data Handling	Performing Standard Investigations
The biomedical scientist must have the expertise needed to work with data in the laboratory according to data protection guidance and confidentiality laws.	The biomedical scientist must be able to apply theoretical knowledge and technique effectively whilst performing a number of crucial investigations according to Standard Operating Procedures and Quality assurance.
Professional Relationships	Research and Development
The biomedical scientist must maintain professional relationships to ensure service users and patients get the best service. The biomedical scientist must maintain effective teamwork as well as appreciating the work of team members.	The biomedical scientist must be able to apply theoretical knowledge, understanding and investigative comprehension of disease to developing scientific techniques to help study said diseases. This can lead to an evidence-based approach to research disease identification, source, pathogenesis and surveillance.

The content of the IBMS is generic but an excellent introduction into laboratory working without focusing on specific scientific knowledge. The same issue exists as mentioned before with the degree. The Registration portfolio can be done in a different discipline such as biochemistry and the scientist eventually works in Haematology. However the modules and skills gained in the Registration portfolio are essential building blocks and transferable as topics like Health and Safety and Quality are universal across all disciplines and also provide a strong basis for scientists moving up the career ladder .Scientists can move into Quality, Information Technology (IT) and Health and Safety roles which may feature outside diagnostic roles. Communication and having a Code of Conduct are essential. It may not necessarily help with knowledge but it does help in establish a strong foundation as to how a biomedical scientist or any professional health worker should behave.

Combining these two degree and portfolio the disadvantage for biomedical scientists is clear. Someone doing an IBMS accredited degree would not have a large amount of discipline specific knowledge in their degree and the Registration portfolio, whilst giving an element of laboratory working, does not support discipline specific work unless you do the portfolio in the discipline you work in. This may not be a negative aspect. Radiographers train and work as therapeutic or diagnostic radiographers and may choose to specialize further in their career. A report describing the National Radiography Services Skills Mix project presents the four-tier model of service delivery identifying four levels of practice: consultant practitioner, advanced practitioner, state registered practitioner and assistant practitioner (DOH, 2003). In order to facilitate the transition from newly qualified radiographer to competent clinician the College of Radiographers' suggests preceptorship but there is no direct guidance from the professional body allowing individual departments to determine what consisted of preceptorship and it could consist of a work-based objectives model or could take the form of a more supportive or coaching approach (Nisbet, 2008).

Other allied health professionals (Dietetics, Occupational Therapy, Physiotherapy, Podiatry, Speech and Language) note the relevance of preceptorship with Oxleas NHS Foundation Trust establishing a preceptorship portfolio focusing on communication, health and safety and security, equality and diversity, quality, personal and professional growth and professional and post specific working (Oxleas Foundation NHS Trust, 2020a, 2020b).

There is no such recommendation for preceptorship in the relevant guidelines for biomedical scientists. Scientists are deemed competent once they are signed off as competent yet there may be time to build confidence or practice on weak spots, but this is reliant on the laboratory. This time may be considered as some form of preceptorship for biomedical scientists. The issue with biomedical scientists is once they have completed their degree and portfolio they may receive a job somewhere they have no experience in. The biomedical scientist is signed off as competent in theory but the discipline could be new. In this case a preceptorship might be beneficial yet this is reliant on the laboratory.

Learning in the laboratory may have its benefits but must have some collaboration with university education. Vissers *et al* . (2014) notes that in order for a competency-based education program for physiotherapists to work professional physiotherapists and universities must work together to ensure what is taught and what is practiced is the same content. Katoue and Schwinghammer (2020) also note the advantage of a competency based education as it suits the needs of patients and society. The use of portfolios with observation as an assessment are noted as being advantageous .Tetzlaff and Warltier (2007) support the use of portfolios in anesthesiology noting that a range of assessment techniques like peer review, observation and case based problem resolution are beneficial. Observations are also used for assessing the competencies of surgeons as demonstrated by Williams *et al* (2019) who noted that the number of observations needed was more than the certification requirements and recommended different cases and observers.

2.5 IBMS Specialist Training Programmes

There are several training programmes available from the IBMS. There are four post registration qualifications from the IBMS designed to deliver structured training to increase knowledge and support career progression (IBMS, 2021b). All these training programmes are discipline specific and are targeted at scientists with at least 2 years registration. None of these IBMS training programmes are aimed at newly qualified scientists. They are relevant to CPD and give knowledge and experience to managerial roles, research training and quality. However he IBMS Specialist Diploma may be relevant as it contains the following Haematology topics with knowledge and competence based framework.

- Primary Investigations of Blood and its Components

- Cell counting and haemoglobin concentration
- measurement
- Erythrocyte sedimentation rate (ESR)/plasma viscosity
- Identification and enumeration of peripheral blood cells by microscopy
- Infectious mononucleosis
- Screening test for sickle cell haemoglobin (HbS)
- Bloodborne parasites
- Coagulation screening
- Fibrinogen
- Fibrin degradation products
- Anticoagulant Therapy
- Iron Deficiency Anaemia and Iron Overload
- Haemolytic Anaemia Screening tests
- Inherited and acquired haemolytic anaemia
- Abnormal Haemoglobins and Thalassaemia
- Haemoglobin variants (HbS, C, D, E)
- Impaired globin chain reaction
- Unstable haemoglobin
- Macrocytic Anaemia: Vitamin B12 and Folate Deficiency
- Haematological Malignancies
- White cell malignancy
- Polycythaemia
- Haemostasis Abnormalities
- Bleeding disorders
- Thrombotic disorders
- Lupus anticoagulant (IBMS, 2019b)

This is not as essential element of being a scientist but it does provide standardisation to what is learnt in the laboratory. It is also not aimed at newly qualified scientists. I feel that there should be some standardisation as the only things that relay competence are the individual laboratory training in each hospital. If there was the same programme in all hospitals, this could at least provide resources and standardisation. This would benefit the profession at large as a scientist going from hospital to hospital would not need extensive retraining.

2.6 IBMS and Health and Care Professions Council standards

The training standards set by the IBMS is for someone who is working towards an IBMS qualification. But the IBMS note that training does not stop at qualification (IBMS, 2018a).So someone just trained only has what UKAS requires which is the laboratory training programme and how this is delivered is up to the laboratory. I believe that this may not be as sufficient at this time and am looking to already standardised programmes that the IBMS has to offer. I believed that any set up training programme can be used to develop training for newly qualified scientists.

The IBMS provides education for registrants of the Health and Care Professions Council (IBMS, 2018a) and therefore has to comply to the HCPC Standards of education and training (Health and Care Professions Council, 2017). The IBMS published the Clinical Laboratory Standards for IBMS Qualifications and Guidance for Training Laboratory Management and Approval which has standards according to Environment, Facilities and Equipment, Health and Safety, Quality Workload and Staffing and Education and Training (IBMS, 2018a).

With respect to the standards of education and training the IBMS require the laboratory should be safe and spacious enough to enable all necessary activities to take place, with all appropriate documentation up to date. The standards state that the training documentation to represent the training policy (which should cover all levels of staff in the department) should be in place which states and describes staff evaluation and training schemes as well as roles of training personnel, the scope and availability of training opportunities, information on professional and regulatory bodies as well as IBMS qualifications. The standards state each training programme in the laboratory should cover the timetable, rota arrangements, training appraisals, assessment techniques and relevant knowledge and technical skills.

There are no set time-lines recommended for trainees nor the order of learning or how to actually train which is understandable as it is up to each laboratory and the skills of the trainee. Rota arrangements should also include a trainer, at least at first, checking comprehension of knowledge and skill and being available for questions. It could be that the trainee was trained in haematology and does not need much training. There was very little mention of training resources. Any laboratory would have hundreds of cases on a daily basis to learn from. There is nothing recommended but also are the guidelines and standards of procedures well written and easy to understand for trainees? The issue here is that these positions are for qualifications yet their set up would be beneficial and an asset to training for newly qualified scientists and could use the same tools and techniques.

The IBMS have several personnel in place to allow training to take place efficiently and have standards in place for their requirements of staff and are summarised as follows (IBMS, 2018a).

2.6.1 Training manager

The first is the training manager who is the senior scientist with overall training authority for all staff in either a single department with different sectors (like blood sciences which encompasses Haematology, Biochemistry and Immunology) or over a laboratory service with many departments (this is usual where there are several laboratories spread out geographically like a hub and spoke model which will be discussed later in this thesis). The manager is responsible for assessing training needs as well as training supervision and design. The location of the training manager must however be noted. The manager could cover a specialist area or many departments or come from another discipline. Each discipline is different with different things to focus on. Would a manager that has come from another discipline be able to know what a trainee would need to become competent on the bench? For the Registration portfolio and the Specialist portfolio there are set guidelines of what is to be achieved and the portfolio itself acts as a guideline. For training a scientist who had just completed the registration portfolio what would be their training needs?

2.6.2 Training officer

Another senior position mentioned in the standards is the training officer who is the individual having training authority within a department. The training officer must review their trainees regularly and maintain all protocol and training records. Like the training manager, the training officer will aid in training and establishing and delivering the training policy, training manuals and training plans. They also support staff by undertaking appraisals, marking assessments, and reviewing evidences suitable for different qualifications. The training officer is someone who signs off and sets assignments but are they the one validating next to the trainee and teaching them morphology and going through the scientific and technical knowledge of being a scientist i.e. the truly practical side?

2.6.3 Mentor

Another relevant training personnel noted in the standards is the mentor. The training mentor is a staff member with expertise and experience who will aid the trainee in expanding knowledge and developing technique that will enable their growth personally and as a scientist. This is a helpful role, which can aid the trainee to feel confident. It would also be another person for the trainee to turn to if they needed assistance. As mentioned before, the mentor could help with the personal qualities and building capability as they would have the experience to do so.

The standards require that “appropriate numbers of staff with the required knowledge and skills to support training for Institute qualifications while also meeting the demands of the service” (p. 3). The standards note each laboratory has its own range of tasks and competencies that is required of staff, hence a suitable skill mix of staff is deemed essential. This I believe is a critical part of the standards as managers may not factor in people and time required for training and may prioritise running the service.

2.6.4 IBMS Laboratory Training Approval

IBMS approval is a two-way accreditation. The laboratory is also being assessed. Pre-Registration Training Approval refers to approval of laboratories in which biomedical scientists trainees (through the IBMS Registration portfolio) receive the Health and Care Professions Council Registration. The portfolio has some specific scientific discipline sections but also covers a range of generic topics like quality control, health and safety and professional conduct. Post-Registration Training Approval relates to the approval of laboratories in which specialist training (like Haematology or any other biomedical science discipline) of qualified biomedical scientists can occur through the IBMS Specialist Diploma. Training approval depends on if trainees have successfully finished the course. It could be that training approval has expired as there has not been a trainee for a while and there is not a current and relevant training programme.

The IBMS Registration portfolio is done according to the IBMS standards and if these are not adhered to then this provides a weak foundation for newly qualified scientists making any training they do later in their career to be corrective of the poor training they received initially. Learning as a biomedical scientist is continuous as demonstrated by standards of the HCPC (HCPC, 2017) and IBMS (IBMS, 2018b) and the CPD programme by the IBMS (IBMS, 2020a).The IBMS also state that working towards qualifications is not the only time you learn. This suggests that scientists should not just be running a service but teaching and learning (IBMS, 2018a) This is not just recommended for UK bodies but also the European Medicines Research Training Network which hopes to develop a framework to support CPD in the biomedical sciences and has a number of guidelines such as self motivation, review, records and goals but ,quite crucial to this project, the efforts and support of those around them including review of competence (Hardman *et al*., 2013).This is mirrored in the HCPC (HCPC, 2017) and the IBMS guidelines (IBMS, 2018b) and suggests that training and learning cannot be through self study alone and is a group activity . However individuals have other roles other than teaching, learning and training so time, staff and resources must be acknowledged in business plans to ensure an effective service. In the next section I demonstrate that there has been a overhaul of pathology services as well as a lack of consideration for training and learning which mean due to lack of staff the above guidelines may be challenging to meet.

2.7 The Health Care and Professional Council

As of November 2020, there were 23,723 Health Care and Professional Council registered biomedical scientists in the United Kingdom (HCPC, 2020d).This is a relatively small number compared to other healthcare workers like nurses and doctors and is also divided into the several disciplines as noted above. It stands to reason that research into training for biomedical scientists may not be as frequent and issues from each discipline may not be as widely discussed leaving problems unsolved.

The Health and Care Professions Council is the legitimate regulator of biomedical scientists as well as other health professionals. The HCPC was set up to protect the public and regulates a range of professional titles which are protected by law. Out of many approaches to becoming a HCPC registered biomedical scientist in the UK, the most common is achieving a Certificate of Competence from a successful Institute of Biomedical Sciences Registration portfolio. The HCPC has several sets of standards which must be adhered to allow and maintain registration. These are the standards of Proficiency, Conduct, Performance and Ethics (HCPC, 2016).The aim of training is to meet these standards so all scientists are fit to practice. There are several crucial points to the training and education standards (HCPC, 2017) that are described as follows. The HCPC state that “Assessments must provide an objective, fair and reliable measure of learners’ progression and achievement.” (HCPC, 2017, p. 9).The standards include practice-based and evidence-based learning. The HCPC standards state that the training syllabus must be compatible with current practice, exhibit a strong link between theory and practice, encourage autonomous, reflective thinking and allow competent delivery of learning outcomes. It also states any training programme should have robust quality control measures in place to ensure it meets all the requirements. As well as a suitable curriculum, the HCPC notes the opportunity and facility for trainees to undergo practice based learning must be available with a competent monitoring scheme present to ensure this. The standards stress the need to have sufficient and available resources and arrangements to support the education and welfare of trainees. The HCPC standards also require a suitable number of staff to enable successful training with requirements that staff must be qualified, experienced and possess specialist knowledge. Staff must have their own Continuous Personnel Development programme to further enrich their role in the programme (HCPC, 2017).I am keen to investigate in this thesis whether these standards are being met and if these standards are not being met then what issues are causing this. I note how guidelines can be interpreted differently by different laboratories. A “suitable number of staff” is reliant on what the laboratory management deems suitable and relies on skill mix as well as actual numbers of staff. This is the same with “sufficient and available resources and arrangements.” This is up to laboratory management and may not take into consideration what the trainee needs. Laboratory management may have other priorities like financial agenda and supplying staff for the 24hour shift rota.

As a regulator of the profession, the HCPC must ensure that all registrants are fit to practice. Complaints about registrants may be submitted by members of the public or other professionals. The complaints concerning a registrant's fitness to practice can be 'impaired' due to one or more of the subsequent reasons:

- Misbehaviour of a registrant if they fail to meet the Standards of Conduct Performance and Ethics,
- Incompetence of a registrant due to recurrent lack of expertise and technique over a prolonged duration of time,
- Conviction or caution for an offence in the United Kingdom (or anywhere where said activity would be illegal in the United Kingdom.),
- Physical or mental health issues of a registrant due to chronic conditions that are not treated or accepted by registrant or
- A ruling determined by another regulatory body involved in health or social care (HCPC, 2020b).

An investigation will take place which may be followed by a hearing if the Investigation Committee (responsible for reviewing all evidence) deems it necessary (HCPC, 2020c).The hearing will end in the following outcomes: No further action, Caution, Conditions of practice order, Suspension or Striking off order (HCPC, 2020a).The one reason that stood out to me is the one regarding incompetence. If someone is deemed incompetent, then why was he or she deemed competent to take on the task in the first place? Is there a failing in the training programme of the laboratory? Or did staff who are deemed competent but are actually incompetent deem him competent because they didn't know any better? The HCPC only investigates the individual reported but it does not investigate the laboratory in which the scientist is working or training. This role falls down to United Kingdom Accreditation Service.

2.8 Training and United Kingdom Accreditation Service

Medical laboratory accreditation is evidence of a laboratory working effectively to quality standards and the current accreditation body is the United Kingdom Accreditation Service

(UKAS). This government-recognized body is the only national accreditation association in the UK and checks internationally agreed standards in organisations to ensure technical and managerial competence and this includes Medical Laboratory Accreditation, External Quality Assessment Accreditation and Point of Care Testing Accreditation (UKAS, 2018a). As part of their role they work to make sure that all accreditation is compliant to the ISO 15189 which is a compulsory requirement for quality and competence in medical laboratories (UKAS, 2018a). UKAS accreditation covers the subsequent laboratories:

- Clinical Biochemistry
- Toxicology
- Endocrinology
- Haematology
- Blood Transfusion
- Microbiology
- Virology
- Parasitology
- Serology
- Mycology
- Histopathology
- Cytology
- Mortuaries
- Immunology
- Genetics
- Andrology
- Histocompatibility & Immunogenetics (UKAS, 2018b)

External Quality Assurance (EQA) providers can also accredit medical laboratories to ISO/IEC 17043 Conformity Assessment, which is about general requirements for proficiency testing schemes as well as how to establish and manage such schemes (ISO, 2010). These requirements cover evaluation, testing and management of proficiency schemes and items as well as troubleshooting, education, and quality control (ISO, 2010).

2.9 ISO 15189:2012

Compliance to the requirements of ISO 15189:2012 demonstrates quality that can be clarified by UKAS (UKAS, 2018a).The ISO 15189 covers Personnel, Accommodation and environmental conditions, Laboratory equipment, reagents, and consumables, Pre-examination processes, Examination processes, Ensuring quality of examination results, Post-examination processes, Reporting of results, Release of results, and Laboratory information management (ISO, 2012) .The most relevant to this study are in the Personnel section and are training provision, competence assessment per person, reviews of staff performance, continuing education and professional development, and personal records of relevant skills (ISO, 2012).

As mentioned previously UKAS accreditation assures that a laboratory is competent to function which includes the competencies of the personnel as well as the validity of test methodologies. A paper was written by UKAS Medical Laboratory Technical Advisory Committee to provide guidance on the assessment of competencies of clinical staff and the use of External Quality Assurance (EQA) programmes (UKAS, 2017).The paper noted it is up to the laboratory to determine what measures are suitable to assess the competency of its staff. The paper also stated what aspects of the laboratory are assessed. This includes all aspects of internal and external quality control as well as records to determine compliance. The paper noted which personnel records could be checked which can include competency records of staff as well as any appointment, induction and mandatory training records. It also included general laboratory checks which may include assessing EQA schemes and reviewing examples of knowledge sharing. The paper stated that EQA can be used to assess competence but can also have an educational component. The paper recommended that all laboratories take part in an EQA scheme. One of the most important aspects of checking a laboratory against ISO 15189 is assessing the validity of the laboratory methods for assessing achievement and maintenance of competence (UKAS, 2017).

Whilst this advice and guidelines are comprehensive and checks a variety of laboratory aspects there are a few issues to note. UKAS are checking if all the staff competency documents are signed, dated and present. They are also checking whether training programmes are in place. However this does not necessarily mean staff are competent as it could be viewed by the laboratory as a tick- box exercise to avoid non-compliances. There is no assessment by UKAS to see if competent people are taking time out to test the trainee while signing them off on documentation, how long the trainee spent on each section, how long a competent person spent training with the trainee, how many competent people were around the trainee with time to answer questions and how much time the trainee spends learning theoretical knowledge off the bench. Like any workplace strong personalities may play a role in rushing tasks and a new trainee may not be able to speak up. They may feel competent if they are signed off by competent staff. However what if the 'competent' staff has gaps in their knowledge due to these very same issues and are passing these on to the trainees? A trainee does not know what they do not know as they are still learning and it is up to the experienced and truly competent scientists to pass on this knowledge.

2.10 General training in the NHS

One of the things I noticed whilst training was that not just the actual skills but the qualities or personal skills that were needed and I always wondered whether these could be developed through adequate training and if they were not present if the training had been poor. The NHS, IBMS and HCPC all have elements of qualities that they expect their staff to have.

The NHS Knowledge and Skills Framework (KSF) is an extensive framework which states the knowledge and skills required for NHS staff and as well as suitable staff evaluation and advancement processes (Department of Health, 2004b). This is one of the main points of Agenda for Change, the other two being job evaluation and terms and conditions. Equal pay legislation was used to influence job evaluation, hence transferring staff to a new integrated pay system. Current terms and conditions are calibrated to give fairer working conditions including leave and working times. The NHS KSF consists of 30 aspects which specify relevant and generic functions that enable the organization to deliver an excellent public service with six of these being essential to every post in the NHS and are stated as

1 Communication

2 Personal and people development

3 Health, safety and security

4 Service improvement

5 Quality

6 Equality and diversity (Department of Health, 2004b).

The other 24 are relevant to certain professions and are differentiated into Health and wellbeing, Estates and facilities, Information and knowledge and General (Department of Health, 2004b).The documentation is about applying knowledge and skills not the personal attributes. The documentation states that it is unfair to make conclusions that would make a negative difference to salary and career development. It acknowledges that it relates to personnel behaviour due to their actions not their qualities. Having qualities that benefit the profession is an asset and may make the scientist easier to train. Can qualities be developed? Qualities like communication (extrovert, clear speaker) and personal development (ambitious, like to learn) that are already possessed by a scientist would give them an advantage.

Importance of qualities may not be in the NHS KSF but it is definitely in the NHS Constitution (DOH, 2012).This is a document republished in 2012 to declare a crucial set of principles and values for all staff working in the NHS. It details the rights and duties of patients, public and staff as well as what aims the NHS is to accomplish in order to deliver a service that is both efficient and impartial. These values are patients come first; commitment to care, compassion and everyone counts. Resources should be maximised to benefit as many people as possible but people are treated on an individual basis to make sure they get the appropriate healthcare they need (DOH, 2012).

The NHS healthcare (National Health Service, 2020) website also states what values they require for biomedical scientists.

- An interest in science and technology
- Effective communication skills
- Competent at using current technology
- Accurate attention to detail –taught if you know what to look for.
- Strong interpersonal skills - easy if you are a calm person who can communicate calmly and politely
- Teamwork-extrovert-strong personality

2.11 IBMS and HCPC Codes of Conduct

The regulatory bodies of the profession, the HCPC and the IBMS also acknowledge the importance of values. The IBMS also states important behavioural aspects of its code of conduct (IBMS, 2018b).They include refusing to allow bias or discrimination to cloud their professional actions or duty of care. They should also follow the appropriate whistle blowing guidelines if patient safety or service delivery is compromised. They should also behave respectfully with all personnel during their role. Efficient teamwork is also expected. Note that these are not all personal attributes but if you have certain qualities this may be an advantage. Common qualities are teamwork, ethical integrity, professional behaviour, lack of bias and communication.

"Good communication skills are vital for relaying clear and concise information, advice, instruction and professional opinion to colleagues and service users to inform decisions on the care of a patient." (IBMS, 2018b, p. 6)

The HCPC highlights the importance of communicating appropriately and efficiently to both service users and carers. The framework requires the registrant to be courteous and respectful as well as actively listening to carers and active users and noting the needs and preferences. Information given to the users and carers need to be relayed in a way comprehensible to patients and their carers, taking into account any language barriers and communication requirements. The relevance of communication with colleagues is also noted with the team working together to aid the service users. Important and necessary data must be given to colleagues involved in the treatment of the patient. Communication is essential to give clear and necessary information to staff. Those of a nervous nature may waffle or freeze and not be able to communicate as well or as clearly as they like, leaving out information or giving out wrong information. Barakat (2007) noted the relevance of interpersonal skills and suggested they can be learnt and monitored via taped consultation, observation, feedback and colleague feedback and incorporated in training programmes.

Teamwork may be challenging for those working with a strong personality and those with a meek personality may feel bullied or not listened to. Ethics may be developed through culture, a place where mistakes are acknowledged so learning may take place. Froman (2010) suggests ethical cultures especially in challenging times is important and notes such an environment supports human development. Bonczek and Menzel (1994) suggest this is a continuous process starting with those in leadership roles educating their subordinates.

This links with educating for capability as mentioned before. If graduates have been trained in their training programme or degree for capability then this would merely work on skills they already had and this would aid in their development. In this thesis I was keen to see if any training was given and if scientists were going through these key aspects whilst training and if so how these qualities can be developed.

The importance of Knowledge, Skills and Personal Qualities clearly play a part in the NHS and therefore as a biomedical scientist. It would be useful to investigate training needs in relation to these three aspects.

2.12 Chapter Summary

The role of a biomedical scientist is defined as well as how the profession has evolved over the years. Haematology is also defined and the changes in diagnostic and scientific elements are noted with awareness that laboratories are becoming more automated. This chapter also sets out the aims and roles of the regulatory bodies of the biomedical scientists. The regulatory bodies have a role regulating training, providing structure to the training programmes as well as providing professional guidance on conduct and ethics. They do not have any training guidance for specific discipline learning and the efficiency of their advice and guidelines relies on the laboratory management assessing the situations accurately and honestly.

Figure 2.12

Professional and regulatory bodies involved in biomedical scientist's career pathway.

Registration pathway		Roles of professional and regulatory bodies	
IBMS Registration Portfolio	IBMS Accredited degree	IBMS • Professional body • Continuous Professional Development • Establishes Clinical Laboratory Standards for IBMS Qualifications and Guidance for Training Laboratory Management and Approval and ensures laboratories adhere to them	Other IBMS Training programmes • Certificate of Expert Practice (online) • Certificate of Expert Practice (specialist areas of practice) • Diploma of Expert Practice (DEP) • Higher Specialist Diploma (HSD) • Diploma of Higher Specialist Practice (DHSP)
HCPC registered Biomedical Scientists		HCPC • Regulatory Body • Ensures fitness to practice • Establishes Standards of conduct, performance and ethics, proficiency, CPD, education and training and ensure laboratories adhere to them.	
Pathology Diagnostics Laboratories: Microbiology, Biochemistry, Histology, Cytology, Immunology and Blood Transfusion Roles of proffessional and regulatory bodies		UKAS • Ensures ISO 15189:2012 Medical laboratory is adhered	NHS • Established NHS Knowledge and Skills Framework (KSF)

to

Chapter Three- Organisational Change

3.1 Carter report

There have been several changes to NHS healthcare in pathology in the past 25 years which inform the current climate today. The ones most relevant to this thesis is the First and Second Carter review. The briefing of Lord Carter of Coles' review of NHS Pathology is known commonly as the Carter review (Carter, 2006). Completed in 2006, the Carter review was an investigation into pathology and how well and efficiently it was being run with the aim to reform working practices (Carter, 2006). A second review was also done based on data collected since the first report (Carter, 2018).The first report highlighted the importance of laboratory medicine stating that "70–80% of all healthcare decisions affecting diagnosis or treatment involve a pathology investigation" (Carter, 2006, p. 5). The report recognized the workload of all the disciplines and stated over 130 million haematology tests are performed annually with NHS laboratory services costing £2.5 billion in the UK per year (Carter, 2006).

This report had many recommendations and ultimately led to the formation of pathology networks with a hub and spoke model that focused on what both the patients and users needed and expected. Alongside this, Carter also suggested the workforce needs to be redesigned to allocate staff to workload as well as a more efficient skill mix.

In order for these changes to occur teamwork from staff working in the laboratory and commissioning services as well as Trust Providers and the Department of Health in England was needed to optimise pathology services by changing, implementing and maintaining crucial managerial, financial, quality and operational aspects (Carter, 2018).

An issue that Carter noted was the different priorities between commissioners, and pathology managers (Carter, 2006). The former had limited insight and comprehension about laboratory medicine whilst the latter are affected by the financial priorities of the trust and failed to engage in process plans. As an added strain, Carter also identified that pathology was excluded from local delivery planning as well as national plans associated with planning and investment leading to unrealistic demands on the service which are difficult or impossible to meet.

One of the key elements I read into this is that there might be an issue with the misalignment between funding and workload. Workload includes training and if funding given does not include that the numbers will be inaccurate. Carter requested that the personnel champion pathology but to do this they need an accurate understanding of what pathology is. One of the larger issues as well is the lack of “financial, operational, workforce and performance” data at regional national and local levels (Carter, 2006, p. 28). Finances can be inaccurate due to silo budgeting and costs of pathology in primary and secondary care are assessed together and financial accountability in these sections are not recognized independently. Training is what I would call a “hidden” cost. It does not have to do with tariffs and set costs so its value might not be taken into consideration. Those championing pathology must also realise that financial saving and service optimization are not the only goals of pathology. Staff development and satisfaction as well as safe working conditions should also be relevant as well as the passing of skills otherwise staff loss means the loss of valuable skills and trainers and support running a service.

There are several recommendations in the Carter report that would have an impact on those working in Haematology. New technology and standardisation of working processes were recommended (Carter, 2006). New technology requires staff to write new standard operational procedures and staff to be trained as well as finding ways to implement the equipment into practice safely. This means time and staff must be put aside to be allowed to do this without affecting the service, training and quality maintenance. Carter also recommended quality assurance and accreditation (Carter, 2006). Ensuring quality at all levels requires staff often, but not necessarily, at senior level. This will require again protected time for staff and possibly staff working just in or partly in quality. These staff should not be considered as part of running the service or training. On a minor level, implementation of end to end IT connections, decision support and knowledge for clinicians from pathology would decrease workload for the laboratory. This would benefit biomedical scientists as the clinical team would have a stronger idea of what the patient needed and would only request appropriate tests. Carter also recommended an appropriate sample transport system with specimens taken at locations and times which are favourable for the patients (Carter, 2006). Samples must reach the laboratory within a certain time frame to ensure sample integrity. Samples need to reach the laboratory at a time where staff are available to test them to support appropriate workload allocation to staff.

Carter recommended that a strong workforce plan with" numbers, skills and grades" should be created once appropriate data has been gathered which could lead to the development of a migration programme and would help with relocation and redeployment (Carter, 2018, p. 22).Freezing and loss of positions, as well as limited procurement of all levels of training are the result of staff turnover and lack of financial resources of some NHS Trusts and a lack of supportive data could further hinder this (Carter, 2006).The current issue of increased technology means different and ever-changing skill sets and multidisciplinary working should be encouraged. The exact data collected is not known but must include dedicated training/trainee time and numbers. Staff is continuously changing so a training plan like this will always be required. This workforce data should also make allowances for those who are training others and getting trained themselves. Carter notes that the area of training needs more investigation but certain elements are deemed appealing such as clear-cut training standards created by service needs (Carter, 2006). The Carter report acknowledges that these standards should be supported by appropriate academic qualifications with advanced training delivered by suitably accredited training organizations. The Carter report stated that Department of Health and Strategic Health Authorities must provide funds to education and training as well as commissioning programmes for the pathology workforce and acknowledges this will be easier with more data to assess the financial aspects in pathology (Carter, 2006). As well as traditional biomedical skills, specialist discipline and managerial knowledge and skills need to be maintained and plans must be put in place to ensure this (Carter, 2018). Training and education needs to reflect what the service needs as well as the skill mix and end to end working will mean more opportunities in clinical leadership and in business management and training should be accommodated for these roles (Carter, 2018).

The data collected in this report was mostly quantitative. It also relies on analysers and IT systems working correctly with no interruptions. Certain cases might take longer to get results and certain clinical cases need urgent attention. Newly qualified people may have more questions or be extra careful making them slower. There is no data on how long to train scientists as well as writing the SOPS and competencies to aid training. A suitable skill mix is desirable but each person is an individual with different strengths and weaknesses especially when they are training. As noted above, the Carter report has good suggestions to improve pathology. However there is little idea of how to implement these changes with the current workforce. Finances must be put into the workforce to allow them extra time and staff to implement the quality changes suggested, perform efficient training, support continuous personal development and run a productive and safe service. Time and staff must be provided to write SOPS, assess quality and implement quality related changes. There must also be time and staff available to implement IT changes and new analysers as well as train staff to use these. Changes to any service for experienced staff like booking courier services and sending certain tests to reference laboratories must have all relevant items in SOPS within easy access. The rearrangement of workforce must be done bearing in mind that staff grades do not necessarily reflect the skill set of the scientist if they are in the middle of training. If staff are put out of hours and they are not sufficiently trained it means certain tasks may be left for more experienced members which on a busy shift leads to unfair teamwork. Staff who are not trained well may lack confidence and competence on shift, and can lead to possible harm to the patient.

Staff training must be prioritized before working out of hours to ensure they are confident and competent and this must not be a mere paperwork exercise in which staff are signed off. This requires time, staff and resources away from the service. Scientists do not come readymade as some are given a grade and are not necessarily working to that level; and even if they are, for the most part it could be that they have some weaknesses that need working on. As noted before the only real training competency checker is from the laboratory for UKAS.

3.2 Current Laboratory Situation

NHS Trusts are aiming to put these recommendations into practice .The sheer overhaul of pathology services in the UK from separate trusts to networks has however been time consuming and is still on-going on today. Networks will consist of the main hub and spoke laboratories. Spoke laboratories will provide core pathology needs with the hubs also providing specialised tests. The Template structure for essential services laboratory – Blood sciences provision document (NHS Improvement, 2018) suggested that the management of training should be at the hub and note that as well as having adequately trained numbers of staff, spoke staff who need to be trained should be frequently rotated to the hub to gain their skills, expertise and experience. One of the issues with management of training in this case is there is no indication of whether staff is allocated for actual training. The training officer is spread over several sites meaning they may not take on an active day-to-day training role at each site and there are no other positions other than the mentor but this is a supportive role. There is also no mention of training resources. As well as accounting for various leave, sickness and flexible working, NHS Improvement (2018) notes that staff rotas need to be in tandem with resources, personnel and workload at spoke laboratories. This is also what was noted for Carter report. The documentation also notes that shift pattern suggests the morning has a large workload with less and less work coming in the evening leaving the night shift to be used to only do emergency work. Due to Agenda for Change and the Shift system, it is especially important to judge the competence of technical staff working alone. This is as scientists may have been put on the shift that are not as experienced or may be used to working only in the day or part of a team. However, there may be a benefit for another scientist to be present or contactable. Trainees must be adequately trained before working out of hours and a suitable skill mix must be devised without experienced staff members teaching and doing more than their share of the work. Experienced staff may be frustrated and feel rushed if they are doing extra leading to stress and possible mistakes. It might be an idea for trainees to be placed out of hours when there are more staff and a dedicated trainer to share the training load.

The introduction of Multidisciplinary scientists was noted as beneficial (NHS Improvement, 2018). Multidisciplinary scientists are trained in more than one discipline. This often happens in Haematology and Blood Transfusion currently. Multidisciplinary biomedical scientists “allow scientific duties to be concentrated, which reduces the overall laboratory resource requirement” (NHS Improvement, 2018 p. 13) and is deemed by the documentation to be ideal for a spoke. I believe this will require trainees to be given adequate time and organization from management to master many disciplines .This would be helpful to combat staff shortages but it does mean creating a novel training programme that can ensure confidence and competence in all disciplines even after a period of not working in certain disciplines. I suggest this would also mean departmental support for CPD to maintain skills and knowledge and would have to factor into working time with relevant teachers. It is essential for managers to allow trainees to rotate through disciplines without prioritising their own departments and letting work politics get in the way.

3.3 Agenda for Change

In the past few years there have been many changes in staffing arrangements in Trusts due to Agenda for Change. Agenda for Change is to modernize the NHS and create a new pay system based on job evaluation (DOH, 2004). In the case of biomedical scientists, out of hours was a voluntary aspect and paid at an on-call rate. Agenda for Change has led to many Trusts getting rid of the high pay rate and introducing compulsory 24 hour shifts.

There are several advantages and disadvantages of Agenda for Change. Maynard and Street (2006) noted the following advantages of AfC: better patient treatment and reduced waiting times as well as large pay increases for medical staff. However the authors also note the following drawbacks ; issues with NICE, expensive treatments for a relatively small group of patients, the failure to budget the removal of old technologies as well as the discrepancy of advice given to departments due to financial budgets in different areas. It also has no set prices from pharmaceutical companies. Funding has been used by pay awards as it was believed that this was essential to retain medical staff. AfC also rewards activity yet has many issues, like poor negotiating power and lack of incentives (Maynard & Street, 2006). The authors are discussing AfC generally in this paper but there are two key elements concerning biomedical scientists: the failure to budget removing old equipment and uneven financial budgeting. Poor budgeting could cause a lack of finances in the laboratory affecting staffing levels, the attainment of expensive and possibly better technologies and a decrease in training or educational resources.

Loss of money and progression are cited as disadvantages of AfC by Edwards *et al*. (2009) for radiographers. The authors note that the implementation of AfC has led to a loss of morale due to no hope of career progress; if there are no vacancies then staff do not get promoted and are constantly being up skilled or responsibilities are being delegated down the chain of command. Whilst the latter is a possible learning opportunity, it has also led to practitioners feeling that their pay is not reflective of their skills and experience, especially due to the loss of out of hours rates (Edwards *et al*., 2009). This is a situation which is similar to biomedical scientists as noted by Osaro and Chima (2014).They note a loss of morale and a financial loss due to Agenda for Change .However as noted by Edwards *et al*. (2009),staff are being given extra responsibilities. Continuous professional development and learning up to date procedures and protocols is a professional duty and some professionals may be happy and willing to accept new roles and tasks for their own continuous professional development and possible career advancement. It is also necessary to note that all staff must work within their scope of practice so any up skilling must be within these boundaries. It must not also add to the professionals' workload in such a way that their own responsibilities are not met. If this is not the case there is a clear argument for the need of more staff.

Nursing staff have noted how AfC has changed their profession, noting the effect on the services they provide. James, Gosden, and Holt (2007) note that there was reduced patient time, the loss or decrease of specific services, as well as the decline decrease in patient education. Other drawbacks mentioned in the study have been a lack of professional development and a decrease in study leave. Paediatric nurses suggest that the benefit of better salary was appealing but was worried about the benefits actually being implemented (Walmsley, 2003). Reduced patient time, education and services as well as study time and CPD again suggest a decrease of finances .This may mean decreased staff numbers, meaning nurses not being able to take time for professional development or study. These are possibly not considered a priority whilst running a shift. This also suggests that patients are missing out on the service which is an impact on quality of care. This paper suggests that budgeting for AfC has had a negative impact on the service .However the increased pay may have boosted morale for nurses and they may feel recognised for their efforts.

Another professional group affected by Agenda for Change are physiotherapists. Findings from the study done by Anderson and Warhurst (2019) suggest “political manoeuvring by representative bodies to reconfigure skill development that results in occupational reclassification.” This requires work on the analysis of skill deployment. They suggest more work in the latter “rather than assumptions about these skills’ use being read off qualifications.” They also note a lack of alignment between required skills to achieve the job compared to what is needed to do the job (Anderson & Warhurst, 2019). This is an issue with biomedical scientists as well as having an accredited IBMS degree enables the trainee to work in any discipline. A lot of training occurs in the laboratory, allowing skills to be developed with specialist protocols in mind. For each discipline there is a specialist set of skills and different techniques that needs to be developed. This suggests that time and resources have to be given to appropriate training to enable trainees to become competent and confident scientists. The time and resources needed to train must be taken into consideration when hiring new staff as well as the impact on the service.

Agenda for Change has also had a negative impact on speech language therapists. Loan-Clarke, Arnold, Coombs, Bosley, and Martin (2009) suggest a huge loss to earnings caused a drop in morale. Key issues noted in the study that affected speech language therapists are low staff numbers, requiring suitable financial retribution, increased bureaucracy and stress, little recognition ,no of little work hours flexibility as well as poor facilities, CPD and career progressions. The participants also expressed the wish to stop AfC (Loan-Clarke *et al*., 2009). The stress of biomedical scientists is highlighted by Osaro and Chima (2014) due to organisational change and has had a negative impact on morale.

McCardle (2008) states, speaking for podiatrists, that AfC did not “reward clinical specialism was never achieved” and caused difficulties by rewarding the specialist title prematurely in the career progression, meaning these specialists lacked the experience of their predecessors, and gave a false number of trained staff. The authors note there is increased responsibility for podiatrists due to less working hours of doctors. Clinicians have an unmanageable workload and are unable to meet their patients' needs. Lack of time for CPD has contributed to low morale (McCardle, 2008). The premature rewarding of titles for will possibly have the same consequences as the biomedical scientists. A scientist who has got a position for a Band 5 position but needs extensive training or has gaps in their knowledge or skill set gives a fake number of staff levels. This puts strain on both the experienced and inexperienced staff. The experienced staff have to train and can see issues the inexperienced staff don't but the latter may feel pressure to work to a standard to which they are not capable of without training. Management offering a position should ensure that the person can achieve competence and confidence n their role and work autonomously in a suitable time frame with the correct training. This suggests appropriate training is essential as well as reviewing and assessing a trainee which requires time and effort from the team and organisation from management to ensure this happens.

The advantages for AfC seems to be better patient care and salaried benefits for medical and nursing teams .However allied health professionals seem to have many negative issues concerning Agenda for Change. Increased responsibility, loss of money and morale as well as decreased CPD can have a detrimental impact on training.

3.4 Change Management

For such an overhaul in services, effective change management is essential to ensure quality is maintained whilst the aims of the service are being met. The Carter report notes several trusts being consolidating meaning their staff, management and resources pooled and allocated appropriately as well as streamlining working practices. Stakeholders can be internal or external. The stakeholders for each trust are different but can be employees, government agencies, reference laboratories, public health agencies, patients and policy advisors. Golden (2006) notes that there are several issues in change management in healthcare: stakeholders have different interests, organizations have several goals, healthcare workers have “professional autonomy” and organizations are responsible for finances through their choices of testing and treatments; data may be insufficient to support the changes and the goals may be in conflict with each other. He also notes four clear stages such as what the end result should be, how susceptible the organization is to change, increasing liaison and restructuring organisation as well as implementation and maintenance of change. These are mentioned in the Carter report but not in great detail. There are several sections to change management in this case: firstly organisational change, secondly political and culture change and lastly technological change.

3.4.1 Organizational change

For organisational change there are several theories that are relevant:

- Descriptive, normative and instrumental theories
- Congruency Theory
- Resource dependence theory
- Prospect theory

McCall (1979) noted that it is essential to establish which stakeholders wielded power and could create change as well as the following requirements for these personnel: appropriate standing in the organisation, experience using this change creating power, aware of technical procedures, issues and solutions, possessing control over essential assets that other staff members may use and strong problem solving skills (as cited by Hayes ,2010, p. 144-145).This is noted in the Carter reports, what is absent however are personnel centrally connected to the work such as those working shifts and training, not just those from a management perspective. This also suggests a group effort from management and people in the laboratory. However each discipline has their own processes and specific techniques and suggests staff from each discipline should be involved in organisational change. Donaldson and Preston (1995) note three types of stakeholder theory: descriptive, normative and instrumental. The theory is descriptive if “it presents a model describing what a corporation is”; it is normative if it has “(a) Stakeholders are persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity and (b) The interests of all stakeholders are of intrinsic value” and it is instrumental if it “establishes a framework for examining the connections, if any, between the practice of stakeholder management and the achievement of various corporate performance goals. “The normative theory focuses on financial gains whilst the instrumental theory focuses on moral behaviour. Whilst these are common stakeholder theories Valentinov and Hajdu (2019) note that the negotiation between moral behaviour and financial maintenance may be challenging for managers if they follow normative stakeholder theory but Instrumental stakeholder theory is also disadvantageous as moral behaviour can be accepted even if the financial basics are achieved. The authors note as well that these theories do not encompass all aspects of the organization. They believe that the systems theory can improve both theories as the systems theory has a stronger methodological component.

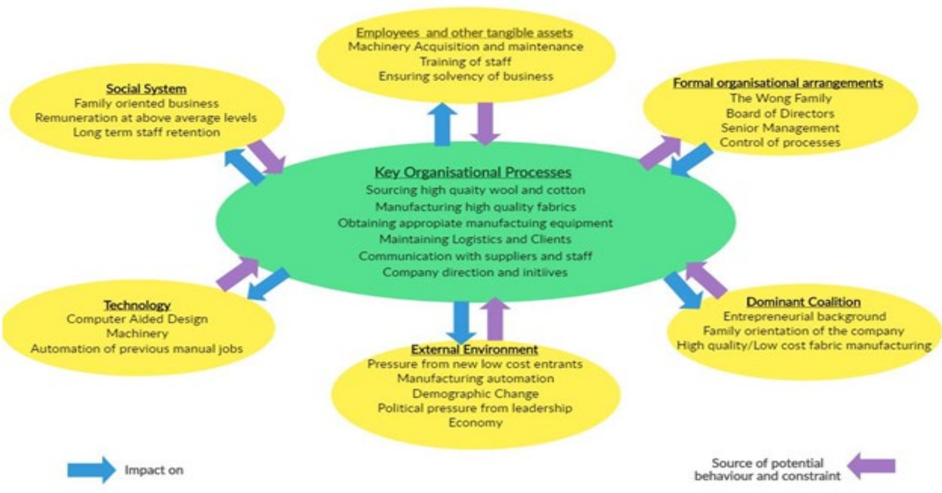
Hayes (2010) outlines the open systems theory as a framework describing an institute as an association of connected sections that relate with a larger environment with the latter being responsible for assets, guidance and knowledge. The authors note that this system is to ensure that the organization keeps going and prepares for disorder by using feedback. They also mention several important characteristics. Strong boundaries must also exist internally and externally. The system should be able to be configured in different fashions and produce successful results. Strong known patterns are used to influence input, throughput and output. Finding equilibrium so that things are steady and if anything goes wrong there are backups available. Different sections come together to fix the imbalance (Hayes, 2010, pg 93-94).The open systems theory may also be best applied to the hub and spoke organisation. Spokes and hubs are linked and in case of issues there are different teams available to support the service .In the case of training this is an option to support training. Hubs would realistically have more cases, bigger budgets and training resources, which suggest they may be the ideal place to train. Trainees could be sent to the hubs with a dedicated trainer or someone interested in training especially if spokes are struggling to train.

3.4.2 Congruency Models

There are two well known congruency models based on Kotter's model (Kotter, 1980) and Nadler's model (Nadler & Tushman, 1980). Kotter developed a model of organization dynamics which has six components: formal organization arrangements, dominant coalition, external environment, technology, social system, employees and other tangible assets with key organisational processes being information gathering, communication, decision making, matter/energy transporting and matter/energy conversation (as cited by Hayes,2010, p 95).

Figure 3.4.2 (A)

Kotter's Model

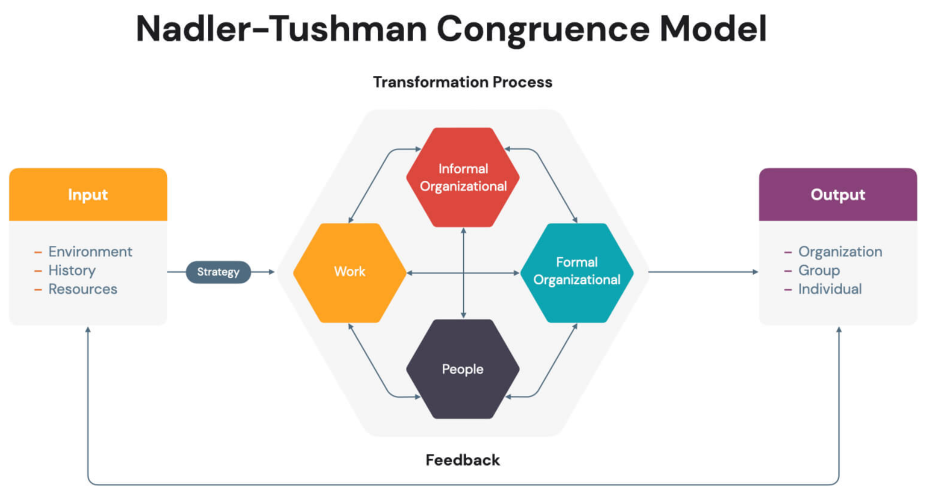


Taken from Northern Rock Case Study Analysis on Change Intervention Ideas (totalassignmenthelp.com)

Appelbaum, Habashy, Malo, and Shafiq (2012) note how the Kotter's model is inflexible and some stages may not be necessary for every case. They also note that it does not cover all situations, and there are limited cases due to the intricacy of change managements. Nadler and Tushman also have a model of organization dynamics and noted four key elements as well as, similar to Kotter's, the need to focus on dynamics (Hayes, 2010, p 99).

Figure 3.4.2 (B)

Nadler and Tushman Model



Taken from Nadler-Tushman-Congruence-Model-for-Powerpoint.jpeg (1920×1080) (hislide.io)

These are the following assumptions with this model: Organizations themselves are dynamic, exist in a bigger picture and have social interactions. There is "organizational behaviour occurs at the individual, the group, and the systems level " with synergy between them (Sabir, 2018). Resource dependence theory-organisation notes that organisations are reliant on resources (Hayes,2010, p 147). Nienhüser (2008) notes the relevance of the power mechanism and that at least minimum effectiveness is essential for it to survive. The capability of managers is lost if organisation aims are not met and they are unable to give vacancies. Nienhüser (2008) notes that management cannot act without resources. This however also speaks to higher management especially due to financial budgets. An important element in the Nadler's model is that the necessary data is essential to make decisions .Poor data or lack of it will not make an efficient service or work practice. However there is also the option for continuous improvements as the process continues allowing shortcomings to be rectified as the model is cyclical.

Prospect theory results that are losses are examined heavier than gains (Hayes, 2010) .Levy (1992) describes the theory" hypothesis that individuals are risk-averse with respect to gains and risk-acceptant with respect to losses and for its emphasis on the importance of the actor's framing of decisions around a reference point." Losses and gains in this setting may be complex to establish as they include not just financial loss and gain but successful and efficient healthcare and satisfied staff and patient care

3.4.3 Political and cultural change

Two major relevant theories are social identity theory and acculturation. Ashforth and Mael (1989) have noted the relevance of social classification. Primarily it provides a definition for other members of the organisation and provides an order of said organisation .It also provides definition of the person in relation to the organisation. Huddy (2001) notes however that membership in groups can be ambiguous and qualities are not fixed. The authors note that this is often the case with political ideology.

Brown (2000) has noted 5 criticisms of social identity theory. The relationship between" group identification and ingroup bias, the self esteem hypothesis, positive – negative asymmetry in intergroup discrimination, the effects of intergroup similarities, the choice if identity for low status groups." In the case of this thesis two identities are relevant, the professional title of biomedical scientist as well as being part of a specific hospital through the hub and spoke model.

Acculturation theory is presented by (Berry, 1983) (Berry, 1984)and elaborates on two sides of acculturation for both the acquiring and the acquired organisation and names four key elements Integration, Assimilation, Separation and Deculturation. Integration requires each organisation generally keeping their own cultures but are joint structurally. Assimilation is when one organisation accepts the culture of the other fully. Separation is when both parties keep their own culture and work independently. Deculturation is where the acquired organisation rejects both cultures. The suggested acculturation method depends on how much the acquired organisation values the maintenance of its culture and how much they want to accept the acquiring organization's culture. For the acquiring organization however the suggested acculturation method relies on its multicultural nature and its diversification strategy (as cited by Nahavandi & Malekzadeh 1988).The aim of the hub and spoke model was to streamline practices in all associated hospitals which will be difficult if the acculturation is not successful for both parties.

Harrison (1972) notes four cultures; power, role, task and person cultures. Power culture relies on domination and exploitation with those in higher positions making decisions. Role culture and staff work within their scope of practice. Set working practices are present. Task culture is focused on the task with colleagues and procedures removed and replaced if it hinders the task. Person culture is for the organization to serve its staff. There is a lack of authority with decisions made by consensus. The culture noted is important especially in a challenging time of organisational change and may influence the morale and retention of staff.

3.4.4 Technical change

Harison and Boonstra (2009) notes crucial aspects of the process of technology change as well as how both personal and technical competencies influence the process. As well as communication, leadership, knowledge and experience in organizational change, knowledge and experience in techno change is essential alongside the relevance of knowledge of IT (Harison & Boonstra, 2009).

Laumer and Eckhardt (2010) however note the relevance of possible obstructions such as issues of both the process and technology used. The results of the change connected to the work, technology and process are also possible bones of content. The context as well as personal differences and characters are influential. This again suggests that people specific to each biomedical discipline should be involved in technological change as they are familiar with the unique processes in their own laboratory.

3.5 Training in Healthcare

As shown by Bosanquet *et al* . (2006a) there are limited finances and resources in the current NHS and new investment models need to be determined to use staff efficiently. In another paper Bosanquet (2006) notes the value of experience and quality of staff instead of quantity as well as changes and NHS plans have negatively affected training in healthcare.

As there is no guarantee that a HCPC qualified scientist will have experience in the field they are currently working in there is a need to train newly qualified biomedical scientists to the standard required to perform. One of the more recent assessments of pathology by Yahaya (2019) suggests that while the Carter report suggests efficiency and cost effectiveness of pathology as the main aims of pathology modernization, patient welfare is also an important essential goal. This is harder to calculate compared to efficiency and cost effectiveness of pathology. This paper also highlights the importance of a relevant skill mix from a financial aspect explaining that a trainee scientist would arguably cause more waste, whilst dealing with a poorly performing piece of equipment, not being familiar with it whereas a trained scientist would know exactly what to do and get to the heart of the problem. The training of workforce is therefore essential. Yahaya (2019) also state that the skill set required for each task should be monitored to give a more accurate test cost.

Training programmes are clearly an established practice which are done further down the career progression line as shown with the above training programmes. As found by Abid *et al* . (2010) an important aspect of training is setting objectives to focus learning, increase understanding and provides instruction to give a clear guideline to what is expected from trainees . The authors also noted that “objectivity provides a platform for learning sets targets for assessment and helps to communicate expectations to learners” (p. 263) to help them stay on topic. In traditional teaching methods where the student is usually the receiver of information and the teacher is the only source of knowledge, the student relies on memory and not on critical thinking. This might become an issue for students especially when, with respect to this thesis, working in the laboratory. This study demonstrates students who learn and are assessed with objectives develop critical thinking skills.

In respect to this thesis, focus should be given to relevant topics as well as ideas of well encountered situations in the laboratory. Learners trained in such an environment become critical thinkers and are able to take initiative in laboratory issues. Bruns (2008) conducted a review that shows there is a need for healthcare professionals to be trained to a high standard with specific focus on what is included in training programmes and what the aims of the training programme should be i.e. to create competent members of the profession. They hope to enable members to work in the laboratory with initiative, creativity, continuous personal development and high levels of quality control and medical ethics.

Hollensead *et al* . (2004) recommends a strong training programme as this would minimize laboratory errors. The authors suggest also a strong quality programme to reduce errors. A study done by Bonini *et al* . (2002) investigated the issue of errors in the laboratory. The number of errors found to occur during the laboratory phase is 13–32% whereas the rest of errors occur in the pre and post analytical stages. Errors during the preanalytical stage include specimen identification, collection and integrity issues. Post analysis errors involve incorrect interpretation of results. This is supported by the idea by Lichenstein *et al* . (2016) who conducted a review of incident reports caused by errors in the laboratory in the Paediatric Emergency Care Applied Research Network (PECARN) from July 2007 to June 2008. PECARN is a multi-disciplinary research institution that focuses on the “prevention and management of acute illnesses and injuries” in all paediatric patients (PECARN, 2020, para.1).The National Coordinating Council for Medication Error Reporting and Prevention severity classification system was used to classify the risk rating of laboratory events. In this report, 42.2% laboratory reports occur in events in the pre-analytic phase with 82.8% of all errors resulting from human factors (Lichenstein *et al*., 2016). Plebani (2010) also notes that in laboratory medicine there are many stages to make errors and suggest that analytical errors are under the responsibility of the laboratory and also suggests automation, better quality and training is responsible for minimizing errors.

Haematology training is also done by those in the medical profession. A paper by Shlebak and Bain (2017) discusses the issues faced by training doctors specializing in haematology and how to overcome these. There are a few relevant aspects that may be relevant to biomedical scientists. The requirements discussed are advanced supervision and fair assessment of trainees. The paper also highlights the importance of having a supportive learning environment with additional aid for trainees having difficulties keeping up. Syllabus content must be reviewed regularly to be kept up to date and relevant. High quality teaching and education must be factored into the programme as well as increased communication between relevant parties to ensure appropriate training takes place by the correct individuals in the correct place. Training must be planned appropriately and trainees must give feedback to help improve the training process as well as highlight any difficulties they are experiencing (Shlebak & Bain, 2017).

There is the comparison between doctors and scientists. However biomedical scientists might have more in common with other Allied health professionals like radiolographers.. Doctors are trained in general medicine and then specialise. Biomedical scientists are not given general training. All their training is discipline specific and when they get a role, it is specialised from the beginning. However some issues may be found to be similar, such as responsibility carrying from post to post, insufficient training, shorter rotations and moving around, working nightshifts (Wakeling, French, Bagnall, & McHardy, 2011).

Datta and Davies (2014) noted that it was essential to maintain education in a service working the 24 hour shift and the impact of training is challenging to know. The authors make the following points. This was an investment in patient safety. Less working hours in the day means training in evening and night where training is challenging. It is essential to restructure training around the service delivery .There was a need for specialist training. “Improved educational governance and monitoring of the outcomes of training by the regulator can inform reorganization and help to ensure that training is provided by the most suitable personnel ”(Datta & Davies, 2014). This is also a possible issue for biomedical scientists where training will have to be more flexible and may need to take place out of hours. Hamilton (2013) notes that a training needs analysis was needed to “identify the gaps between the knowledge skills our users felt they needed, and their perceived level of competence in these skills ; Existing information literacy competencies schemes can be tailored to the specific user group to avoid having to “reinvent the wheel” ” making it also an assessment tool (Hamilton, 2013) . This could be done in each laboratory to see what needs to be done and then later on to see if trainees had any specific gaps. With relationship to surgical training, there are certain issues such as lack of incentive to train as all goals are service orientated. As noted before there was a decrease in European Working Time Directive. However Marriott, Purdie, Millen, and Beard (2011) note that with proper organization could see double the cases without impacting the numbers of hours. This again suggests that biomedical scientists could also be arranged around service delivery. Hutchinson (2006) noted the relevance of tertiary education like the alignment between tertiary education and current practical skills as well as ensuring in the future there is time and resources to keep up with changes and inspiring staff to train.

Chapter Four-CASP Review

This chapter reviews the current literature associated with training in diagnostic haematology as well as potential training ideas .The search strategy is defined and relevant papers are discussed.

4.1. Literature Review

This literature review was conducted to determine what literature to date is available relating to the Haematology laboratory training of newly qualified biomedical scientists. This would establish which areas had been investigated previously and help determine what new relevant questions need to be answered.

The question for the search was: *What evidence exists about the training of newly qualified HCPC registered biomedical scientists in the field of haematology?*

4.2 Search Strategy

To advance my search strategy the PICO method was used. The PICO framework was created by Aslam and Emmanuel (2010) and is used to develop search strategies in literature reviews. This mnemonic is based on P- (Patient, Problem or Population), I-Intervention, C – Comparison or control and O – Outcome. In this study the population of interest is the biomedical scientists, the intervention is the assessment of training needs, and the outcome of interest is the understanding of training needs of scientists. There is no comparison.

4.3 Method

Three electronic databases were searched through the University of Exeter's electronic library. Pubmed, Wiley Online Library and Embase were searched as they are the primary databases for Haematology and laboratory training research.

The search for papers in peer-reviewed journals was conducted in February 2016 and updated in 2020. No new papers were found in the second search.

The title search terms for the search were: **biomedical scientist, training and haematolog*/hematolog*.** This received no results. The title search terms for the search then used were: **training, laboratory and haematolog*/hematolog*.**

Papers were checked for applicability to the study by looking at the title and abstract for relevance and rejected for on the following reasons: a conceptual or theoretical review, a thesis dissertation, a conference or poster abstract, or book chapters. Recent references were targeted to keep up to date with more recent technology. The dates accepted for the literature included were from 2012-2020.

The full texts were also assessed in relation to the PICOS statement, making acceptations and rejections on the following grounds:

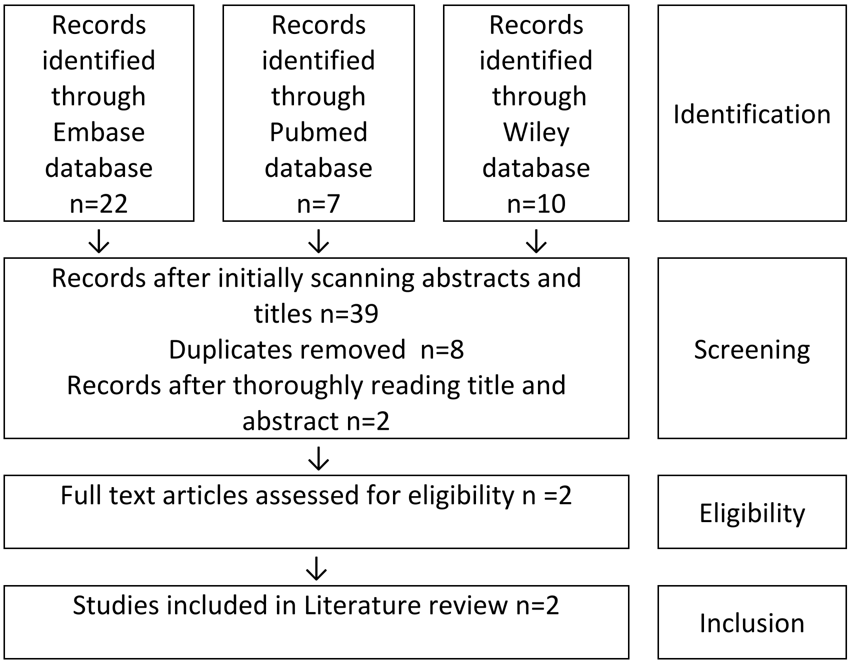
Table 4.3

Inclusion and Exclusion Criteria for Pico Statement

	Inclusion criteria	Exclusion Criteria
Population	Biomedical Scientists/laboratory working in Haematology	Biomedical scientists in other pathological disciplines
Intervention	Assessment of training needs in diagnostic haematology	Assessment of training in haematology research
Comparison	No Comparison	
Outcome	Understanding of training needs of scientists.	
Publication dates	Published from 2012-2020.	
Study type	Papers in peer reviewed journals.	Work not published in English conceptual or theoretical reviews thesis dissertations Conference/poster abstracts , book chapters.

Figure 4.4.

PRISMA flow diagram showing the results of the literature search



4.4 CASP Evaluations

This project is specific to training in a haematology laboratory for biomedical scientists or teaching diagnostic laboratory haematology.

The assessment of the abstract would be sufficient to assess the suitability of the paper.

The 31 papers found were potentially possible to be used. However on reading the abstracts tthey were not relevant to the study.

The two papers identified through the search were appraised in a systematic way by the researcher for quality using questions found in the Critical Appraisal Skills Programme (CASP) Qualitative Research Checklist (2013) (Appendix A).

The paper by Leung *et al* . (2015) came up with a score of 9.5 and the paper by (Navarro *et al*., 2019) came up with a score of 8.

4.5 Results

The results for the literature review question found that there were no studies specifically about training within the haematology laboratories for biomedical scientists. The papers match with outcomes of PICOS statement. A summary of the key findings can be found in below.

Table 4.5

Summary of relevant papers

Author and Date	Title	Summary	Conclusion
Leung *et al* . (2015)	The pediatric hematology/oncology educational laboratory in-training examination (PHOELIX): A formative evaluation of laboratory skills for Canadian pediatric hematology/oncology trainees	The PHOELIX Paediatric haematology/oncology educational laboratory in-training examinations efficiency was assessed to determine the success of their laboratory training curriculum.	Valuable tool to assess efficiency of training programme.
(Navarro *et al*., 2019)	The European Hematology Exam: The Next Step toward the Harmonization of Hematology Training in Europe	The European Hematology Exam was assessed to determine its relevance to training.	Relevant virtual course and assessment to support training.

4.6 Discussion

4.6.1 The paediatric haematology/oncology educational laboratory in-training examination (PHOELIX): A formative evaluation of laboratory skills for Canadian paediatric haematology/oncology trainees

This paper was included as it focuses on laboratory skills and theoretical knowledge in Haematology with an emphasis on morphology. The program covers Haematology, coagulation and haemaglobinopathies as well as malignant and benign aspects, of red cell, platelet and white cell disorders. This is very similar to the specialist IBMS portfolio. In different countries the roles of what laboratory scientists does varies, with some not working on morphology which is not the case in the UK.As such this program would be relevant to scientists training in the UK

Leung *et al* . (2015) stress the importance of laboratory diagnostic skills and paediatric haematologists/oncologists are required to have a minimum of half a year in appropriate laboratory training. The authors noted that the training needed an assessment, which is similar to this project. The PHOELIX Paediatric haematology/oncology educational laboratory in-training examination was the product of this requirement. This includes an examination that can aid in assessing and informing trainees. It also provides doctors with a mechanism to determine the success of their syllabus. This is an essential verification procedure to ensure the training is satisfactory. Eighty nine percent of PHO participants felt that laboratory skills are essential in their profession (Leung *et al* ., 2015).

In this study the trainees were all from the same discipline which is not the case with biomedical scientists. This exam was created and assessed by experts in the field. PHOELIX has practical examinations like microscopy which is very relevant to practical Haematology and the examinations enable trainees to establish what the positives and negatives of their skill set were as well as what needs working on. Feedback is also given to trainees. One of the key aspects of a biomedical scientist ,the technical aspect, may not be fully explored as well as aspects like communication and working under pressure which would not be able to be assessed by a sit down exam and might require a more practical side if such an exam is to be used. There have been requests for extra training ideas with this exam making it an ideal tool to assess whether there is a lack of adequate training or if the trainee has certain weak spots. This exam is as assessment of training. Biomedical scientists do not sit exams and are assessed as competent by the laboratory if they are signed off by a competent staff member. The assessment of knowledge and skill is up to the laboratory .An exam such as this is independent of the laboratory and provides an external assessment of knowledge and skill and point out where the trainee is lacking which could be an issue with training in the laboratory. This study is aimed at medical doctors rather than biomedical scientists. This is not necessarily a limitation as there is overlapping medical knowledge between scientists and medical doctors especially with disease and laboratory results. The breadth of knowledge required for medical doctors may also be higher than biomedical scientists and if this exam was to be developed for biomedical scientists it could focus on their competencies. The scope of practice, with reference to the HCPC and IBMS, is a key element for biomedical scientists. In the case of biomedical scientists, medication and the administration of it is an area where biomedical scientists exceeds the scope of practice. Clinical decisions are made by doctors and biomedical scientists do not see often the entire clinical picture from an MDT point of view.

Rather than doing things manually virtual laboratories may be better to limit use of facilities and also provide extra support in preparation for such an exam. Virtual learning in Haematology has been used as a positive aid. ‘Program for the Innovation & Improvement of Teaching’ at the University of Seville in Spain, which also has a self assessment tool and presents itself as such an aid (Mate *et al*., 2011). After a virtual training session trainees used interactive personal response devices to answer the multi-choice questions related to the recent learning material. This delivery of training with the use of personal response devices increased the attention span in class as well as the information retention rates of the session. The advantage of this study is, unlike the exam and training programme in the paper discussed by Leung *et al.* (2015), that this course has examinations through the course instead of just at the end to ensure continuous learning. Students were therefore tested throughout the course (Mate *et al.*, 2011).The use of personal response devices might prove costly and it might be beneficial to have everything on the computer .Another

learning programme aimed at medical doctors is the clinical skill laboratory (CSL), which is a programme that provides clinical skills training and practice to medical students through models, simulations, peer groups of scientists, role-plays and simulated patients (Al-Elq, 2007). Unlike the exam and training programme in the paper discussed by Leung *et al.* (2015), the CSL is not based solely in haematology. It includes facilities to conduct physical examination, diagnostic, therapeutic procedures, and communication skills. The potential for assessing and training biomedical scientists is promising .Communication skills are an essential part of being a biomedical scientist as noted by the NHS, IBMS and HCPC standards. It is essential for all members of staff to speak clearly and critically while remembering patient confidentiality. Therapeutic techniques could be substituted by technical techniques but the basis is potentially there for a programme for training or assessing biomedical scientists. In addition to development of clinical skills, the CSL uses objectives in learning and simulated patients for teaching and testing.

If this programme is to be adapted for biomedical scientists then tasks in the training programme can be objectives that are required of band 5 biomedical scientists according to the IBMS Training Registration Portfolio. These include

- Experience using Laboratory Information Management Systems
- Able to demonstrate and apply a knowledge of the Haematology
- Good interpersonal skills
- Able to assess laboratory data and authorise as appropriate

- Able to perform laboratory tasks and assays of a complex nature.
- Good knowledge of quality assurance
- Good knowledge of health and safety.

There is the use of factitious patients which can decrease the fear of trainees. Therapeutic and diagnostic skills can also be developed as they have a number of cases on file rather than waiting for a patient with a specific condition to come in. It gives the trainee the chance to diagnose without fear and develop confidence. This programme also allows self directed learning. This is an excellent method that can be adapted to Haematology scientists.

An important task is the validation of Coagulation screens and Full Blood Counts which can easily be recreated with fake patient records. This is the acceptance of results from the analysers taking into consideration the clinical details and actual results. This is an essential part of being a biomedical scientist. This links to the competency to be able to assess laboratory data and authorise as appropriate. This is often viewed one of the most important roles as this requires thorough understanding of Haematology and Coagulation. The results are viewed by doctors who base their clinical decisions on them.

Different hospitals have different criteria for urgency and this would be an excellent learning tool without endangering patients and at the same time promoting consistent good practice. An example would be calling doctors with a patient's severe drop in Haemoglobin and noting down details such as time and which member of staff was spoken to. This could be an excellent learning opportunity to highlight severe clinical details and what to do in such a situation. A laboratory training programme for paediatric doctors was used to highlight the importance of laboratory work (Lehmann *et al.*, 2010). The results of this pilot study indicate that including virtual patients in an intensive and multimedia-enhanced learning tool of practical skills training is enjoyable and successful. Clinical cases are presented and certain procedures are explained thoroughly with the aid of short videos, still drawings and interactive animations. Lehmann *et al* (2010) stated that further investigation was needed to establish whether skills laboratory training can be faster using virtual patients.

4.6.2 The European Hematology Exam: The Next Step toward the Harmonization of Hematology Training in Europe

This paper entails an assessment of the efficiency of the European Hematology exam. This exam is available to all healthcare professionals but the main populations are doctors who have finished their specialty training. As mentioned before the level of knowledge may be higher than needed as it is aimed at doctors but can be generalised to biomedical scientists. This exam is to assess knowledge according to the European Hematology Curriculum (Almeida *et al*., 2018). This curriculum was to standardize haematology training in Europe which is also beneficial to this project as mentioned before there is no standardization of haematology. The curriculum consists of eight main sections which are benign disorders, myeloid malignancies, lymphoid malignancies and plasma cell disorders, treatment of hematological disorders, laboratory diagnoses, thrombosis and hemostasis, transfusion medicine and general skills (Almeida *et al*., 2018). Each of these sections are divided into clinical skills (patient management and treatment), laboratory skills and competences related to regulations and principles with three levels of competency to be achieved for each one. As scientists do not deal with managing patients clinically the first section may not be as relevant. As Abid *et al.* (2010) noted, objectivity is important in learning and the programme has strong objectives which are a positive for the study.

The examination consists of Multiple Choice Questions which consists of three parts: the stem, the question and the answer options. The stem is a realistic clinical situation with relevant information complete with laboratory results or images like blood films. Direct questions are asked with five answers to choose from, with the four incorrect answers being feasible responses. Questions are based on current guidelines. The authors suggested that the exam is used as a learning tool in training and to assess knowledge enabling feedback to be given to trainees. Similar MCQs are taken from a big database created for this exam and is to be established online for trainees' own self assessment. The only question type that is asked in this case is the MCQS. While MCQs are a competent way to assess learning (Brady,2005) it might be beneficial to have real life examples or small essay questions to test genuine understanding. Questionnaires were given to participants to assess their opinions on the exam in which 78% found the exam significant and 19% found it partially significant with respect to their learning. 87% acknowledges the exam organization as "good or very good." Passing candidates were asked their opinions.62% who responded to the survey stated that with their successful results, they expected the exam would aid their future career with 10% stating that this had already happened. The set up of the training programme prior to the virtual exam is however ideal to assessing biomedical scientists at least from a theoretical point of view. The range of topics noted is ideal to biomedical scientist but may be better aligned to specialist biomedical scientists. There is no mention of feedback to the trainees which can help them personally but this is noted in further work.

A standardized virtual programme has benefits as all materials are available online. Resources such as scientific information, clinical scenarios and morphology slides are available giving a compact training tool that can be accessed anywhere with an internet connection. The standardizing of training is also quite relevant as it can lead to less variance in practice. A similar programme could be adapted in the UK using UK guidelines with respect to the IBMS, HCPC and NHS.

4.6.3 Relevant training ideas to this thesis

Communication task simulations could be set up. This could include giving urgent results to doctors as well as simulations of what to do if you newly diagnose a new Leukaemia (this requires the co-operation of the on call haematologist) or an abnormal result like a high INR out of hours. The latter would be to get the patient's phone number as well as contacting the on-call haematologist.

An important part of being a biomedical scientist is the maintenance of analysers as well as troubleshooting when there is an error. It would be especially useful to have screen shots of the analyser screens and the most common issues could be given information and solutions to. This is usually done using the actual machine but simulations can be set up to help train new scientists building up confidence. This could also include quality assurance of the analyser.

Giving a variety of tools may also stimulate learning. Technology is advancing rapidly and electronic laboratories are becoming popular. Electronic laboratories can be a more in-house network or a system across different sites in the network. This is currently done by United Kingdom National External Quality Assessment Service who run a digital morphology course. This is given to all NHS laboratories that are registered with United Kingdom National External Quality Assessment Service NEQAS. This idea is strengthened by Arnous *et al.* (2012) who introduces a computer programme aimed at assisting managing laboratory resources and creating sessions to enable virtual practical laboratory training.

4.7 Summary of evidence from literature review

There is no published evidence of the need for a training programme for newly qualified HCPC biomedical scientists in Haematology. There is also no published evidence of an established haematology training programme.

However there are several possible training techniques that have been proved successful in training health professionals in Haematology. These include virtual programmes using simulated patients and standardized patients. They also include tutorials, interactive learning sessions, instructional videos and image banks for microscopy. An examination at the end to determine the efficiency of the training programme may also be beneficial.

Older papers would have techniques and training methods or procedures that were before AfC or the Carter report. Documentation is continuously reviewed so the most recent version, must match training procedures and what is required of scientists today. A lack of research in this field means fewer papers, but including older papers may incorporate theories and techniques that are no longer be relevant. The research question is about current training needs for which only two were relevant. Smith *et al*. (2019) have published a research paper

4.8 Research question

From this literature review the following research question was formed.

Is training currently sufficient for newly qualified scientists in Haematology?

Chapter Summary

This Chapter investigates the literature to see any relevant documents on training in the field of Haematology. There were only two relevant papers.

Chapter Five– Methodological Review

This section consists of two parts: a critical analysis of methods and the description of the chosen study method.

5.1. Critical Analysis of Methods

An overview of different aspects of common methodologies was investigated to determine the best methodology for this thesis.

In order to determine the best method to investigate the research aims, I was drawn to interviewing groups of participants which could be feasible with group interviews and focus groups, meaning that a large amount of data of participants could be collected at one sitting and be potentially less time consuming than performing many individual interviews. However Guest *et al* . (2017) noted there are aspects other than collection method which affect the quantity and quality of data received, such as participants' previous experiences and how identical the researcher and participants were. In respect to this thesis, I found these factors important as a biomedical registered scientist. I felt the participants would be similar to me as they would likely be scientists or would be working in Haematology as a trainer or a trainee scientist. These are positions that I currently occupy or have occupied in the past.

Parker and Tritter (2006) noted the difference between group interviews and focus groups describing that in the former the researcher regulates the group interactions, asking questions to specific participants and leading the discussion while the deliberation between participants (not between the researcher and participants) is the essential aspect of the focus group. I feel that this deliberation, on contrast to the lack of discussion between participants in group interviews, is a key aspect to this thesis as ideas will hopefully be generated and participants will work off those ideas and expand on them between themselves. Kitzinger (1995) supports this noting group dynamics in focus groups can analyse and formulate ideas. The author also notes focus groups are suitable for participants who are unwilling to be questioned on an individual basis for psychosocial reasons as well as being ideal for those participants who feel they have nothing to share but are able to take part once they get used to group dynamics. This would be important to this thesis as ideas can be developed and discussed leading to more insights that can help answer the research question.

Ward *et al* . (1991) warn that although the findings of focus groups cannot be applied with accuracy to bigger populations they can often give relevant ideas and guides to the research topic. It would be more beneficial in this thesis to use a data collection method that can be applied to bigger populations as the findings could hopefully influence training in laboratories. However I was keen not to rule out focus groups altogether as Gill *et al* . (2008) suggest that while focus groups can be used on its own they can also be used as part of a multi method design or as a method of providing feedback to participants. They also state that focus groups can also be used to assess investigations using other research tools to check their original findings and data. I feel that a focus group may be feasible to use alongside another method.

I also considered interview bias. Gail (2005) states that “Interviewer bias is a type of information bias that arises when an interviewer consciously or unconsciously elicits inaccurate information from study subjects ” (para. 1). Pannucci and Wilkins (2010) suggest that this can be removed or reduced through blinding interviewers. This would be challenging in this thesis as it would mean I would have to get a new interviewer in and not perform the interviews myself. This would also be costly and potentially time consuming.

To investigate the research aims in this thesis semi structured questions may be the best option as it provides some guidance to the participants on what fields need further research in and will allow follow up questions to clarify any relevant issues. A disadvantage of structured questions is that participants may not delve into too much detail whilst In contrast unstructured interviews do not have any prearranged questions and may lack focus on the research structure (Gill *et al*., 2008).

The data collection methods are face to face collection, telephone interviews and digital collection which may be via web survey or email. Participants could potentially come from a range of geographical places which I found appealing. Guion *et al.* (2001) note that good interviewers take on board non-verbal cues which is possible with face to face data collection but this method also has increased costs like possible travel cost as noted by Opdenakker (2006). I found the telephone data collection challenging as if the questions are very descriptive, it would rely on the participants remembering relevant items. An advantage of digital collection is the lack of transcription and data entry, which Lefever *et al* . (2007) state is due to data being input directly online, so there is limited human error in this process and also reduced transcription cost compared to the other methods. Participants also have the freedom to answer questions and reflect in their own time. Due to these advantages I found digital collection the most viable, however this also means that this would be a solo exercise for participants as participants would not be aware of what other participants are saying and would be unable to work off others' ideas. This is the same disadvantage of individual interviews. This means that a lot of data can be accumulated on several different aspects of training which may be relevant to each individual participant but may ultimately lead to difficulties in collating data. In order to combat these disadvantages, I considered using consensus groups.

5.1.1 Consensus groups

There are two main models for getting consensus in groups: The Nominal Group Technique and The Delphi method.

Horton (1980) describes the nominal group technique as a structured group process used to develop ideas in which the members work independently but in each other's presence and details the process as follows. Questions are posed to the group of participants who write down as many feasible answers as possible. The interviewers will ask each participant to state one idea at a time. No group discussion is allowed until this is completed. A written record for each member and the group discussion is helpful to prevent loss of ideas. Participants indicate preference of ideas, rank ideas which may be repeated with discussion and argument. The procedure results each participant ranking their choices to determine the overall group's rating of answers.

The Delphi method is described by Sourani and Sohail (2015) as a structural group communication technique used to affirm consensus among experts. Participants reply in writing to the questions, the responses (statistics and comments) are fed back to participants and they are allowed to change their original responses with a consensus of opinions usually after a few rounds (Kauko & Palmroos, 2014). The Delphi method can therefore be described as "a method based on a multi round survey" with the amount of rounds performed can be "either predetermined or dependent on the criteria of consensus and stability" (Kauko & Palmroos, 2014, p.1). Four rounds of questions are generally anticipated (Hsu & Sandford, 2007). Devised by researchers at the RAND Corporation in the 1950's, this research method was to be used in "policy making, organizational decision making, and to inform direct practices" (Brady , 2015, p. 1).The Delphi method can be done online or via post. Rowe and Wright (1999) describe the classical Delphi method by four major characteristics:

1. Anonymity: This allows greater freedom in expressing opinions with no pressure to conform to other participants. Valid points are based on strength of idea not who has the idea, banishing hierarchy and peer pressure.
2. Iteration: collective participant feedback is given to participants with the freedom to change views if necessary.
3. Controlled feedback: feedback is presented usually quantitatively

4. Statistical aggregation of panel answers: quantitative analysis of data is performed, with the means and medians of the participants' values taken into account.

I believed I could feasibly use both these methods in this thesis so I decided to compare them.

McMillian *et al* (2016) note that NGT are used to find and analyse viewpoints whereas Delphi is used to establish guidelines. The authors note that more experts would be needed to give consensus as creating and developing guidelines would require more elaboration and fine tuning. A Delphi technique is recommended for the development of guidelines as the process involves the experts who will use said guidelines (Murphy *et al.,* 1998). Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) Horton (1980) suggests NGT is a technique involved in creative decision making to achieve an unknown consensus. The formation of ideas is a key element of the NGT suggesting that it is a good fit if ideas need to be generated to solve a problem or answer a question (McMillian *et al* ., 2016). On these definitions, the Delphi method seems like the appropriate method. The research question is to determine the training needs of newly trained biomedical scientists which is more towards developing guidelines rather than idea generation.

There are several other important issues to consider. The NGT has the advantage of each participant being given a chance to speak which is helpful in engaging less vocal members. Everyone speaking one at a time means everyone is heard and is kept on topic. It also has the advantage of not being as much as a time commitment. There is also group discussion in NGT which is not present in the Delphi method (McMillan *et al*., 2016).There is no anonymity in the NGT (McMillan *et al*., 2016). The Delphi method also has several advantages. The Delphi Technique can be conducted online or via email and can therefore be accessed by participants no matter where they are thus eliminating travel time and costs (Mcmillian *et al*., 2016).The NGT would mean travel for the researcher and participants increasing travel time and cost as well as cost of facilities used. The Delphi method has the flexibility of participants answering the questions in their own time unlike the NGT which requires all the participants and researcher having to arrange a convenient time for all the involved parties.

Looking at the above methods I feel the most appropriate method in this case is the Delphi method. This method uses experts and is used to determine consensus. This is helpful to determine what competencies are required by a biomedical scientist and how they are best learnt. Doing this online means that biomedical scientists all over the country can be contacted and transcription costs will be eliminated. It also means that all questions can be answered in the participants' own time. There is however the challenge of maintaining participant retention throughout the process.

5.1.2 The Delphi Method

In order to optimise the Delphi method, I wanted to investigate several aspects. The first was the question type. Delphi purists state that the first round should be unstructured with open questions (Powell, 2003). This allows the participants flexibility to go into as much detail as they wish on the topics and informs the researcher which topics need investigating. The reasoning behind open ended questions is the copious amount of data generated can be whittled down through subsequent rounds to achieve consensus. However other researchers do not have the same opinion. Semi structured questions were used by Soer *et al*. (2008) and structured questions were used by Verhagen *et al*. (1998). Lemmer (1998) states" the use of one panel for each round, or survey, rather than a different panel, or control panels, contributes to subjectivity in the technique" (p. 539) , noting subjectivity leads to the participants working off asked points asked rather than their own personal opinions or questions. The advantage of having more structured questions is that the overall time taken to conduct the Delphi study may be reduced, having got to the heart of the matter more quickly so less rounds are needed. Having broad questions means broad responses which means it may take longer to streamline data and thus the converging of opinions. In this thesis I felt therefore that semi-structured questions would be ideal to focus on training biomedical scientists. Having different panels may be challenging in this thesis as it would require increased numbers of participants which may be difficult to recruit.

Clibbens *et al.* (2012) also state the advantage of pilot studies as it provides guidance and checks comprehension on the first round questions. Piloting the entire study is recommended by the authors not just the first round. They describe the advantages as follows. It serves as trial run to allow the smooth running of the method and to address any procedural issue. It also gives the researcher an idea of consensus ranges, analysis methods and any other aspects that might need further thought. This may not be feasible for this project due to the same reason as above; it would require more participants which may be hard to recruit and it would increase the time span of the study.

The Delphi method relies on purposive or criterion sampling which is a non-probability sampling method (Hasson *et al* ., 2000).This sampling method relies on the researcher choosing the participants by their own judgment. Adler and Ziglio (1996) believe that the participants should have four essential qualities: i) knowledge and experience of the investigative subject ii) participation consent and ability and iii) time availability to take part and, iv) efficient communication skills.

The experts must have accredited academic and professional qualifications to take part in this study as well as capacity and willingness to participate.

There are several things to consider. According to Rowe and Wright (2001) 5 to 20 participants are recommended for a Delphi study. Murphy *et al* . (1998) states that the increased number of expert judges leads to a more definitive collective judgment and increased reliability. They also suggest that less than six participants would lead to decreasing reliability whilst around 12 participants could lead to unpredictable reliability due to possible lack of responses. They also state that: “There is very little actual empirical evidence on the effect of the number of participants on the reliability or validity of consensus processes” (Murphy *et al.*, 1998, p. 37).

I needed to consider how many experts are available who could take part in the study as well as what resources are available. It is important to consider the sample type. It has been noted that heterogeneous groups, experts with widely varying different characteristics and substantially varying viewpoints lead to more high quality and creative decision making procedures than homogeneous groups (Bantel, 1993). It has however also been stated homogeneous groups are used to “define common ground and maximise areas of agreement” whereas a heterogeneous group is to “identify and explore areas of uncertainty” (Murphy *et al.*, 1998, p. iv).

According to Delbeq *et al* . (1975) if participants are the same then a small sample (ten to fifteen participants) may be acceptable. However, they also say that for a heterozygous group consisting of different specialist people then several hundred might be needed as heterozygous groups are also more complex with more factors to consider. Skulmoski *et al* . (2007) suggests that there is more work involved with heterozygous groups, with more challenging data collection, analysis and checking of results as well as difficulties reaching agreement. In this thesis haematology professionals working in both academia and hospital diagnostics were considered.

Akins *et al.* (2005) state that the sample size depends on what is being investigated and how many experts are available with the researchers stating they received reliable findings with their small sample size of 23 participants. The bigger sample, the less scope there is for error and may not represent a larger population. However experts in a field may be limited depending on the field of expertise. Bigger samples however also mean that analysis is more time consuming.

It is hard to estimate how many participants will be needed for this study .Experts could be lecturers or senior scientists.

The Delphi Procedure is as follows:

Round One: Questionnaires are given to the participants via email with a deadline and an aim to return this to the researcher. Analysis of the findings of Round One is done according to a research approach such as qualitative coding. This data is the qualitatively analysed in a content analysis and forms the basis of the second round. Nvivo or any qualitative data analysis software can be used for coding.

Round Two: The findings of Round One are to be scaled down to what the participants deem more relevant in Round two. The researcher may shift the research focus to suit the research aims, or they could be influenced by the viewpoints of the participants (Skulmoski *et al*., 2007) .This depends on the answers received. A second objective is possible ranking and ratings of items mentioned in the previous round. The purpose of the Delphi is to provide collective feedback to the participants and ask if their original answer from the previous round was still satisfactory to them and they have the option to change said opinion.

Round Three: The collective responses of Round Two questions thus inform Round Three questionnaires. The specificity of the questions and the converging of answers should increase with each round. The 3rd questionnaire is distributed like the previous round with all collective participants responses presented with agreement/disagreement /reasons asked for said opinion. The questions should hone in on the specific detail of the research as well as the emerging and collective perspective of the research participants. The endpoint of the procedure is when the consensus or theoretical saturation has been reached (Skulmoski *et al*., 2007).

In order to plan the Delphi method to use it to its optimum use I wanted to consider the advantages and disadvantages. The Delphi method can be time-consuming. This is an issue that has also been noted as the rounds of questions can take days or weeks which makes it very time consuming. Delbeq *et al* . (1975) recommend certain timeframes such as a minimum of 44.5 days to complete the entire process with around 2 weeks for each round. However as I am using the online Delphi method, one of the major advantages is the reduced response time. Cobanoglu *et al* . (2001) and Schaefer and Dillman (1998) found that mail surveys took 14 to 16.5 days whereas email or web surveys took 6 to 9 days suggesting that the latter had a faster turnaround times. However attrition may still be an issue. Scheibe *et al* . (2002) suggest participants care about feedback and are interested in other participants' views. Pill (1971) note that this can be motivating and interesting. Keeney *et al* . (2006) state that it is crucial to have participants interested in the study. I recognise that feedback is therefore crucial to support retention as it is encouraging and persuade participants to keep going. I intend to send the feedback as soon as I can and I will send encouraging reminders to participants who have not completed the questionnaires by the set dates. Keeney e*t al.* (2006) suggest that at least two rounds are necessary, with the number or rounds dependent on time availability as well as whether the initial questionnaire consisted of unstructured questions or not. With the reminders and semi structured questions I am hoping that the rounds will not be numerous and responses will be timely. Fink *et al.* (1984) note the benefit of the Delphi is that it has no geographical limitations which means I can include participants across the country with ease.

An important issue to consider is the technical difficulties. Thompson *et al* .(2003) state participants may have different degrees of computer literacy and access to equipments of varying technological advancement. They also note participants may also answer the same survey several times. This should not be an issue for my participants as programmes can be set up to answer once. They should also have access to computers at work and be fairly computer literate due to their profession. Conboy *et al.* (2001) stated that web based surveys have the benefit of anonymity which encouraged participants to share personal health data which is essential for research in sensitive health issues. I feel that this may be beneficial to this study as participants may be more open with laboratory training issues giving more insights that they may not give with other participants.

Another appealing aspect of the Delphi Method is the lowered cost. Traditional mail surveys are more expensive due to postage costs and stationary meaning email and web surveys are at an advantage financially. Granello and Wheaton (2004) note another financial advantage of email and web surveys: transcription in traditional paper surveys can be costly and tedious. They also noted that while email data still needs to be copied to a relevant database, web based surveys do not require transcription hence phasing out associated errors. This will be helpful to this thesis as there will be a lack of transcription. With advances in technology, researchers also control design which they can make appealing and attractive yet Dillman *et al* . (1998) noted that plainer questionnaires encouraged participants to provide more responses and supported retention during the process. The advantage is it can be more visually appealing than paper surveys. Web surveys also have the advantage of the researcher exercising control over the order in which participants answering the questions unlike paper questionnaires where participants can answer questions in the order that they please (Wyatt, 2000). With the design options, web surveys have the options of ensuring the participants answer all the questions whereas this is not feasible with paper surveys. I felt these ideas were beneficial to this study and in order to peak and maintain interest I intend to make surveys clear and appealing.

5.2 Current Study Method

There were two studies in this thesis: Study One, the Delphi Study with expert scientists to determine the training needs of newly qualified scientists in Haematology and Study Two, the Survey study with newly qualified scientists to determine the training needs of newly qualified scientists in Haematology.

5.2.1 Study 1: Delphi Study with experts scientists to determine the training needs of newly qualified scientists in Haematology

5.2.1.1 Participant selection

Participant selection in the Delphi method as stated before is purposive. In order to strengthen the robustness of this study, inclusion criteria were utilized to identify and invite participants with particularly high knowledge of the relevant issues. Inclusion criteria consisted of experience in training of Band 5 biomedical scientists academically or technically, as well as membership to the HCPC and IBMS. To identify a range of participants meeting these criteria with geographic diversity, I first contacted the IBMS to contact professionals in the relevant discipline in both laboratory and academic settings. These individuals were also asked to nominate other professionals who met the established criteria. Panel diversity was sought in order to capture a range of laboratory training issues across geographic settings. This method identified 20 individuals across Haematology, including Training Officers, Lecturers and Band 6 scientists. All 20 were invited to participate. Study retention fluctuated with an extra participant gained in Round Two and two participants lost in Round Three.

Table 5.2.1.1 (A)

Participant attrition

Delphi Study	Number of participants
Round 1	20
Round 2	21
Round 3	19

Same participants were used for each stage of the Delphi. Bias can be introduced by the participants (Hallowell, 2009).If participants leave early; they introduce their views and do not follow it through. If participants come later then data from the previous rounds are already analysed and they did not take part in that. However there was always a question in each survey for the participants to add whatever they wanted about any issue so atleast they could get their view across.

Table 5.2.1.1 (B)

Participant demographics

Participants	Numbers
IBMS Training Officers	18
Lecturer in Biomedical Sciences	1
Band 6 Biomedical Scientists	1

Despite initial invitations to Liaison officers from the Universities offering IBMS accredited university courses, only one responded. Regions represented by panellists were within the United Kingdom only.

In the initial contact, potential participants were informed that there would be likely three or four rounds of questions. They were also informed that the study was based on their commitment to participating in all the rounds. Participants remained anonymous to one another throughout the study.

5.2.1.2 Materials

A questionnaire of semi structured quantitative and qualitative questions focusing on core competencies, essential qualities, training techniques, the current training situation and the factors affecting training was used (Appendix F).

SurveyMonkey Software which was used for online questionnaires was used in this study.

5.2.1.3 Procedure

Invitations for the study (Appendix C) were advertised via the IBMS website and its journal The Biomedical Scientist. The scientists who responded to the advertisement were all IBMS registered professionals and consisted of 18 Band Seven training officers, one Band Six Specialist Scientist and one Lecturer in Biomedical Sciences. Around 20 participants were aimed to be chosen. Once participants were recruited, an introduction letter and consent forms (Appendix D and Appendix E) were sent out introducing the study. Data was collected via administering questionnaires.

This study involved three rounds of iterative questionnaires distributed online via Survey Monkey. The first round of questions used semi-structured questions consisting of approximately 10 questions (Appendix F).Round 1 consisted of quantitative and qualitative questions. The qualitative questions focused on organizational change to the training in the laboratory, the current laboratory training situation and whether the IBMS degree is sufficient base for new trainees. The qualitative questions were analyzed using a content analysis

The quantitative responses focused on relevant competencies, developing competencies and essential qualities. The data from the Haematology/Coagulation and IT Competencies were compiled together to come up with a comprehensive list of competencies. The second round questionnaire was constructed from the content analysis performed on collated data gathered from the first questionnaire.

In Round 2, participants were give a summary of the results and asked if they agreed with them in respect to 1) Core Competencies, 2) Theoretical Knowledge, 3) Technical Knowledge and 4) Personal Qualities in a yes/no response and if no what they would choose. They were also asked to rank their top ten qualities of a biomedical scientist from 1 to 10.

A question was asked if there were relevant Standard Operating Procedures available. Likert agreement ranges were used with a tick box to tick or not as per participants opinion (Likert, 1932).

On receiving data from questionnaire 2, descriptive data analyses were done so percentages could be fed back to give a more visual presentation to panelists. Responses were given to participants in Round 3 and questions were asked on competency relevance, personal quality development and specialist knowledge development. The third round questionnaire was to invite participants to consider what other participants have said and whether they want to change their mind and put through a new idea or opinion.

Frequent contact, flexibility around closing dates and personalised ‘thank you’ messages were sent in the hope of increasing response rates.

5.2.1.4 Data Analysis

Qualitative responses in the rounds were analyzed using content analysis to identify items. Items were analyzed and grouped according to common themes. Frequency counts were calculated to determine the percentage of panelists responding in agreement or disagreement for quantitative questions. Agreement Levels were also calculated as well as what ranges was deemed “Agreement”, “Neutral” and “Disagreement.” Agreement was deemed 75% and above, Neutral was 25%-75% and disagreement was less than 25%. Results are presented with items in order of popularity and issues of disagreement were reported. For an alternate visual data representation, frequency bar charts are also used with the values corresponding to the number of participants who agreed to the item. Data for the ranking of secondary qualities of biomedical scientists were analysed using measures of central tendency (Mean) to present judgement of participants.

5.2.1.5 User Consultation

A user consultation was not done as the first round of the Delphi Study will be semi structured questions for scientists to lead the discussion on the assessment of the training needs of newly qualified scientists. A user consultation was not required as it will potentially just be an extra round of Delphi questions.

5.2.1.6 Ethical issues

This project required ethical permission from the University of Exeter Psychology Research Ethics Committee. The NHS REC review was not required for this research as research participants will be recruited due to their professional roles as scientists and they will be recruited through the Institute of Biomedical Sciences Institute. GDPR and Data Protection Act 2018) became legal on 25th May 2018 and the University of Exeter brought this into action. Surveymonkey was used for the Delphi method and this was used prior to the implementation of General Data Protection Regulation (GDPR) and Data Protection Act 2018.After the General Data Protection Regulation (GDPR) and Data Protection Act 2018 was implemented Qualtrics was used.

5.2.2. Study 2: Survey study with newly qualified scientists to determine their training needs in Haematology.

5.2.2.1. Participants

The participants were four newly trained Band 5 scientists who have been HCPC-registered in the past 2 years. They are also registered with the IBMS.

5.2.2.2. Materials

The survey used in Study Two was the survey used in the last round of the Delphi Study was used in Study One.

Qualtrics software which is software designed for data collection and analysis was used in this study.

5.2.2.3. Method

Invitations for the study (Appendix H) were advertised via the IBMS website and emails were sent to the participants from the previous study. The scientists asked to take part are IBMS registered and HCPC registered band 5 biomedical scientists. These scientists are fairly newly registered, with the registration age under two years. Around 20 participants were aimed to be chosen, hoping to match the previous analysis. However only four participants were recruited. Once participants were recruited, an introduction letter and consent forms were sent out introducing the study (Appendix I and Appendix J). Data was collected via administering questionnaires. The anonymous survey consisted of questions initially asked via the Internet survey site Qualtrics. The last round of the Delphi study was presented as a single survey to the participants (Appendix K).The questions presented what the experts had agreed on with the option for the trainees to add or/and delete items relating to relevant competencies, training methods ,personal quality identification and development.

5.2.2.4 Data analysis

Frequency counts were calculated to determine the percentage of panelists responding in agreement or disagreement for quantitative questions. Agreement Levels were also calculated as well as what ranges was deemed “Agreement”, “Neutral” and “Disagreement.” Agreement was deemed 75% and above, Neutral was 25%-75% and disagreement was less than 25%. Agreement levels in this study were compared to the agreement levels obtained in the Delphi study. A content analysis was done on the answers to the qualitative questions.

Results were presented with items in order of frequency and issues of disagreement were reported.

5.2.2.5 User Consultation

A user consultation was not done as this survey was used to assess the opinions of the newly qualified scientists against the experts' opinions.

5.2.2.6 Ethical issues

This project required ethical permission from the University of Exeter Psychology Research Ethics Committee. The NHS REC review is not required for this research as research participants will be recruited due to their professional roles as scientists and they were recruited through the Institute of Biomedical Sciences Institute.

Chapter Summary

This chapter displays a critical analysis of methods as well as honing in on the chosen method. The chosen method is described and key features like participants' recruitment and ethical consideration are described.

Chapter Six– Results

This chapter displays the results of the first study, the Delphi study assessing the training needs of newly qualified biomedical scientists. This chapter also shows results of the Survey study targeted at the newly trained band 5s.

6.1 Results of Study One, the Delphi Study with expert scientists to determine the training needs of newly qualified scientists in Haematology

Twenty individuals completed Round One of the Delphi Study and thereby constituted the expert panel for assessing the training needs of newly qualified scientists. Study retention fluctuated with an extra participant gained in Round Two and two participants lost in Round Three. Consensus items were identified for the quantitative questions and a content analysis was done on the qualitative questions. The items between 25%-75% are deemed neutral with items less than 25% were deemed as disagreement. The items that scored more than 75 % are the ones that are the most relevant. This scale is used to distinguish between the levels of consensus among participants. In order to determine the strongest level of consensus these ranges help give e a clear indication of what items the participants agree on the most. Previous Delphi studies have used similar ranges (Nieuwenhuys *et al.,* 2016),(Desnoyer *et al.,* 2017).

6.1.1: Essential Competencies for working the 24hr shifts

The following table shows the pooled competencies chosen by the participants and demonstrates what competencies they deem essential. The competencies involved technical skills with underlying scientific theory, I.T, Quality Control and General laboratory working. While Round Two shows the pooled initial ideas of the participants, Round Three shows the comp

Table 6.1.1:

Essential Competencies for working the 24hr shift

Competency	Percentage Agreement Round 2
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Erythrocyte Sedimentation Rate/Plasma Viscosity	100
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting equipment for Glandular Fever	92.86
Appropriate Film referral when necessary.	92.86
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Anticoagulant monitoring screens including International Normalized Ratio, Anti-Xa assay and New Oral Anticoagulants.	92.86
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for D-Dimer Testing	85.71
Direct Doctors to the appropriate pathway for requesting for specialist tests	85.71

Dealing with outstanding work for all Haematology and Coagulation sections.	85.71
Mandatory training	85.71
Specimen reception-including preparation of all samples for testing	85.71
Use of Quality Management Software System.	85.71
Rapid Diagnostic Tests for Malaria Parasites.	85.71
Making and staining blood films (including Malaria films) manually or via automation	85.71
Recognising a Clinical Emergency and what actions to take.	85.71
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Sickle cell test	85.71
Use of Laboratory Information Management System	85.71
Using and Troubleshooting Interfaces, analyser software and LIMS	85.71
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Full Blood Count	85.71
Blood Film Morphology especially Blasts Haemolysis features, Leukaemia Schistocytes and Positive Malaria Identification	85.71
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Coagulation screen	85.71
Validation and Interpretation of all results	85.71

Use of tracking systems	78.57
Log incidents	78.57
Use of Courier services	78.57
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting equipment for Manual Coagulation	78.57
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Factor assays	71.43
Use of Patient Administration Systems	71.43
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Van Willebrands Screen	57.14
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Glucose -6- Phosphate Dehydrogenase	42.86

Round Three shows the complete agreement of all mentioned competencies.

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%

6.1.2 Training Competencies

The above competencies that the participants deemed essential can all be matched onto the requirements from the various syllabuses (Registration portfolio, NHS Mandatory Training, Specialist IBMS Portfolio and Individual Laboratory Training) that the scientists may come into contact with on appointment to a new position. This does not include any items from the degree syllabus. The Registration portfolio and NHS Mandatory Training are essential but the Specialist IBMS Portfolio is voluntary and not aimed at newly qualified scientists and the Individual Laboratory Training is dependent on each laboratory. However it means that there is potential in the future to use these syllabuses to cover all these competencies to support training for newly qualified scientists.

Table 6.1.2

Matched Training Competencies to Syllabuses

Specialist IBMS Portfolio
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Erythrocyte Sedimentation Rate/Plasma Viscosity
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting equipment for Glandular Fever
Appropriate Film referral when necessary.
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Anticoagulant monitoring screens including International Normalized Ratio, Anti-Xa assay and New Oral Anticoagulants.
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analyse Testing
Rapid Diagnostic Tests for Malaria Parasites.
Making and staining blood films (including Malaria films) manually or via automation
Recognising a Clinical Emergency and what actions to take.
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Sickle cell test
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Full Blood Count
Blood Film Morphology especially Blasts
Haemolysis features, Leukaemia Schistocytes and Positive Malaria Identification
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Coagulation screen
Validation and Interpretation of all results
Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting analysers for Factor assays
Individual Training
Using and Troubleshooting Interfaces, analyser software and LIMS
Dealing with outstanding work for all Haematology and Coagulation sections
Use of tracking systems
Use of Courier services
Use of Patient Administration System
IBMS Registration Portfolio
Direct Doctors to the appropriate pathway for requesting for specialist tests
Specimen reception-including preparation of all samples for testing
Use of Quality Management Software System.
Use of Laboratory Information Management System
Log incidents
NHS Training
Mandatory training

6.1.3 Training Techniques

The following table and figure demonstrate the training techniques recommended by the participants as well as what the consensus is for the most popular training methods for technical knowledge. The techniques with the strongest consensus are techniques that suggest one on one learning with experienced scientists, reviewing case studies and a structured laboratory programme. The techniques with the strongest dissent are mostly group based activities. The techniques that were considered neutral mostly involve the student taking in information in a less active way such as reading, listening and observing.

Table 6.1.3

Training Techniques

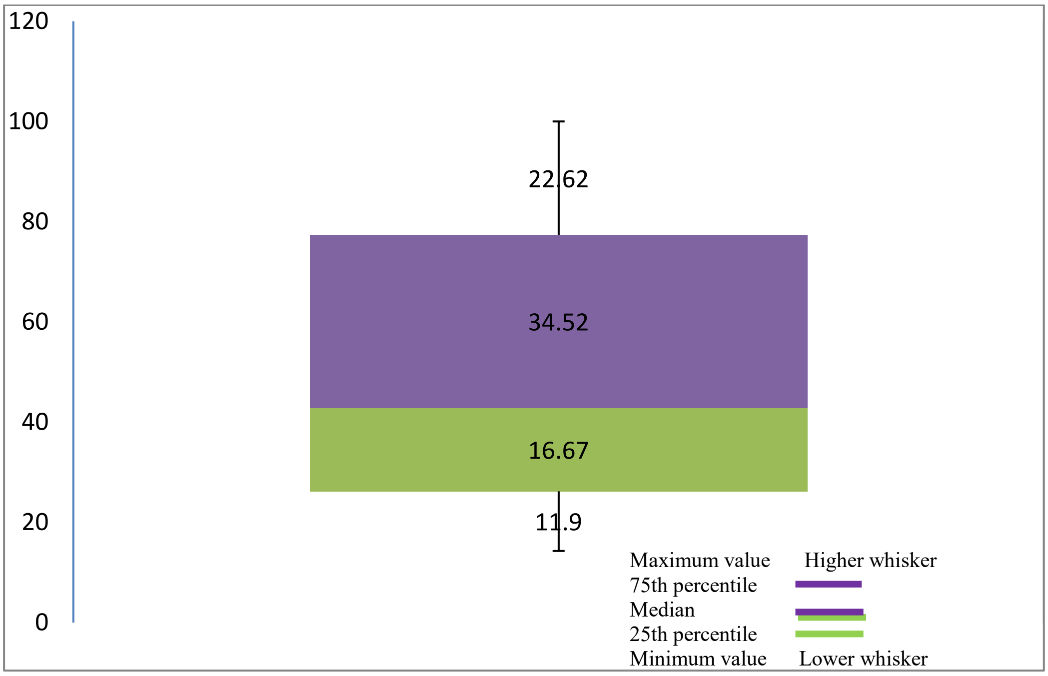
Training Technique	Percentage Agreement Round 2
Shadowing Experienced Scientist prior to lone working.	100
Case studies-EQA, Internal and those which give equivocal results.	90.48
Digital Morphology Scheme or Lab own morphology training scheme	85.71
Mentor system: 1-1 meetings, review training at regular intervals.	85.71
Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test	80.95
In-House Structured training programme	76.19
Self directed learning/Ownership of own development	71.43
Read SOP watch/observe, write, do, and review	52.38
Specialist IBMS portfolio	47.62
Observation	42.86
Training opportunities from NEQAS and Haematology/Coagulation Automation Companies.	42.86
Tutorials	42.86
Team input-Info/knowledge from Managers and Consultants as well as Heads of department.	38.1
Lectures in relevant topics	33.33
Use of Training folder	28.57
Working FlowCharts to enable staff to look up necessary information	19.05
Workshops	19.05
Examination Audits	14.29
Placements	14.29
Seminars	14.29

Agreement ≥75%, No Consensus: 25%-75% ,and Disagreement ≤ 25%

Note: participants did not request any further changes after Round 2

Figure 6.1.3

Box and whisker plot for technical training



6.1.4 Teaching Theoretical knowledge

The following table and figure demonstrate the training techniques recommended by the participants as well as what the consensus is for the most popular training methods for passing on theoretical knowledge. This table has only competencies which are classified under either agreement or disagreement. The agreement of which training techniques is better for teaching theoretical knowledge are similar to teaching technical skill and involve one to one working with an experienced scientist, assessing knowledge and going through case studies.

Table 6.1.4

Teaching Theoretical knowledge

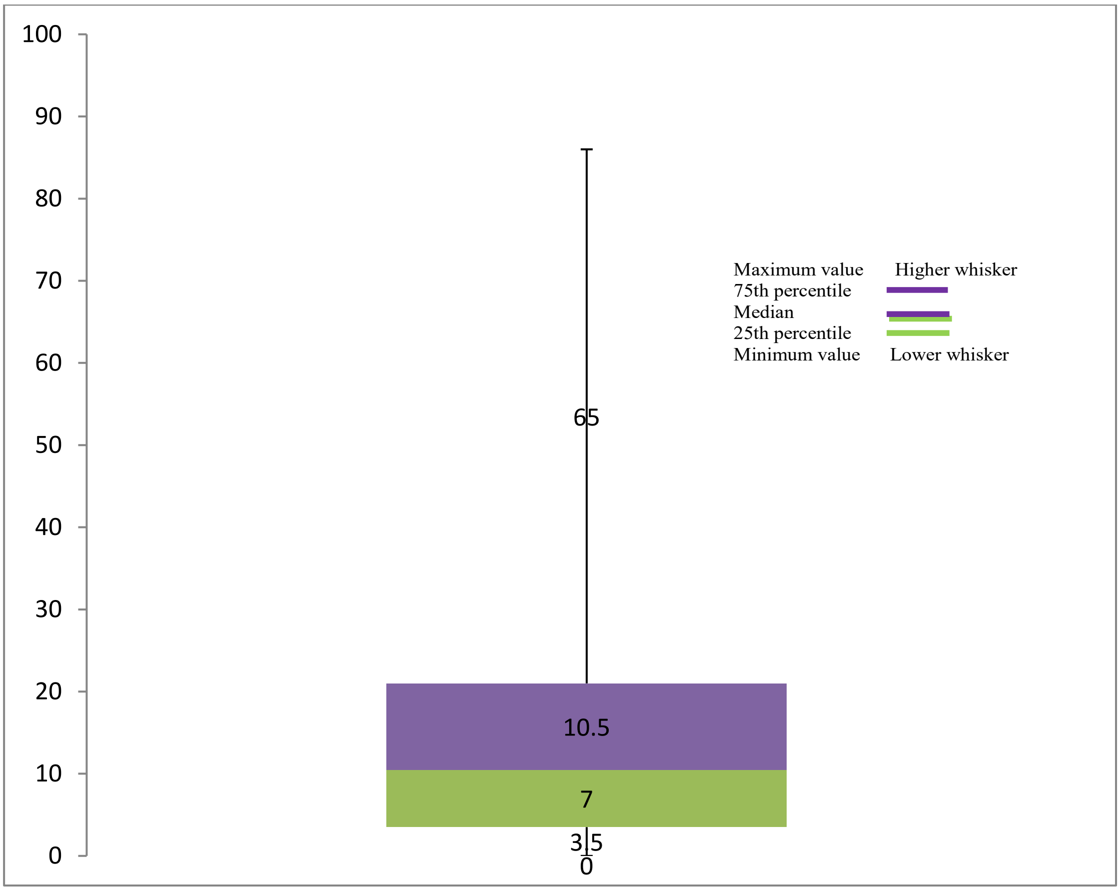
Teaching Specialist Knowledge	Percentage Agreement Round 2
Case studies-EQA, Internal and those which give equivocal results.	86
Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test	82.5
Shadowing Experienced Scientist prior to lone working.	79
Mentor system: 1-1 meetings, review training at regular intervals.	79
Digital Morphology Scheme or Lab own morphology training scheme	75.5
Tutorials	21
Specialist IBMS portfolio	17.5
Seminars	17.5
Training opportunities from NEQAS and Haematology/Coagulation Automation Companies.	14
Lectures in relevant topics	10.5
Use of Training folder	10.5
In-House Structured training programme	7
Read SOP watch/observe, write, do, and review	7
Observation	7
Self directed learning/Ownership of own development	3.5
Working FlowCharts to enable staff to look up necessary information	3.5
Placements	3.5
Examination Audits	3.5
Team input-Info/knowledge from Managers and Consultants as well as Heads of department.	0
Workshops	0
Witness statements	0

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

Note: participants did not request any further changes after Round 2

Figure 6.1.4

Box and whisker plot for Specialist Knowledge Training



6.1.5 Essential qualities for Biomedical Scientists

The following table demonstrate the qualities recommended by the participants as well as what the consensus is for the most popular qualities deemed essential for a biomedical scientist. The qualities that have strongest consensus are qualities that focus on organization, working efficiently under pressure and competent lone working. The qualities that are classified as being in disagreement are personable qualities whereas the qualities in the neutral range are quite mixed such as being a team player, thinking of the patient and attention to detail.

Table 6.1.5

Essential qualities for Biomedical Scientists

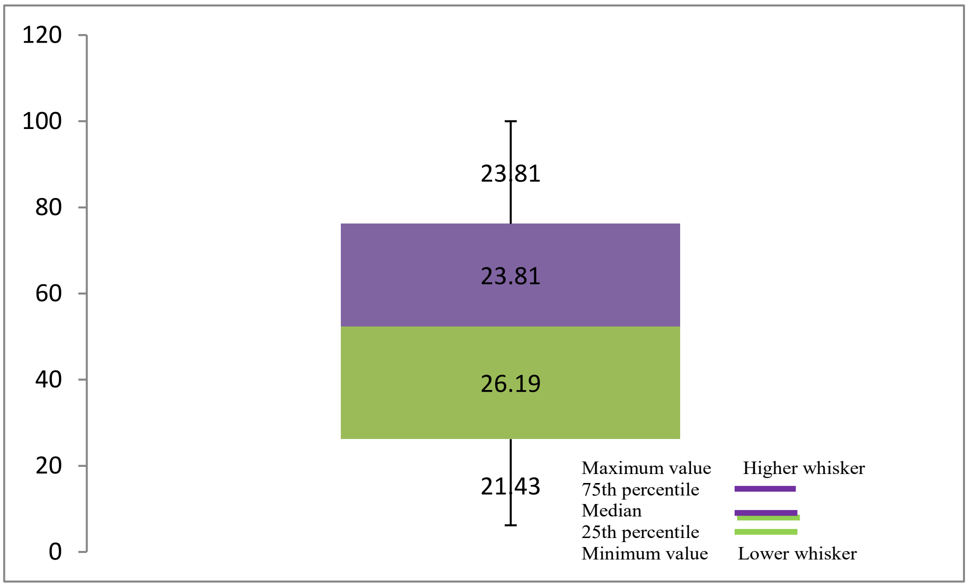
Qualities	Percentage Agreement Round 2
Work under pressure	100
Time management	100
Communication	95
Good problem solving skills	90.1
Work on own initiative	80.95
Ability to know where personal knowledge and experience is exceeded and what to do	76.19
Ability to work alone	76.19
Able to multi-task	76.19
Organisation skills	71.43
Professional	61.9
Knowledge of scientific language for conversations with medical staff	57.14
Attention to detail	52.38
Confidence in own abilities	47.62
Patient conscious	47.62
Team Worker	47.62
Efficiency	47.62
Cope with a lack of sleep	28.57
Approachable	23.81
Flexibility	23.81
Good understanding of hospital policies	23.81
Patience	19.05
Polite	4.76
Firm	4.76

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

Note: participants did not request any further changes after Round 2

Figure 6.1.5

Box and Whisker plot showing essential qualities for biomedical scientists



6.1.6 Essential Secondary qualities for Biomedical Scientists

The following table demonstrates the consensus for the most popular secondary qualities deemed essential for a biomedical scientist. There was strong consensus for the following qualities: Work under pressure, Time management Communication. This table ranks the remaining qualities on a scale of one to ten.

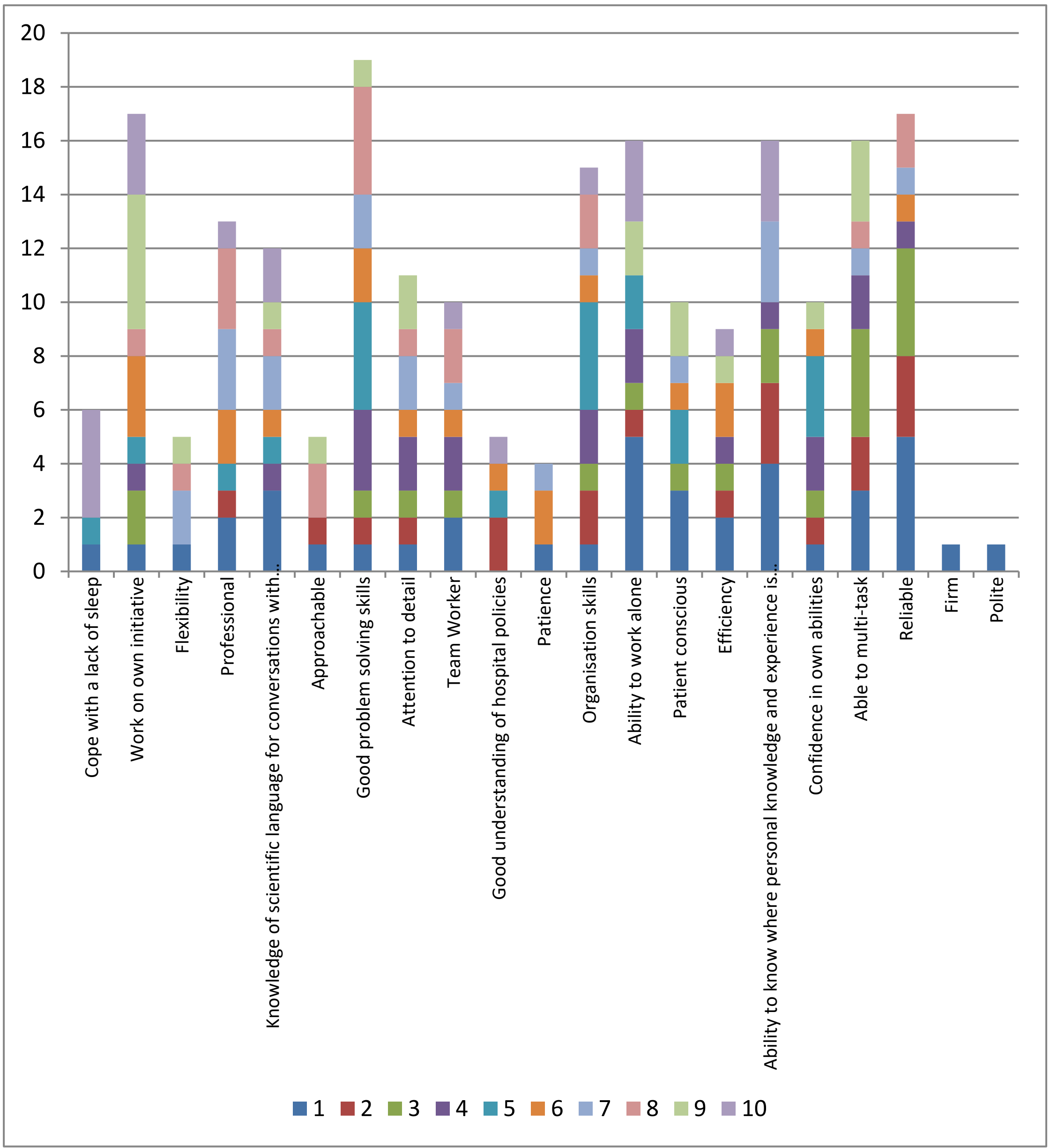
Table 6.1.6

Essential Secondary qualities for Biomedical Scientists

Essential Secondary qualities	1	2	3	4	5	6	7	8	9	10	Mean
Cope with a lack of sleep	1	0	0	0	1	0	0	0	0	4	7.67
Work on own initiative	1	0	2	1	1	3	0	1	5	3	6.88
Flexibility	1	0	0	0	0	0	2	1	1	0	6.4
Professional	2	1	0	0	1	2	3	3	0	1	5.85
Knowledge of scientific language for conversations with medical staff	3	0	0	1	1	1	2	1	1	2	5.75
Approachable	1	1	0	0	0	0	0	2	1	0	5.6
Good problem solving skills	1	1	1	3	4	2	2	4	1	0	5.53
Attention to detail	1	1	1	2	0	1	2	1	2	0	5.45
Team Worker	2	0	1	2	0	1	1	2	0	1	5.2
Good understanding of hospital policies	0	2	0	0	1	1	0	0	0	1	5
Patience	1	0	0	0	0	2	1	0	0	0	5
Organisation skills	1	2	1	2	4	1	1	2	0	1	5
Ability to work alone	5	1	1	2	2	0	0	0	2	3	4.75
Patient conscious	3	0	1	0	2	1	1	0	2	0	4.7
Efficiency	2	1	1	1	0	2	0	0	1	1	4.67
Ability to know where personal knowledge and experience is exceeded and what to do	4	3	2	1	0	0	3	0	0	3	4.44
Confidence in own abilities	1	1	1	2	3	1	0	0	1	0	4.4
Able to multi-task	3	2	4	2	0	0	1	1	3	0	4.31
Reliable	5	3	4	1	0	1	1	2	0	0	3.29
Firm	1	0	0	0	0	0	0	0	0	0	1
Polite	1	0	0	0	0	0	0	0	0	0	1

Figure 6.1.6

Stacked column chart for the ranking(1-10) of secondary qualities for biomedical scientists



6.1.7 Development of qualities

The following table and figure demonstrate the techniques for development of qualities recommended by the participants as well as what the consensus is for the most popular techniques. The development methods with the strongest agreement were through actively working as well as being guided by experienced scientists. The techniques with the most dissent were those that might be challenging to implement in laboratory working like courses and workshops due to time away from laboratory, as well as the requirement of extra finances and more resources like staff and course materials. Most of the neutral techniques focus on assessment rather than development.

Table 6.1.7

Development of qualities for biomedical scientists

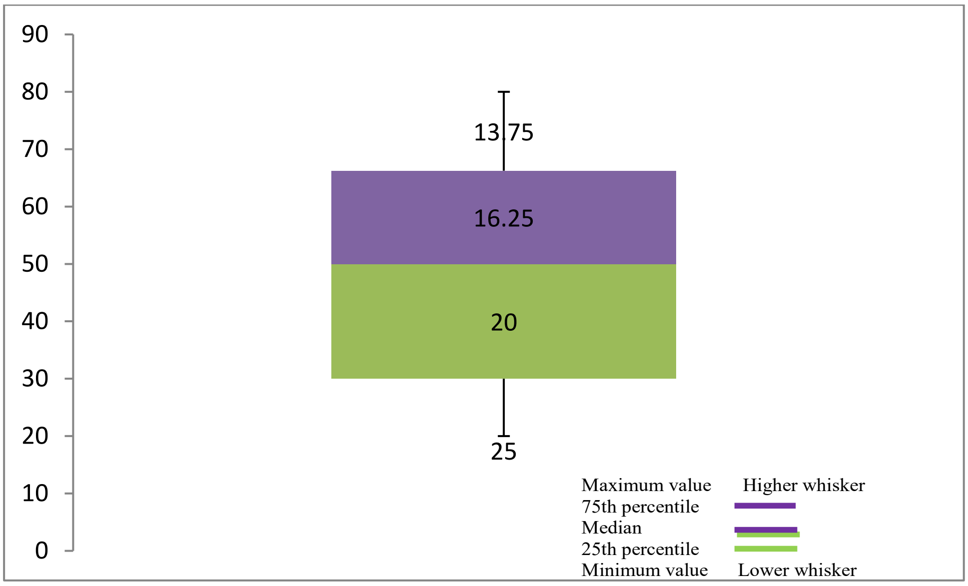
Quality development	Percentage Agreement Round 2
Shadowing an experienced scientist	80
Experience, Everyday working	75
Mentoring-one to one training, coaching	70
Assessments testing real-life knowledge in a time limited scenario	55
Personal reflection	50
Incorporated in Laboratory training.	50
After shadowing a scientist on a weekend shift, trainee BMS is left alone in the laboratory with trainer BMS out of lab but nearby enough for trainer to come in if needed. The trainee BMS is also shadowed by a trainer BMS on the first night shift. Meetings to ensure trainee BMS is confident after these scenarios to work alone.	45
Daily tick-sheet for completing specific tasks in specific times.	25
Training Courses	20
Workshops/role playing that mimics real life scenarios	5

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

Note: participants did not request any further changes after Round 2

Figure 6.1.7

Box and Whisker plot for quality development for biomedical scientists



6.1.8 Current Training in laboratory

There are several main themes that have come up in the responses of the participants: the high level of training required for newly qualified scientists, short staffed situations, specific characteristics of laboratories, the relevance of a well structured training programme and variance of adequacy levels of new scientists.

Participants noted the variance of adequacy levels of the new scientists.

It is adequate but there is room for improvement in some areas.

Adequate for absolute basics

Barely adequate

Good

The variance of adequacy suggests that training is not consistent across different hospitals. Twenty-five percent of participants acknowledged an inadequate level of technique skill and knowledge for trainees suggesting a high level of training.

As this newly qualified BMS has had no experience in Haematology, no experience with operating the analysers and has little to no knowledge in relation to Haematology, therefore is starting back to basics

The knowledge they have is very broad and so a lot of basic theory is needed before they can proceed confidently in some of the tasks ie. validation of results, requesting further tests, knowing the urgency and interpreting clinically significant results

Once a scientist is deemed competent, they are assessed by a competent person. This is a formal documentation procedure in which the assessor and trainee acknowledge that the trainee is competent to perform the task. Training competencies are inspected by UKAS as part of their quality assurance policies. Competencies usually assess knowledge and skill of the scientist performing the diagnostic techniques used in the laboratory. All scientists must be formally deemed competent before they perform tests unsupervised.

The participants had noted that the trainees have to be retrained in theoretical knowledge with one participant pointing out the practical side of laboratory work such as "*validation of results, requesting further tests, knowing the urgency and interpreting clinically significant results.* " Another participant pointed out that knowledge should "*involve classroom activity to give information needed as well as to train to run analysers and kit.*"

The participants infer that there are different aspects of the knowledge of a biomedical scientist: theoretical and technical. The theoretical side is the scientific knowledge including haematology diagnosis, disease and treatment and the technical knowledge includes using kits, analysers and tools. The participants' views reflect the content of the Specialist IBMS Portfolio which has knowledge and competence sections.

Twenty percent of participants noted the importance of standardized training programmes.

One participant has stated that there is a programme in their laboratory already: *HCPC scientists follow a structured training programme within the Haematology lab. This covers routine Haematology and Coagulation and some areas of specialised Haematology and Coagulation. More specialised areas are not included in the initial training but are covered at a later date. The scientists perform tasks under supervision until deemed competent to perform unsupervised. Examination audits are performed to assist with the assessment of competency. For morphology, a 6 week training programme is followed covering all aspects of morphology and blood parasites.*

A well rounded training programme would be one aspect of strong preparation that would enable newly qualified scientist to go on the shifts.

Another participant noted that *the specialist portfolio does help to give some sort of standardisation.* The specialist portfolio is as mentioned as a well structured programme which covers all the aspects needed to work on shifts. However there are also extra topics, taking on board specialist tests which in this time may be done at another more convenient time if it is not required urgently by the hospital. The training situation in the laboratories seemed to be a struggle bearing in mind the level of training required for new scientists and the added pressure of laboratories being short-staffed. However there are positive aspects including some staff being committed to training as well as the laboratory possessing a good well structured training programme.

Twenty-five percent of participants believed that the laboratories were short staffed, citing reasons of lower numbers of qualified staff, due to staff turnover as well as the latter covering the 24hour shift leaving few qualified scientists to train.

One participant noted that training is sufficient if there is enough time and staffing to do this.

Current training in the laboratory is adequate for new HCPC scientists if there is sufficient time and staffing to allow for this. Proper, good quality training takes a lot of time and can be labour intensive if done properly.

The issue of short staffed was also brought up by other participants.

Training programmes are in place as part of the IBMS requirement for training laboratories but due to lack of experienced staff laboratories are recruiting very little newly qualified staff as they are unable to give them training.

One participant noted that *the Universities are not really appropriate for post registration training where theory has to grow into expert practice. The lab is the right place; however there is a major problem, staffing levels in many lab are simply not at a sufficient level to training new staff.*

The meaning of short staffed was not defined by the participants. The definition could refer to vacancies not being filled, the business plan being understaffed or the participants' perceptions of not having enough staff to support the workload.

Fifteen percent of participants stated that training is affected by various laboratory characteristics like laboratory culture and commitment to training. One participant noted a number of factors that affect current training.

Depends on where you are located and what type of access the trainees/members of staff have i.e. the bigger the lab and the more tests you are exposed to, sometimes is better due to an increased ability to absorb information and experience a more diverse diagnostic and monitoring situation.

As mentioned in the introduction hub and spoke models are one of the reorganization models of the NHS. This may put newly qualified scientists if they are based at a spoke at a disadvantage, as the hub has a bigger repertoire of tests and hence more learning opportunities. However guidance documentation for spoke sites (NHS Improvement, 2018) noted that the spoke staff should be rotated to hubs to continue learning opportunities. Hub staffs are also exposed to more clinical dilemmas, abnormal results and troubleshooting issues. This may be difficult to do in the short staffed situations. The qualified scientists may want to take the lead to find a solution more rapidly and not explain to the newly qualified scientists what they are doing. The spoke staff however may have the advantage that as they have fewer tests so scientist can be rotated quicker and learn faster. Spoke sites may also be less busy than a hub giving it a less stressful environment and may be more suitable for learning.

Laboratory culture seems to play a big part in training. One participant noted that *an enthusiastic training officer and colleagues who had a significant amount of experience to guide and train you to become competent for the variety of assays we tested.* As well as more senior staff members, the participant stated *More experienced band 5 colleagues were* *mainly in charge of laboratory training and I found this beneficial as they had previously experienced the same worries and problems, and usually know how to troubleshoot more complex issues with IT and analysers, including the potential limitations of some assays that the trainee may come across.*

This is very interesting as it seems that training is a group effort by the laboratory rather than one person like the training officer. One participant stated *I think it requires a strong commitment from the department that training will remain a priority.*

This matches what the previous participant mentioned as it seems that commitment was definitely prevalent in their laboratory if several members participated in training. It is interesting to note that the band 5s were in charge of training. This would mean that their training would definitely be more current. However there is a downside to this. This is only a successful way of training if the band 5's has been thoroughly trained; otherwise this is just a case of passing on poor training. A commitment to training would mean that training would be a priority and would not be brushed aside in stressful situations. In challenging times it may be difficult to train new scientists as experienced scientists are working out of hours and carrying the responsibility of the workload. The impact of possible stress on the experienced scientist running the laboratory whilst training new scientists should be acknowledged and might create a tense atmosphere which is not fair on either member and may dent the confidence of the trainee.

As well as the willingness to train, the experiences of staff also play a role in training newly qualified scientists with one participant stating: *We have a variety of experienced members of staff that have gained experience from all over the world (including areas in Africa, Canada and the Caribbean) which is especially useful for trainees when we come across examples of haemoglobinopathies, examining blood films for morphology and parasites. We also have a number of staff from different background disciplines such as microbiology, histology and immunology (our laboratory only has 3 – haematology, blood* *transfusion and biochemistry; histopathology is run from our sister site). This allows staff to understand and train with a multidisciplinary approach using experiences from many different areas, which is sometimes rare in larger laboratories particularly where staff have been there for a number of years and only been trained in one discipline.*

Scientists who work in laboratories which get samples from areas with certain demographics may be more knowledgeable and experienced in their diagnostics. Also population demographics in parts of the UK vary which mean that hospitals placed in these areas would receive a bigger workload for certain tests which may enable new scientists to gain more experience in these cases. One participant noted as well that the multidisciplinary background is an advantage which may prove as a learning opportunity but in this study focusing on Haematology may not be relevant. However as noted in the Carter report, multidisciplinary training is to happen in Clinical Blood Sciences (Haematology, Biochemistry and Blood Transfusion) so staff who have similar backgrounds might be at a huge advantage in providing a service and hence train quicker.

6.1.9 The effect of NHS Organisation on training

There are three main themes that have come up in the responses of the participants: negative impact of reorganisation, inadequate staff numbers and a rush to get newly qualified scientists on the 24 hr rota.

Reorganization has been a major theme in the effect of NHS organization.

Pressure on staffing, both in numbers and work allocation has influenced training. Also, the merging / collaboration of laboratories will affect training. This may be positive in that trainees have greater access to other laboratories with a bigger reportoire of tests and specialist staff who could carry out more training. Or it may be negative, in that there may be a 'factory' environment with little opportunity to develop further skills and experience.

Participants noted the factory-like nature of the hub and spoke models and the shift of staff to other sites to complete training. They also noted the high staff turnover and increasing workload. They were also aware of the shorter time trainees took to work unsupervised as well as vacancy gaps being filled by qualified staff as there was no time to train. As well as newly qualified scientists not getting adequate training, this participant stated that:

There is a huge recruitment and retention problem within pathology and therefore for this reason organisations are focused on getting these gaps covered with qualified experienced staff rather than new qualified staff that will require training. Currently organisations cannot physically provide training due to this pressure.

This means that newly qualified scientists are not appealable to laboratories furthering the gap between their qualification date and starting their professional career as a HCPC registered scientist. This might decrease the new scientist's familiarity due to lack of routine of techniques and knowledge.

Many participants noted that staff numbers and skill mix were not compatible with the increasing workload as well of the nature of the work.

I think the AFC has a huge impact due to which now are leaving the profession and moving to private sector or industry.

A generational gap has meant that the majority of laboratory scientists with lots of experience have retired leaving a training vacuum

Fewer staff available to do training or cover while training is given

They also noted the staff turnover due to retirement and the impact of Agenda for Change. Participants noted the lack of staff available to train as they were on the shift system and there was no one to train or cover the shift whilst training. They also noted that whilst training the trainee was not a qualified person, therefore giving a false idea of how many staff of certain grades there were. During assessment of how many staff is required to run a shift and train it is essential to take into consideration the skill mix and who is training and who is doing the training as well as how long it will take trainees to get up to speed. This will give a more accurate data that can support training.

A rush to get on the 24 hour rota was noted as well as a strain on those training and those delivering it. Due to staff shortages, there has been a rush to be put on the shift, yet the quality of training has gone down. It would be harder to train once the trainee is doing out of hours shifts.

Agenda for change and pathology modernisation as seen lower pat for out of hours sessions and great responsibility for those being trained and those delivering training. Meetings occur to comply with ISO15189 that training is reviewed but I am not sure the overall quality has improved.

The overall organisational change in the NHS has affected training in that there is more of a rush to get BMS staff once trained onto the out of hours rota as these staff are usually on the new 24/7 contract and hence when working in these out of hours shifts are cheaper for the department and thus more cost-effective for the department's budget in comparison to the established BMS staff that are on the older contracts.

A positive aspect was that being alone on a shift developed confidence in scientists as they had no one to turn to. However this same situation of having no one to turn to could leave trainee scientist feeling stressed.

Regarding the current training status of the laboratory and the effect of NHS organization 90% of participants have something challenging to mention.

6.1.10 How the accredited IBMS degree supports the profession

The themes the participants have discussed are the relevance of the accredited IBMS degree and placement year.

A newly qualified scientist would have two IBMS accredited items which would be the Accredited IBMS degree/ an HCPC approved honours degree in biomedical science and a successfully completed IBMS Registration Training Portfolio. Between these two accredited pieces of intensive work, it is believed that a scientist can work as a HCPC scientist. The findings suggest that there might be a lack of theoretical and technical knowledge or a lack of delivery of this knowledge during the IBMS accredited degrees and the registration portfolios.

Or is it that the technical training received is not sufficient for scientists to work efficiently? One participant stated *"The whole training schedule is aimed at trainees passing a general portfolio. Any haematology training is a by-product of fulfilling module not the aim"* If this is the case then any training received will not be sufficient as it will be a series of exercises tailored to pass the portfolio rather than a full rounded training program in Haematology. These participants did not state whether the trainees had done a generic portfolio in Haematology. Two participants noted the relevance of doing the same discipline portfolio. The first noted that trainees not trained in the field have a lot more to learn: *It takes these BMS's a lot longer to get settled into the laboratory and to get underway with the specialist portfolio in Haematology as they have a wider gap to fill in compared to those BMS's that have completed their pre-registration portfolio in Haematology.* He also noted that *As this newly qualified BMS has had no experience in Haematology, no experience with operating the analysers and has little to no knowledge in relation to Haematology, therefore is starting back to basics.*

The other participant in this school of thought states training is *Adequate if trained in Haem for registration. Basic trained for registration in alternate discipline. Usually inadequate from sandwich placement students.*

However another participant noted *Yes, i think the IBMS degree is adequate to support the profession. The degree allows the PTP students to be actively trained in the lab whilst* *following the portfolio. This allows them to gain evidence and experience whilst working to HCPC standards. I cannot say in any way how the IBMS degree does not support the profession.*

Sandwich placement students would realistically not be trained in each discipline in a year yet it might be feasible if they were in one discipline for one year. The participant noted that trainees from alternate disciplines have basic training. This would make sense as the portfolio is generic, covering basic knowledge about confidentiality, health and safety and quality control and is not discipline specific.

There is also the argument that even if technical and theoretical knowledge is included, how much is retained and used appropriately depends on the aptitude of the trainee.

High level of training required suggests that trainees are lacking. This ultimately goes back to the degree and the registration portfolio. Assuming the trainee has had no other experience in the laboratory as a Medical Laboratory Assistant or Advanced Practioner, the degree and the registration portfolio should be sufficient to be a competent scientist. Irrespective of if the scientist has completed their registration portfolio in a different discipline, their undergraduate degree would still have an aspect of Haematology as acknowledged in the introduction. However how are these delivered and in how much detail is up to the university.

I don't feel that the Biomedical Science degree is enough to support the profession. Newly qualified staff members are coming in to out lab Haem/BT with very little knowledge of the subjects which makes training challenging with the staff mix that we have and the time that we really need to dedicate to get them up to speed on the theoretical side of things.

The degree needs to be more tailored towards HCPC standards of proficiency/ IBMS registration portfolio standards. This would free time for employers to provide more at the bench training.

Unless it is the Co-terminus/ integrated degree, the other degree routes provide a knowledgeable candidate but one without much application.

There is clearly an issue with knowledge and skills learnt and not being translated to working practice, if these knowledge and skills are available in the first instance.

6.2 Study 2, the Survey study with newly qualified scientists to determine the training needs of newly qualified scientists in Haematology.

This section displays the findings of the viewpoints of the newly qualified biomedical scientists regarding their training needs. The last questionnaire of the Delphi Round was used and four participants took part.

6.2.1 Unnecessary Competencies

This table demonstrates the competencies that the expert scientists have chosen as essential but the newly qualified scientists deemed unnecessary. They are all in the disagreement range and concern morphology.

Table 6.2.1

Unnecessary competencies chosen by Band 5s

Unnecessary Competency	Agreement Level
Blood Film Morphology especially Blasts, Haemolysis features, Leukaemia, Schistocytes and Positive Malaria Identification	25%
Appropriate Film referral to Haematology Consultants	25%

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

6.2.2 Added Competencies

The below table demonstrates what competencies the newly qualified scientists feel should be added to the list of essential competencies chosen by the experts. These were all in the disagreement range. The only one that is not associated with any of the others are bone marrow staining. There are also competencies chosen for attending clinics which is not always appropriate due to patient contact.

Table 6.2.2

Added competencies chosen by Band 5s

Added Competency	Agreement Level %
Pathology error reporting and CA/PA (corrective and preventive action) awareness	25
Requirement and how to perform a Citrate Platelet Count. And under what circumstances would this be requested. How to communicate the results for this?	25
How the results for all tests are communicated in laboratory reports and via the telephone (which you provide as essential)	25
Allow for shadowing to monitor the authorisation of results for Haematology Ward patients.	25
Perls' iron stain for bone marrow samples.	25
To be given the opportunity to attend clinic when a patient is having an trephine biopsy or a bone marrow aspirate.	25
How to maintain slide staining analysers and how to do it manually if analysers fail to work	25

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

6.2.3 Training methods

The most effective ways of training as determined by the experts in the Delphi Method are

- Shadowing Experienced Scientist prior to lone working.
- Case studies-EQA, Internal and those which give equivocal results.
- Mentor system: 1-1 meetings, review training at regular intervals.
- Digital Morphology Scheme or Lab own morphology training scheme
- Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test.

There was 100% Agreement level from the Band 5 participants on what the experts had chosen.

6.2.4 Alternate Training methods

These were the other training methods that the newly qualified scientists felt should be added to what the experts had chosen. All the methods were in the disagreement range and involved a variety of methods like structured training programmes, external training, SOP learning and seminars.

Table 6.2.4

Alternate training methods for technical skills chosen by Band 5s

Training Technique	Agreement Level %
Specialist Portfolio Questionnaire	25
Seminars	25
Training Opportunities from NEQAS and Haematology/Coagulation Automation Companies	25
In--House Structured training programme	25
Read SOP watch/observe, write,, do, and review	25

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

6.2.5 Teaching Specialised Knowledge

These were the other training methods that the newly qualified scientists felt should be added for teaching specialist knowledge.

There was 100% Agreement level from the Band 5 participants on what the experts had chosen.

6.2.6 Essential Qualities

The following table demonstrates which qualities are deemed essential for biomedical scientists by the newly qualified scientists. The only quality the participants agree on is essential is attention to detail. The qualities that the participants chose that are classified as being in disagreement are qualities that might rely on having a senior scientist as a guide. Planning and thinking on your feet are qualities that are considered as neutral.

Table 6.2.6

Alternate qualities chosen by newly qualified scientists

Quality	Agreement Level %
Attention to detail	75
Able to multi-task	50
Good problem solving skills	50
Ability to know where personal knowledge and experience is exceeded and what to do	25
Patience	25
Ability to correctly learn and follow standard operating procedures	25

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%.

6.2.7 Quality Development

The following table demonstrates training methods that the newly qualified biomedical scientists deem important for developing qualities .The three quality development methods that were the most popular match what the experts chose. The development methods that were considered neutral were mixed such as reflection and training courses whilst the only element that caused disagreement was a protocol on how to prepare a new scientist for lone working.

Table 6.2.7

Alternate training methods for developing qualities chosen by newly qualified biomedical scientists

Quality Development	Agreement Level %
Experience, Everyday working	75
Mentoring	75
Shadowing an experienced scientist	75
Assessments testing real-life knowledge in a time limited scenario	50
Personal reflection	50
Training Courses	50
Incorporated in Laboratory training.	50
After shadowing a scientist on a weekend shift, trainee BMS is left alone in the laboratory with trainer BMS out of lab but nearby enough for trainer to come in if needed. The trainee BMS is also shadowed by a trainer BMS on the first night shift. Meetings to ensure trainee BMS is confident after these scenarios to work alone.	25

Agreement ≥75%, No Consensus: 25%-75%, and Disagreement ≤ 25%

Chapter Seven– Discussion

7.1 Discussion Summary

The aim of this project is to assess the training of newly qualified biomedical scientists in Haematology laboratories by involving expert biomedical scientists and newly qualified scientists. This study involves assessing the current training situation including the effect of NHS organization. The latter refers to a lack of qualified staff available to train as well as supporting the 24hr shifts. Also mentioned was the deficiency of specialist knowledge and technical skill of the trainees which hinders training. As well as identifying essential competencies required by scientists on the 24hr shift, the training techniques for passing on technical and specialist scientific knowledge were identified as shadowing, mentoring, case studies, competency assessment and the specialised morphology training. The identification of personal qualities were stated as communication, working under pressure and time management while the development techniques were noted as mentoring, experience and shadowing an experienced scientist.

7.2 Current Training Situation and NHS Organization

In this discussion I will first explore the current training situation in the laboratory, the causes of the issues as well as what needs to be considered or done to improve the issues according to the expert biomedical scientists. As a lot of these issues overlap they will be discussed together.

Four main themes were identified in the responses of the expert biomedical scientists on the current training situation involving the level of training needed, the need of a well-structured training programme, short staffed laboratories and certain laboratory characteristics like staff demographics and laboratory culture.

7.3 Short staffed situation

Expert practice takes time to develop and if there are fewer scientists to help train and run the service it could be that training is rushed. As there is a large technical side to being a biomedical scientist, the laboratory rather than university, would realistically be the best place to train. The laboratory however seems to lack staff to train. Short staffed situations are not as simple as not having enough staff. It also means a lack of qualified staff and an inefficient skill mix. Staff can be trained in some areas and not others. Staff who can perform certain tasks may train others to do so but this means that they are training others and not getting trained themselves in other areas to increase their skill set. Eventually all staff might have the same deficient in training unless a trained scientist invests the time to teach them. Biomedical scientists have their roles clearly defined. As well as running a shift they must train. It is important as well to acknowledge the time and resources it takes to bring a new scientist to a level where they are competent and confident. A fully qualified scientist running the shift and expected to train at the same time is stressful on the trainer and may be insufficient for trainees. Majeed *et al* . (2018) suggest that the short staffed situation means that hospitals must use staff appropriately to do tasks within their field and not extra work like administrative work to conserve time and effort into their own responsibilities. With respect to this thesis, there must be a clear distinction between the responsibility to train and the responsibility to provide a service. Training and working a shift are therefore two separate roles and sufficient staff, time and resources should be allocated to each. Initially, trainees must be brought up to a skill level where they understand what they are doing and can perform at least several tasks before they work with qualified staff members on a shift to enable fair teamwork and high quality of care.

The situation that the expert biomedical scientists describe is not in accordance with the HCPC practice based learning recommendations (Health and Care Professions Council, 2017) that there should be an “adequate number of appropriately qualified and experienced staff involved in practice-based learning” (p. 8) and “Practice educators must have relevant knowledge, skills and experience to support safe and effective learning and, unless other arrangements are appropriate, must be on the relevant part of the Register ” (p. 8).

The IBMS also has training standards (IBMS, 2018a) that state “*Staff facilities should be adequate to support the appropriate level of training. Staff should have access to a range of current and relevant literature, and opportunities for training and development/courses” (p. 3).* It also states ” *There should be appropriate numbers of staff with the required knowledge and skills to support training for Institute qualifications while also meeting the demands of the service*” *(p. 3).* The IBMS notes that it is difficult to assess these aspects and requires honest feedback from laboratories.

It is the duty of the scientists registered by IBMS and HCPC standards to be helpful and professional but it is also the requirements of UKAS, IBMS and HCPC that there should be sufficient numbers of staff available to support training. As members of professional bodies, biomedical scientists can also raise the issue of short staffed situations which affect their training. Gafson, Sharma, and Griffin (2019) found that a reason for failing to raise concerns for junior doctors is that management and senior staff did not act on these concerns and this behaviour would not change. This might be the case for biomedical scientists as well.

It might also be worth investigating whether managers are reporting these difficulties in training to the IBMS as well as short staffed situations to UKAS and other relevant bodies on their own initiative. It is essential to raise the distribution of staff numbers and skill sets to the relevant bodies so they are aware of the situation.Managers must give a fair assessment of staff needed to account for shift working, training, various leaves and continuous professional development. Osaro and Chima (2014) note that whilst the low levels of staff is due to government budget cuts, managers have an ethical obligation to explain to hospital managements when targets are unrealistic and low budgets are insufficient. The authors also state that a necessary requirement is that the IBMS and CPA (Clinical Pathology Accreditation,) establish benchmarks to determine what constitutes adequate laboratory staffing levels required to promote a safe and quality service. They state that the inadequate numbers of staff is stressful for those working and leads to quick and inefficient training as well as possible errors while working and can affect patient care. The authors note other relevant aspects such as inexperienced scientists and incompatible skill mix, staff turnover, unsatisfactory remuneration as well as the psychosocial effects of working in the laboratory. The authors note the skill mix is inefficient with experienced band 6s being replaced with newly qualified band 5s who require significantly more training to meet necessary competency requirements causing more work for the remaining fully trained band 6s.The turnover further contributes to this with staff taking 3-6 months to be replaced. The authors also expand on the financial and psychological disadvantages that biomedical scientists face. The authors noted that biomedical scientists have faced a financial loss with some staff taking a salary reduction of 25 to 30% due to adjustments to on call allowances and introduction of Agenda For Change. This has led to low morale especially in work culture and the possibility of harm to patients as biomedical scientists are rushed to train. The division between efficient training and running a shift must be noted in staff numbers whilst giving information to the necessary bodies. Those who champion pathology must truly understand the complexities in pathology so they can understand how much staff and resources are needed.

One of the possible reasons of discontent is the change management process of the implementation of Carter’s suggestions. As Valentinov and Hajdu (2019) note one of the problems that managers may face is the negotiation between moral practices, various stakeholder interests and financial benefits. It is possible that in the goal of saving money, poor training and work practices were adopted. The lack of resources also puts managers in a weak position as they have no bargaining power and have nothing to really offer staff, leading to the sense of low morale and stressful work conditions. Lack of resources is financial which means money for staffing is not what the scientists deem it should be and some may choose to leave the profession. Training relies on sufficient amount of staff. As mentioned by other AHP's previously as well as the participants, a loss of staff is a common issue in AfC. Correct staffing numbers taking into consideration upskilling and training are needed to run a service that can encourage learning for both experienced and inexperienced staff as well as running a quality service. Like radiographers, biomedical scientist may not feel as though their pay is reflective of their skills which have a loss of morale (Edwards *et al*., 2009). This may allow professionals to feel undervalued which seems to also be the case for the participants of this study. The process of change management and acculturation is crucial .Members may also not feel confident being a part of their new organisation. Older members may not feel part of the new culture and new people may not be sure how they fit in. As well as culture working practices must also be streamlined. Adapting to this change requires people who are knowledgeable in the laboratories. Possible power cultures may be detrimental when a few people have power. The identity of professional autonomy might also be at loggerheads against management.

During the whole change management process there are no details as to how to support training. Focusing on financial aims might be easier as the data is easily available through budget costs and turnaround times. The aims of pathology are to provide accurate results and a quality service. In order to do this, staff must be trained appropriately. Whilst Kotter relies on gathering organisational information prior to change Nadler requires a loop of feedback. The relevance of both these models is the inclusion of data before and through the processes. Training data is not prevalent in the Carter report which focuses on service effectiveness and financial savings. Data from staff who train and are being trained may be crucial in this case according to both congruence models as how to improve processes.

However even if data was not taken initially for change management, through feedback taken now and in the future as noted by Nadler's model, processes can be improved. A training needs analysis was deemed important by another AHP group in light of AfC (Hamilton, 2013).This could be done initially to evaluate what was needed in each laboratory specific to each discipline. This will show help determine what is lacking in the training as just because someone is trained does not mean they are competent. Other members of an AHP group,Loan-Clarke *et al*. (2009) also note similar issues to the participants in this study. Key similar issues are deceased training while working the shift as well as less time for CPD. More bureaucracy means less time for training and working the shift. From the other professions, similar issues have come up as the participants have noted that it is a challenge to train and work the shift. Suggesting that training must be restructured around service delivery, twice as many cases can be assessed (Marriott *et al*., 2011). This relies on strong organisation and may be an option for biomedical scientists. It would also familiarise newly qualified scientists to working out of hours and they would be aware of what tasks need doing. They would also be with experienced scientists and the participants did note that shadowing experienced scientists out of hours was recommended. This may not be the only option to enable training. It is noted that the open systems which in this case can give more leeway to training as one of the characteristics is that different methods of working can give successful results (Hayes 2010, pg 94).Open systems are more flexible and would be relevant in such a complex task. Open systems give a variety of ways of giving results suggesting many ways of training and assessments to provide competence. Lack of staff means that strong organisation is needed across the hub and spoke model. If the spoke is unable to train their staff then they could be sent to the hub which would have access to more cases, tests and possible training resources. One qualified and experienced person could train several people or supervise them or direct them when in the laboratory. Using the same person for this role would mean that training would be consistent and the trainer would get to know the trainees weaknesses and strength and help them work on their struggles by giving extra help in some areas. This would build confidence in the trainees and they, under the direction of their trainer, have a clear individual training plan. This would enable training to continue in an agreed timeframe and any delay would be known due to familiarity between trainer and trainee. A suitable action plan could then be established. Lack of staff suggests that resources such as virtual learning could contribute to training. Tertiary education provides a theoretical base to a biomedical scientist yet to applying this knowledge to real life is a skill that is developed during training. Diagnostic haematology is constantly changing so theoretical knowledge must be reiterated during training to ensure that scientists are both confident and competent. Virtual learning could provide both theoretical and technical knowledge building experience and speed without affecting patient care.This would help build competence and confidence.

For other AHP groups a strong common theme is the loss of finances. This has led to a loss of staff as well as increased out of hours rates. Agenda for Change was established to be a fair assessment of pay. However does not seem to be the case as many of the AHP groups feel their skills are not reflective of their pay and they are being upskilled. If Agenda for Change was accurate there would be no need to pass responsibility down the chain of command. This may lead to professionals leaving their professions causing a loss of valuable skilled workers. Reduced staff numbers has led to issues causing a reduced service and lack of CPD time, suggesting that there is simply not enough staff to run a service and develop competent individuals which will have an effect on the future workforce. Undertrained scientists will lack the skills and knowledge and possibly confidence of scientists coming before them and may pass these gaps of knowledge when they are training other scientists.

7.4 NHS organization data

The themes that have emerged hold more negativity than positivity. The Carter report as previously mentioned in the discussion may hold answers as to why the above situations are occurring in the laboratories.

The issues that the participants have raised are no surprise in light of the Carter report. The issues found in this thesis were all related to situations of being short staffed which may be due to an inefficient skill mix and lack of qualified scientists. There are no staff numbers relevant to pathology which may explain why there is difficulty in gaining funds. Service consolidation has gone ahead without appropriate staff numbers being decided and a training curriculum in light of these changes. It is unsure when the number of workforce and composition data will be available so decisions can be made nationally and locally. It is unsure when the data about skill mix and training and any issues that are being investigated by the Department of Health will be available. There is also no budget information because of the silo based budget and lack of financial structure in pathology. Positions are being lost or frozen. This means that until more information is received the situations of which the participants mention will continue. Data is not the only means of getting information about pathology. As the Carter review states Health Authority and Health Commissioners do not have an accurate review of the role and function of pathology and managers were not at local and national meetings and failed to provide that insight (Carter, 2006). It was also stated that managers were more concerned with the Trust's financial priorities. Managers in pathology must give information so that an accurate view of what is needed in terms of, with respect to this thesis, training personnel and resources. If this is not happening then it may explain the lack of finances for staff and frozen positions. They could use the IBMS and UKAS guidelines on requiring adequate staff and resources to strengthen their case. The quality of training should also be maintained as well as financial priorities. Training scientists in a timely and resourceful manner reduces the stress of the scientists working the shift as well as creating competent biomedical scientists. It is essential then that until this situation is resolved there is some form of aid to support training in a 24 hour setting. A key part of the Carter report was the role of the commissioners. There seems to be a divide and lack of understanding between commissioners and providers who seem to have different understandings as demonstrated by Appleby *et al* (2014).The authors note commissioners want a reduced expenditure while providers want the income from increased workload leaving unsigned contracts and revised plans creating a mismatch between funding and workload.

The lack of data and information means that changes cannot be made based solely on the recommendations and thorough investigations must be done before changes are made to pathology.

7.5 Hub and spoke organization

The strengths of a hub and spoke system mentioned in the Carter report are numerous (Carter, 2018). This model allows the streamlining of the services and suggests hierarchy of control where centralised commands can be issued. A smaller management team is needed as there will not be leaders at every site meaning a lesser staff which in turn has financial benefits for the network. More financial benefits are achieved if services are streamlined instead of replicated technology and kits being used at every site. Gaille (2015) noted the following advantages and disadvantages of the hub and spoke model with the first advantage is that the consistency of having a single policy or procedure across different sites supports implementation and does not allow for individual site variation in practice and knowledge. The second advantage is that a variety of sites means that talent can be sourced locally. However the author also notes that one of the problems is that this model depends on all elements working to the highest standard all the time. Another disadvantage the author noted was that there could be a disagreement with management decisions and local leaders refuse to support implementation leading to a variation in practice. The author also noted that if there is a breakdown at the hub it could be disastrous for the spokes that would have to carry the extra work. This can be resolved by having multiple hubs.

The Carter review focused on saving money and providing an efficient service however the impact on training was not noted as they mentioned that they had not given enough consideration to this aspect. Satta and Edmonstone (2018) noted that consolidation has generally saved money but more research and analysis is needed to determine not just the financial aspects but also quality. This is essential as for correct training; resources must be given as well as instruction and support. Consolidation cannot take into consideration just financial aspects. As shown by consolidation in Canada where the budget was slashed by a third, there was a huge loss in staff numbers which leads to a loss of knowledge and manpower (Carter, 2006). The report also noted there was also insufficient time to set correct IT systems, service targets and contracts as well as plans between targets. This seems to have been replicated in the UK which is a negative impact on both workforce and training. Carter (2018) highlights the advantages of consolidation as being the standardisation of service and economies of scale with the latter meaning up to date equipment due to bigger purchasing and negotiating power with manufacturers and suppliers.

Whilst looking for strategies on improving pathology in the UK, research was done on health models from Sweden, Australia, Canada and America (Carter 2006). The Carter review noted that the Nykoping hospital in Sweden had an excellent IT system where different laboratories can see results from different sites through electronic records and share a novel patient number. An integrated system means that the entire patient history can be seen within the network. This saves personnel from sites from transcribing information and also stops them calling other sites for patient details. This can lead to better decision making and gives a clearer idea of what the patient needs and wants leading to improved clinical care and prevents test duplication. The Carter review also notes that Stockholm has a network of 20 diagnostic and treatment centres with the main laboratory having excellent access due to a railway station next to the centre which provides emergency, primary and chronic care (Carter, 2006). Workload therefore varies throughout the day as patients can come at suitable times. The centres must take into consideration the laboratory time tables and shift times and be supported by a transport system to support efficient sample delivery if this is to be implemented in the UK. Varying workload may not be feasible depending on staff level available. The Carter report mentions that staff in Sweden stated that these models worked due to precise process and change management (Carter, 2006). They stated that staff were reluctant to change and needed incentives for supporting compliance as well as showing improvement across the entire system (Carter, 2006). This has to be noted whilst implementing in the UK.

The Carter report investigated several laboratories in America, with consolidation happening but healthcare still not integrated due to many different providers (Carter, 2006). The IT system in Vanderbilt was found to be commendable with links to contemporary and recent research-based evidence of best practice as well as patient records providing instant advice on what diagnoses, test and treatment was relevant for that patient (Carter, 2006). This would be helpful in the NHS leading to the decision making and very supportive to clinicians. There seems to be a lot of investment in IT and transport with the transport being essential as the pathology laboratory work is divided into hot (emergency) and cold (routine) so work can be from regional and private laboratories. The hot and cold models are similar to the hub and spoke network with appropriate staff at each site. The Carter report states there is set reimbursement tariffs for laboratory tests with only clinicians(not the laboratory) having the power to add on tests and the role of pathologists is not clearly defined(Carter, 2006). This needs to be looked into as laboratories can add on tests in light of clinical urgency. If this is implemented in the UK, there must be clear SOPS for clinical areas that correspond with what the laboratory does. This will stop unnecessary testing and inaccurate interpretation of results.

The Carter report notes that Australia has the independent sector working in community with the public sector working in hospital laboratories on a new accreditation framework that has led to improved finances through cost reduction and improved quality

(Carter, 2006). Competition for contracts is based on quality of the contract not financial savings which is what the Carter review also recommends for the UK. This is an essential aspect that could be investigated by other researchers to see how quality was improved and, with respect to this project, if and how training was improved.

As Satta and Edmonstone (2018) states quality must be maintained and from the reviews done in previous countries there are several things that need to be accounted for .The workload needs to be in line with staff numbers, staff must be supported with changes, improved transport and IT links with clear standardised SOPS between clinical areas and laboratories must be established and quality must not be compromised.

With NHS organisation happening, there seems to be a threat to training. With the low number of staff available and the distinction of working a shift and training, it might be beneficial to centralise training at the hub. The hub would have a wider range of cases and tests increasing knowledge and skills for the trainees. It is essential to assess whether the hubs have staff to both train and run a busy service. It would definitely be cheaper and efficient to send trained people to the spokes as there would be less people to train being an emergency laboratory that does not perform specialist work. It would be better if the hub encourages a culture of learning so the spokes doesn’t have to. This was one aspect that the expert scientists noted was essential to training. A commitment to training was deemed essential with the combined experiences and knowledge of qualified and experienced staff. Those willing to train could also spend more time doing so, enabling a clear divide between running a service and training. It would then leave those preferring to do out of hours and shift working to be left to it. It is essential that communications about training are maintained between the spokes and hub. In order for things to run smoothly quality management and Health and Safety as well as robust governance structure must be maintained. There must also be consistent operational procedures, reviewing of all aspects to check that there is no variation and trainees are learning the same things.

There is no training delivery guidance in the Carter report and may be up to each network to decide their own style as each laboratory has their own UKAS accreditation. There is no hub and spoke information about training personnel. There is no formal training plan in place and no staff allowances in this report for training. It is not published where the training office is based over several sites which mean there may not be any official training personnel on each site. This might be a clue as to why the registration portfolio is limiting and the training may not be detailed. Registration portfolio trainees may not have been given sufficient attention from their training officer. No training structure is noted in the Carter report with each laboratory having their own UKAS accredited competency records for each staff member. There is no note of how this training is to be delivered or any guidance on reorganization and Agenda for Change. One theory is that the expert scientists find training challenging because the same old training methods are being used with no acknowledgement to the severe changes that are happening in the NHS .The above training situation does not seem to fit in with the requirements in the guidelines by the accrediting bodies HCPC, IBMS and UKAS for training. The training standards for the HCPC and IBMS are specifically for training programmes such as the Registration portfolio and the specific Specialist portfolio. If the IBMS has standards for training for accredited titles for both the Registration and Specialist portfolio then it stands to reason that training scientists would require similar situations to train for a similar level which do not seem to be met. UKAS, IBMS and HCPC also have regulations on staffing levels and safety and as mentioned before this should be raised with the relevant authorities if conditions are not met. Strong organization is required for centralization with the most important aspect is that quality is not compromised for staff and resources in order to allow for excellent patient care

7.6 Shift work

The expert scientists note that there is a rush to get on shifts. UKAS demands that trainees are signed off and this means that they should be competent. Could it be that not much time is being given to thorough training? Are trainees being shown things once or twice and then expected to know it? Once on the shifts, it might be difficult for the trainees to get into training mode especially if they are with qualified staff who do not like training or are doing out of hour shifts when there is limited staff. It is also suggested that trainees are being trained to the bare minimum so they can do the shift. If a trainee is on their own with a minimum amount of knowledge they may not be safe on a shift. There might be some areas that the trainee has not trained in yet and they are on shift doing certain tasks. It is difficult to find time for the trainee to train in said areas as it would require the trainee to coordinate hours with their trainer. There are also issues of lone working to consider as some hospitals employ only one scientist to monitor the laboratory. Charter (2010) pointed out several requirements for lone working, which may be needed at spoke sites. A fully competent person was needed especially in regards to analyser maintenance and who possesses knowledge of chain of command. They also note that procedures must be clear and concise and reviewed regularly to be kept relevant. Charter (2010) notes that lone working creates added stress and can turn into fatigue, impaired concentration and boredom which can lead to poor practice. Working alone has good and bad points like thinking on your feet and becoming more confident but it also can increase stress and anxiety.

Working the 24 hour shift can lead to an inconsistent routine that may affect health as well as, sleep patterns leading to possible tiredness and low productivity at work or elsewhere. Rimmer (2016) consider that sleeping on shift may be beneficial with Dr Michael Farquhar a sleep specialist noting “There is still this idea that if you are being paid you must not sleep, and that is fundamentally wrong. Your brain is not meant to be awake at night” (para. 2). Sleeping on shift may also help with alertness while working which promotes better care for patients. Sleeping on shift may improve both mental and physical health aspects of night working. Sleep rotation might be something to implement if there is enough staff to cover the work. Shift work has a series of negative aspects which Arlinghaus and Nachreiner (2016) state as being “poor work-life balance, decreased opportunities for social participation, family problems and negative effects on partners and children.”They note that staff choosing their hours might have some of the effects diminished but it does not remove them completely.

There might also be shift inequality meaning that certain shifts are deemed more popular and given to certain people. Working shift work means avoiding peak time which might be suitable for some scientists. Another positive item also is the financial aspect for the trust; shift work saves money. Shifts means that staff gets better pay. Wilson (2002)notes that working on a shift leads to increased responsibility, increasing skill set and a feeling of pride. Shift work however has its challenges especially with scientists being aware of the financial remuneration which existed prior to Agenda for Change. Shifts can be tiring as mentioned above and lone working can be isolating.

Would the trainee feel confident and fit to practice which are essential for the code of conduct for the IBMS and HCPC? This quality of practice is to be questioned checking to see if trainees understand key concepts and are able to draw knowledge and skills in times of stress. If training is rushed then trainees may be pushed to go on before they are ready. It feels that training should be given more priority but how will this work? If there is no one to train then hiring more qualified staff may be an option but an increased budget is down to management and trust finances. The relevant professional bodies do require sufficient staff to practise safely. The Carter report does not look at training for biomedical staff in great detail .It fails to account for training time as well as staff needed to make trainees feel secure and competent .It focuses on the service rather than the aspects of training .As each laboratory has its own accreditation, it makes sense that each laboratory should have its own training people, ideally who match the trainees rota and can shadow and mentor them and give constructive feedback on their progress. It would also take the weight off all the scientists who are trying to run the service without being asked continuous trainee questions or being asked to supervise .The training person would be designated to training only and run the service as a secondary role in times of emergency. Dedication of an experienced competent person would mean repetition of tasks, a person who would know what stage the trainee was at instead of a new person training the trainee each day. Trainees are not confused by the new styles of training by different people. It means that training would be in a secure place with a willing teacher which would be a better culture for trainees. Consistency in training would also be more efficient. This however means there would be one less person to do shift work. Shift work leads to more financial gain and more days off in the week so it may not be ideal for the person who is the dedicated trainer. However it is only till the trainee is fully competent.

It is advisable that newly qualified scientists are fully trained before they are put on any kind of shift and should not be considered as a full scientist. It would make sense that during UKAS inspections staff grades be noted and accounted for so the skill mix can be deemed as safe.

7.7 Multidisciplinary working

Multidisciplinary working is one of the recommendations of the Carter report. This will require efficient Continuous professional development to allow staff to work competently in all disciplines. Woods *et al* . (2000) have stated the importance of having a competency programme directed at multidisciplinary MSLOs (Medical Laboratory Scientific Officers) working in biochemistry and haematology. The programme was used as training documentation and subsequently performance reviews. Divided into two levels, the first part of the programme enabled training for MSLOs to make them competent for lone working and some shifts whilst the successful completion of the second section is equal to competency needed for state registration by the Council for Professions Supplementary to Medicine. This programme ,with respect to this project, has some ideas that can help to create a programme to train biomedical scientists. The authors note that they used IBMS guidance to create this training approach as well as gaining IBMS accreditation for CPD tasks like lectures, practicals and courses. The authors stress that strength to their successful training programme is the link between training and CPD. In the Carter report this has not been organised. For example if a scientist is to work in biochemistry for three months and then three months in blood transfusion it would mean that it would mean it would be six months until they work in Haematology again meaning that any changes in procedure would not be known unless the scientist had successful CPD. However this means organization between disciplines and time must be allocated to maintain competence and knowledge of staff. This is an essential element that must be considered in this project in not just multidisciplinary laboratories but also large hub laboratories. Staff can be rotated between disciplines or sections of laboratories which means it is essential for them to be aware of maintaining knowledge and skill even if they are not currently in that discipline. Access to resources will make scientists able to do lone working or shift work even if they haven't worked in that area for a while. This means that for efficient training, a training programme based on relevant guidelines and organization from managerial departments is needed. Murray *et al* . (2009) also noted key elements of multi disciplinary training and working. In a study to investigate whether multidisciplinary working deskilled workers, three training area were deemed as lacking. These were identified as training, supervision and assessment of competencies. The authors warns about deskilling, suggested it is due to advanced technology as the level of expertise required is less than previous years .Murray *et al* . (2009) state many ideas that were also brought up by the expert scientists in this study. There is a premature removal of trained leading to a decreased supervised training period as well a lacking in trainee needs. They also suggest an ongoing commitment to training through management and staff, suggesting that training is a team effort. In this study the term multidisciplinary refers to one department like blood transfusion or Haematology which in the UK Haematology scientists usually work in both already. The authors also suggest the self confidence of the trainee is a reason that they are left alone. However confidence does not mean competence and this must be assessed accordingly before working unsupervised. As noted with technical advances, less theoretical knowledge may be needed as well as evolving technical skills. However the analyser means different knowledge not less. It is still crucial to understand the scientific knowledge behind disease and the testing done in laboratories as this will develop further understanding of what the analyser does and therefore being able to troubleshoot competently when things go wrong. It also means knowledge about the analyzers need to be added to training. Multi disciplinary working has a twofold benefit, providing increased skill and knowledge for scientists as well as providing multi skilled capabilities to help manage the laboratory. Yip (2010) noted staff acknowledged that multidisciplinary working was more beneficial for increasing skill set and developing staff than laboratory management. The author noted that the conducting of training was the real issue with a lack of communication and planning so resources could be used appropriately and unless this was done it was not beneficial to cross-train for managing staff across laboratories.

Making sure trainees are competent is an important idea that is mentioned by Burton (1999) who suggested that bench work takes a lot of time for the trainee to be competent but this is essential as rushed training does not lead to deep knowledge about the topic or instrument. The author suggest that the most efficient way of cross training is by bench work followed by other methods like lectures, workshop ,training videos by providers and academic teaching. Burton noted staff might be happy to learn new skills or they might have a preferential discipline already making them not as eager. This may not be for new scientists entering the profession but if in the future established scientists need to be trained in multiple disciplines the latter may be a case.

There are several strengths and weaknesses to multidisciplinary working. A strength is that there is a bigger pool of trained competent staff in case of sickness or staff absence. A weakness is that managers from many disciplines have to work together which may lead to personality clashes. Managers may also prefer staff to work in a certain discipline rather than multidisciplinary sections. Another weakness is pressure to learn many disciplines in different circumstances. It could also be looked at however as an opportunity to learn more discipline-specific skills and knowledge. Different and multiple voices solve problems. Staff from different backgrounds who are self sufficient add to the repertoire of talented staff at the network. Yet this positive can also be a negative. Too many voices, too many conflicts, different department values from staff and management may contrast with individual working practices. Communication must be ensured to allow understanding between teams.

From these studies and the research done in this project, there are several key points to implement as the Carter report noted training multidisciplinary scientists are also on the agenda. Strong organization from the different departments to support the coordination and education of trainees based on a training programme informed by professional guidelines and supported by professional bodies. Scientific knowledge which forms the basis of biomedical sciences should be passed on as well as knowledge and skill about technical aspects of the role. These recommendations have not been put in place. If training is being deemed as insufficient by the experts in one discipline, will it be feasible to train in three (Haematology, Biochemistry, Blood Transfusion) which is what the multidisciplinary scientists are .The report does not discuss the delivery merely the outcomes.

Multidisciplinary working will be challenging in the future due to the lack of focus on one discipline. The training time to build competence as well as reiterating what was learnt after a rotation in a different department especially in newly qualified scientists who lack experience in pathology laboratories must be protected. Multidisciplinary working was to help with staffing but this will not be the case if they require constant retraining. It might be better to focus training o the traditional disciplines and allow multidisciplinary working once a scientist is experienced, competent and confident. Strong organization from management is essential with a set timetable to ensure enough time and staff is available. The issues mentioned by the participants such as problematic staffing levels and rushed training are not mentioned in any documentation nor how to overcome these obstacles.

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7.8 Theoretical Education aspect of a Biomedical Scientist

Two main themes that come up when discussing the education aspect of biomedical scientists is the importance of the Laboratory Placements in training and the lack of specialised knowledge that newly qualified scientists seem to have. The combination of these two elements should enable the scientist to be competent. These are two aspects of learning with the degree focused on education and the placement representing workplace training. In order for scientists to be competent, an education in theoretical knowledge is needed as well as knowing how to apply that knowledge through technical skill learnt through training. Education is often more general with knowledge gained for future employment whereas training is for the scientist's current job with tasks being very specific.

Competency records focus on the actual action of performing the task with the acknowledgement of the knowledge behind the process and possible results making both training and education essential.

7.8.1 IBMS degree

The expert scientists noticed that the trainees possessed a lack of specialized knowledge. As noted in the introduction there are two types of knowledge that may be beneficial to biomedical scientists: Theoretical knowledge and Technical knowledge. Technical knowledge is the knowledge of automation, kit and tools as well as how to apply scientific knowledge to clinical results. This may be the knowledge that the placement year students pick up on more having the opportunity to learn in the laboratory. However there is also the issue of specialised theoretical Haematology knowledge that the participants note that is lacking in the newly trained scientists.

It would certainly be a huge help if the degree covered both theoretical and technical knowledge. It might be not as feasible for the technical side as there is variance in analysers, kits, tools and standard operational procedures across all laboratories. The undergraduate and postgraduate programmes are accredited by the Institute of Biomedical Science and also adhere to the academic requirements for registration with the Health and Care Professions Council (HCPC).Some programmes have integrated laboratory training for which the Institute's Certificate of Competence is awarded, allowing the recipient to be possibly eligible for HCPC registration. Other programmes allow the individual to undergo the Certificate of Competence post graduation.

The theoretical side of scientific knowledge in degrees can easily be monitored through accreditation. It has to be noted however that the range of degrees that is accredited by the IBMS is wide and includes Pharmacology, Sports Science and Biology degrees. There are three reasons why the expert scientists may feel that new trainees are lacking theoretical knowledge. The degree content is lacking for new scientists, newly qualified scientists took an accredited degree that was not in their field and that degree is therefore lacking for their current field or it could be that the trainee simply did not retain the knowledge that they learnt in university.

If there is a lack of theoretical knowledge would newly qualified scientists struggle to link between the different techniques in the laboratory? It may be noted that maybe trainees lack technical knowledge as they previously used different analysers, kits, tools and standard operational procedures. The trainees could also however feel new at the job and struck by the responsibility that they now carry and prefer to be retrained to avoid mistakes and therefore not take as much initiative or be as vocal about their knowledge.

The expert scientists have noted that the content was far too generic. They also noted that there were some modules that were unnecessary like patient interaction or other subjects not relevant to the biomedical scientist discipline.

All three biomedical sciences degrees I examined have an assessment via exam and Derby University and Kent university have a practical assessment whereas the assignment for Gloucester University is not specified. The contact hours for Derby University is not mentioned but Kent University and Gloucester University have 29 and 36 contact hours and recommend independent study of 123 and 124 hours respectively. Derby University state that the module that it is 20 credits with Kent University noting that it is 15.Derby University mentions it uses lectures, practicals and case studies and that “different haematological disease, their laboratory diagnosis, blood donation, donor screening, use of blood components and principles and techniques in haematology and transfusion laboratory.” Kent University ‘s syllabus includes the life cycle and disease processes of red and white blood cells .It includes common pathological conditions and how it affects various blood indices. The syllabus also includes critical aspects of haemostasis. It also covers experimental investigations regarding haematological disease. Gloucester University also includes study in blood components in healthy and diseased patients as well as knowledge of techniques used in haematological research and laboratory diagnostics. All of these modules have a component of blood transfusion .

It is to be noted as well that there are several disciplines in biomedical scientists: Haematology, Biochemistry, Microbiology, Genetics, and Cellular pathology. The majority of the biomedical sciences degrees are generic and of the same title. Some are more definite such as BSc (Hons) Healthcare Science (Life Science) (Blood Sciences, Infection Sciences, Cellular Sciences ,Genetic Sciences) and Transfusion and Transplantation).An IBMS accredited degree has the same issue as the generic Registration portfolio. A graduate could have an IBMS degree in Infection sciences do a registration portfolio in Cellular Sciences and obtain a Band 5 position in Haematology. It is true that the degree does not carry a lot of focus on one discipline or all of them, but it also depends on which discipline the scientist is registered in and where they are currently working.

As part of the investigation into the education of biomedical scientists it is essential to see what the criteria is for accrediting an IBMS degree. This has been covered in the Introduction. There is a component of specialised knowledge however this depends on the degree. It is unrealistic for student applying for university to know exactly what course will be relevant for their future career. It could be there is a vacancy in haematology which a newly qualified scientist could apply for even if they had a degree that focused on cellular pathology and would fully be in their rights to do so as it is an IBMS accredited degree. Degrees in Infection Sciences, Genetics and Cellular sciences degrees are also accredited

IBMS degrees and combined with a Registration portfolio, HCPC registration as a biomedical scientist can be received (IBMS, 2022).Other degrees that are not accredited by the IBMS require top up modules. In this case the student must liaise with IBMS accredited universities to see if relevant top up modules are available. If top up modules are in the field that the person is working in then it may be quite useful to work practically and technically side by side. Scientists are required to perform CPD throughout their career and continuous learning might be beneficial especially if they are training at the same time. The scientific knowledge would be reinforced whilst the technical knowledge was taught.CPD can take the form of work based learning as well as self directed learning .The HCPC also notes professional activity and formal education as CPD (Health and Care Professionals Council, 2022). The IBMS also have an online portfolio to collect all these evidences as the HCPC can audit scientists at random to check they are maintaining CPD (Institute of Biomedical Science, 2020a).

As there are many providers of the accredited IBMS degrees there is a great deal of variance in the course content. The benchmarks specialised knowledge may be sufficient however there are a number of issues to address. It also depends on the student. Someone studying to pass an exam may not necessarily retain the knowledge when a biomedical scientist position comes up months or even years after graduation. They may also not prepare for their new position by going over old lecture notes containing relevant specialised knowledge. This would give the impression that they had no knowledge or very little, as the expert scientists stated when they started training. The trainees may also expect to be trained from scratch when they start a new job so they do not make too much of an effort. Also a newly qualified scientist may not take a band 5 position straight away and their knowledge could be outdated especially regarding practical technique and automation. It is unlikely due to the variance of the course content that the laboratory that the trainee ends up in correlates perfectly.

7.8.2 Registration Portfolio and Laboratory Placement

While the degree gives a general strong base in biomedical scientists through the above skills, the laboratory may be the best place to pass on technical and theoretical knowledge as it is stated by the expert scientists that the lab placement is highly beneficial. Note as well that in a laboratory placement the trainee would not spend a whole year in one discipline, but possibly different ones depending on the hospital and university agreement. That means that the trainee is only spending at least 4 months in one discipline and it is still viewed as a major advantage. If the laboratory trained scientists in specialised Haematology knowledge then the trainee would have all the theoretical knowledge that was relevant to work in that laboratory. The co terminus degree allows a period of training in a laboratory which is IBMS approved for pre-registration training. The registration portfolio completed during the co- terminus degree involves the trainee rotating in the different disciplines of biomedical science. The co terminus degree has the advantage of working in the laboratory with increased practical skills and familiarity of the laboratory.

The lack of practical skills and application which was noted by the expert scientists may be hard for universities to include in academic settings. The difficulties would arise from the number of automation and test kits as well as a host of clinical scenarios that are easily present in a laboratory as a part of routine and budget. The practical side of academic degree might also require more time that the degree timetable allows. If there was a stronger collaboration between universities and hospitals students could be rotated. This might be difficult however as the number of students might be too much for the size of the laboratory and the student may not receive one on one teaching. The expert scientists rate the co-terminus as the single item that gives a major advantage.

There should be a well structured programme anyway through the guidelines of the IBMS, UKAS and HCPC. According to IBMS there should be a training programme linked to generic and specialist level. This could mean that these programmes are inefficient. Laboratories should have a training programme in place as they are already training haematology trainees. Why was it noted the trainees have very little knowledge? This could be the fall back if the generic portfolio is being done just to get the qualification. As mentioned in the Introduction, UKAS compliances dictate that trainees must have competencies that are signed off by a competent person. Each laboratory should have a training officer as mentioned in the introduction .This is an official title for those who supervise the registered and specialist portfolio (IBMS, 2018a). A training officer may also take part in shifts. In current hub and spoke models, a training officer may only be based at the hub.

However anyone who is competent can train if it says so on their signed off competency record (IBMS, 2018b). This means that actual training has to be done by those in the laboratory. So why do most laboratories feel that training is challenging when they have these measures in place? It could be that there is not a well-structured training programme in place, or even if there is one it is not efficient for these times. A well-structured programme involves the correct amount and level of specialist knowledge and technical skill being relayed during a suitable period of time. This would involve the trainee being rotated in suitable areas with an appointed trainer so it requires a certain amount of organization from laboratory management (or whoever does the rota) and liaison with the trainer (IBMS, 2018a) In these times of laboratories being short staffed, that may prove challenging. If there are insufficient qualified people to train while running the service, it would be difficult even though there is a clear training programme. There is no national set of guidelines for biomedical knowledge and each laboratory relies on each individual laboratories SOPs. If there is no time to read the SOPs thoroughly or be assessed for competence through a variety of methods then the trainee may not be competent or confident.

Through my own experiences I noted a lack of discipline specific resources through the IBMS and my own laboratory. There are no standard learning materials specific to each discipline apart from the IBMS textbooks. Laboratories have SOPs which are often quite heavy with complex language. Useful tools would be easy to understand scientific information on diseases and why they give the results they do. Well written SOPs would be beneficial as well as clear flow-charts for analysers and techniques. Training is challenging specially in laboratories that are slim on time and staff .Virtual learning for validation can be used as an assessment tool as well as a teaching tool. Morphology libraries with information pinpointed on different cells and their relevant features and why they appear, as well as how to quantify cells and how relevant these numbers are. Virtual learning can be across all IBMS Laboratories taking a lot of work off strained laboratories .A similar programme has been developed for radiographers called Radbench a digital image interpretation scheme which generates images and measures the answers in terms of sensitivity, specificity, and accuracy as well as a decision making map(Wright, 2013). This can be used as a training tool and not just for assessment.

Weak spots and areas that need more work are highlighted with such a scheme. Scoring gives an idea of competence and can build confidence through strong scores.

7.9 Training Competencies

The content from the Specialist portfolio that the scientist might come in contact with has been mapped to what the expert scientists have mentioned. This suggests that the content from the expert scientists matches the current syllabus. This does not include any items from the degree syllabus. Each competency in the Registration and Specialist IBMS portfolio has a knowledge and competency section which can be used. The Band 5's also had items to add and take away. One participant suggested removing morphology which is a critical part of being a biomedical scientist. They also had several things to add. Communication is a quality that the experts deem essential. Shadowing a scientist is also a training technique that the scientists view as efficient. The other items they mentioned are covered by the competencies. One participant noted that they would like to take part in a clinic which is rare as biomedical scientists do not usually associate with patients. Staining bone marrows is often done in the laboratory but are looked at by Haematology Consultants.

The Specialist portfolio is a well structured programme which covers all the aspects needed to work on shifts. As noted in the results the competencies of the specialist portfolio match which make it an ideal base for training. The portfolio recommends a variety of learning tools to implement this knowledge but the most important issue is that the content matches what new scientists need to know. The variety of learning methods may not always be feasible with the current challenges to training like lack of staff. However it is important to know that the specialist portfolio covers the needed knowledge and associated competencies.

7.10 Passing on Scientific and Technical Knowledge

It seems that the expert scientists who are responsible for training are imparting scientific knowledge in a very similar way to training which is very practical and involves active learning rather than passive methods. This also suggests the above idea that technical and theoretical knowledge are two aspects of biomedical knowledge is sound.

A number of expert scientists suggest that they would deliver scientific knowledge the same way they would train suggesting that the two might be more successful delivered hand in hand.

The five most popular ways of training were identified as

- Shadowing Experienced Scientist prior to lone working.
- Case studies-EQA, Internal and those which give equivocal results.
- Digital Morphology Scheme or Lab own morphology training scheme
- Mentor system: 1-1 meetings, review training at regular intervals.

- Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test

Whilst mentoring and shadowing required a qualified person around, case studies and morphology could be done at least in part virtually to strengthen training. Case studies are invaluable as the cases judge knowledge and can also be an amazing learning tool for rare cases. They are also based on real details and clinical details without any fear of affecting patient safety. A similar set up could be done for Morphology. Competency assessment exams are essential in determining the range of knowledge and technique that a student knows. Like case studies there is no fear of affecting patient safety. This could be done virtually throughout training to identify strengths and weaknesses. At the end of training a competent person could sign off the trainee in accordance to UKAS guidelines.

The Band 5s agreed with the training methods for technical skill and specialist knowledge but they also suggested traditional structured training methods like training opportunities from NEQAS and Haematology/Coagulation automation companies, in--house structured training programme and the procedure where the scientist reads the relevant SOP watches/observes, writes, does, and reviews.

7.11 Virtual learning

The Syllabus seems to be proficient as it matched what the expert scientists said. It is the passing on of the technical skill and specialist knowledge that is needed. Virtual training programmes would be beneficial which incorporates the competencies /knowledge of the IBMS specialist portfolio. The issue with this is that trainees may not feel the true importance of dealing with patients as they know it is virtual. It suggests that in these challenging times that there should be more standardised resources available across the UK so trainees could have study aids as well as standard SOPS in their own laboratories to help them feel more confident. Techniques may be different in each laboratory but morphology, Coagulation and Haematology results are universal. This would enable the scientist to know the meanings behind the results and morphology and when to notify the clinician. If the scientific knowledge can be removed then it gives more time to technical training like LIMS and analyser troubleshooting.

Lewis (2014) performed a critical analysis of the adoption of virtual learning in undergraduate degrees globally as well as nationally in biological sciences as well as how to use this method efficiently by itself and in tandem with wet laboratories. While the author believed that virtual learning develops knowledge and engages students he also noted that during development it may be costly and can be possibly limited based on the model used. There are several recommendations in this paper such as increasing the virtual learning alongside traditional laboratory methods as well as integrating it in the course through careful design as well as considering development of knowledge and learning outcomes. High quality images and technology is required .Evaluation of knowledge should also be done.

Williams *et al* (2017) discussed the use of Whole Slide Imaging in histopathology. The authors cite the Carters report and that digital pathology would be beneficial to centralization as staff and experts from different sites could see the slides and help with diagnosis. The authors notes the benefit of digital pathology on learning as a tool to continuing professional development as well as an archive of slide images to be an excellent training tool. The authors also lets the trainer and the trainees to view the slides together and can therefore he discuss together like a multi-headed microscope but with more direct pinpointing on the key aspects of morphology.

Rare and challenging cases would also be available and training in these cases would increase the skills of scientists working and prepare them for when a real life patient came in. This would be especially efficient with blood film morphology slides in haematology. Evans *et al* (2004) note that there are poorly designed student learning resources available online and in educational organizations. This is something that the IBMS and NHS can work on to provide standardised resources on its own merit or as part of a training programme. Hall *et al*. (2004) suggest that WEBCT is a system that allows virtual learning for laboratory teaching. This programme can be made according to need. They note that shift work means they cannot attend regular sessions and can learn in their own time or protected time. It involves a chatroom and can be adapted to need.

Hyde *et al* . (2005) note that for redesigned roles in the NHS both educational institutions and healthcare providers are needed together, with the competencies stated by the healthcare provider and the educational institution providing the standardised training programmes. Potkonjak *et al*. (2016) state the advantages and disadvantages of virtual learning. The advantages are that it is cost effective, can be adjusted to what is needed and can support multiple users. It is also an excellent learning tool as mistakes do not have any consequences to the patient. The disadvantage is making such a system in the first place. The second major disadvantage is the virtual system itself. The student knows that this is not real and may not understand the relevance of what they are doing.

A virtual training programme means that it might not be essential to have a trained person around to lead the training which is beneficial in situations when the laboratory is short staffed. It is also important sometimes to get the trainees out of the way if they are not as competent or confident so they can increase their skill set and knowledge .It builds confidence without compromising patient safety. It also incorporates the self study element that the expert scientists also mentioned as a learning technique. .A virtual programme also allows for all learning material to be easily accessible and in one place so no time is wasted in gathering necessary items.

In the Pandemic virtual learning as well as meetings has become more prevalent. Training/teaching virtually may be beneficial and assessable for trainees all over the country and takes the strain off the laboratory. Virtual learning is already popular in the medical profession and this looks to be eventually the same for biomedical scientists. Decision making software like Resimion enables students to take part in case interpretation or scenarios and the consequences of their actions.(May, Anderson, Clark, & Hull, 2021).In the future in the long term this looks like a viable option what with the participants mentioning having no time or staff to train. In the short term this may be possible but not as prevalent as such programmes would take a while to develop. It will be challenging to train if covid cases increase as workload increases and staff may be off for isolation periods.

7.12 Qualities of a biomedical scientist

There are several personal qualities that the HCPC and IBMS require a biomedical scientist to have.

The three most popular as determined by the expert biomedical scientists are communication, working under pressure and time management.These three are not surprising considering the previous data that we have received on laboratories being short staffed and having increased workload. Time management and working under pressure point to a high workload done by a limited amount of people in a short span of time. Time management is a transferable skill present in many work fields but working under pressure suggests that there is a lot to do. There are a lot of situations in the haematology laboratory which are considered urgent like disseminated intravascular coagulation or diagnosing a blood cancer, or a haemorrhage. This requires a cool head especially if you are working alone as there is always a bleep for new emergencies. Please note as well that depending on the hospital the biomedical scientist also mans the blood transfusion department. The blood transfusion department has an emergency branch called cross matching. Cross Matching is an essential process preceding a blood transfusion to determine whether the blood from a donor is compatible with the blood of a recipient. If a scientist is performing one task such as cross matching then all the work in Blood transfusion and Haematology stalls to a certain extent. It is true that a medical laboratory assistant may load the automation for FBC or prep the samples for coagulation and then subsequently load the coagulation analysers however the validation would be done by the biomedical scientist as they would be the only one qualified to do so.

Communication is also the most popular quality. This is one of the most important qualities from the IBMS and the HCPC. Communication as a scientist is crucial. In the case of an abnormal blood film or results, the biomedical scientist is the first person to know anything about the situation. It is important to pass on crucial imformation to the Haematology Consultant, doctors, nurses and porters.

The Band 5s did not agree with the qualities chosen by the experts. It is interesting that they asked for qualities (able to multi-task, good problem solving skills, attention to detail) that the experts might have developed with experience and are now second nature. These are qualities that new scientists might need especially when they are not as confident in their abilities.

There are certain qualities that are required by the NHS, the IBMS and the HCPC. The NHS states that following qualities are required an interest in science, effective communication skills, competent technology, accurate attention to detail, good interpersonal skills and teamwork. The NHS also has general values for all staff: Patient comes first, Dignity, Respect, and Compassion Quality. The IBMS expects it scientists to have qualities of teamwork, duty of care, respect, effective communication and whistle blowing. The HCPC also has similar values. It is interesting that the NHS qualities do not match two of the most popular qualities that the expert scientists brought up. Is there any aspect in the current training that builds up on these skills? The Carter report, HCPC and IBMS and NHS do not offer any advice on how to develop these qualities.

7.13 Development of Qualities

In the Registration portfolio, witness statements as well as reflective statements can be used to demonstrate that the trainee has these qualities. However maintaining these qualities when you are a scientist working alone or with the responsibility of being a HCPC registered biomedical scientist may not be as straightforward. This study questions what the best way to develop these qualities is.

One of the most common ways to develop these qualities is experience according to the experts. As the data the expert biomedical scientists have given suggests there is a case of short staffed laboratories so training might be rushed and the priority might be the technical and scientific knowledge rather than developing qualities.

As noted in the Introduction, a capability framework could be set up with the mentor (as recommended by the IBMS). The required capabilities from the HCPC, NHS and IBMS could be included in this framework. Satran *et al*. (2020) mentions developing capabilities through talking about experiences in a group with experienced nurses which can be done with a mentor as a newly qualified scientist would not have a wealth of experiences that an expert would have. The expert scientists do note that a popular way to develop these qualities is experience. Like Satran *et al*. (2020),O'Connell *et al*. (2014) and Fraser and Greenhalgh (2001) note that group work to develop capabiities is important as they provide feedback and active discussion. Group work may not be feasible due to the small numbers of scientists training at the same time suggesting again that the mentor may be a better option to develop capability.

Whilst the three most popular qualities according to the experts are communication, working under pressure and time management, it is essential that the scientist has the technical and scientific knowledge and has the confidence to perform. If the newly qualified scientist is trained in a rushed method, they might not feel very confident and it would affect their ability to work under pressure as well as affect their time management. According to this thesis, the three most popular methods for developing these qualities according to the experts are mentoring-one to one training, coaching at 70%, experience, everyday working at 75.00% and shadowing an experienced scientist at 80.00%.

Having an experienced mentor may be helpful as the mentor would be able to give advice on what to do and would be available to answer any questions that the newly scientist may have. It is also incredible comforting to the scientist to have someone to turn to when an issue arises. This would build confidence in the trainee. If they were in a difficult situation and need to call their mentor on the bench they would remember the advice more clearly and hopefully apply it to other similar situations. The coaching aspect would also inspire confidence. It is essential that mentors have a positive idea about the work that is done in the laboratory. They must be respectful of the knowledge, skill and qualities that is required especially in these challenging times. The mentor must be aware of trainees not knowing what they do not know and their mentor's attitude towards work and their behaviour is a huge learning curve. They must be patient and try to remember what it was like to be a trainee and the challenges it brought. The third is the mentoring system which has similarities to shadowing and highlights the importance of having an experienced scientist.

The second most popular is everyday working. In a supportive environment, a trainee would realistically learn on the job. They would learn from mistakes and even if they were slow they would at least learn to plan and communicate clearly. However in this time of limited resources and high workloads tensions in the laboratory and outside on the wards may be running high especially in cases of clinical emergency. This fact alone would affect their confidence. This might not be an option in this current climate as the laboratory may be a stressed out place and training is rushed to get on shifts without qualified staff around. The everyday working may not be the ideal technique anymore.

The first method of developing qualities is shadowing an experienced scientist. This is a unique way of learning as you are not actually doing anything but merely observing in a real clinical situation. It is understandable why the expert scientists chose this method. It would not be hard to remember what a scientist had done when you are alone doing it. It might be easier to remember then someone giving instructions. The calming reassurance of a experienced scientist may be a calming reminder as they actually have a memory to draw on. The new scientist can see how the scientist communicates urgently, working under pressure and with efficient time management. The scientist can also explain procedures retrospectively after laboratory emergencies if there is no time during the procedures. This strengthens the idea that a dedicated person should also be responsible for training. A calm experienced person who manages time-dependent procedures is more beneficial for the trainee who can learn at ease and thoroughly rather than a stressed out scientist made to cover a shift and train. The scientist may make a trainee feel like they are interrupting and in the way. Shadowing an inexperienced person may teach the trainee inefficiently. They might not be as calm damaging the trainees' confidence.

The three next popular development techniques are assessments testing real-life knowledge in a time limited scenario at 55 % and both Personal reflection and Incorporated in Laboratory training at 50%.The real life assessments are a very good idea as they mimic real life and they take away the fear of affecting patient safety. They also build confidence, efficiency and speed. These assessments could be virtual for all trainees. Validation of results for haematology and coagulation as well as case studies for morphology would be quite straight-forward computer-based as has been shown by virtual programmes noted in the Literature Review. Even real life scenarios could be done providing there are qualified staff to give feedback and supervision.

The personal reflection is interesting as it allows the scientist to take the time out to think about what they could do better or what they did well. Reflection certainly has its merits but in a time limited scenario it is unsure whether the calmness of personal reflection will carry through. There is also the option of laboratory training. There is a lot of information to take in when trainees are learning, would this be a step too much to take in at this resource limited time ?

The Band 5s agree with the developments of these qualities which are also quite similar whilst also suggesting reflection and real life assessment. The real life assessments are quite interesting as it can in some respects be done virtually especially for validation and morphology.

The truth is as well that some people have these qualities already inbuilt into their personalities. They might have the ability to remain cool under pressure and have excellent communication skills. There are also trainees who might be at a slight disadvantage if they are of a slightly nervous or flustered nature. However it is possible to develop these qualities through the methods stated by the expert scientists.

There are many options here for the developing qualities, but they rely on having qualified staff around. During struggling times it may be beneficial to turn to technology so an actual qualified professional may not be required. The issue of staffing at this point must be discussed. It seems that trainees are in a rush to be put on shifts and need to be trained quickly. In this case does the trainee help out with the shift or is there time to train? Is it easier for qualified scientist to be on their own or work with trainees interrupting them or giving trainees allocated time when staffing is better? A virtual programme would also help with scientific knowledge and technical skills, hence developing confidence. Virtual programmes can also help with real life scenarios testing their knowledge on how to act in certain situations and how to follow critical procedures.

Chapter Eight-Conclusion

8.1 Conclusion

The research question was to determine if current training is sufficient for newly qualified biomedical scientists in Haematology to work the 24hr shift? From this study, current training is not sufficient. Times are challenging right now in the world of UK pathology. There is a lack of coherence between financial budget, managers and different levels of staff working to provide a service. Reorganization has had a huge impact on the service with staff struggling to provide training. These findings suggest that the Haematology laboratory needs more resources to provide suitable training to newly qualified scientists to enable them to participate competently and confidently in the 24 hr shift. This research study gives a strong idea of what is knowledge is needed by newly qualified biomedical sciences as well as ideas on how to implement theoretical and technical knowledge. The qualities deemed essential are also noted as well as how to develop these.

8.2 Clinical implications

This study can be translated into a training aid to the laboratory with the variety of methods that the experts and band 5s have suggested. There is also an important aspect that involves developing personal qualities as well as technical and scientific knowledge .Virtual learning can be a valuable tool in training haematology scientists. Case studies and validation cases can be uploaded in databases making a relevant library for trainees. Virtual learning takes the stress away from supervising and explaining certain things to trainees. This would improve the laboratory culture. It would also create confidence in the trainees. Virtual learning could be used not only for the mentioned cases but for any of the topics needed to help gain scientific knowledge and technical skill. All basic knowledge might be from one textbook that can be adapted virtually allowing for standardization of the science curriculum. Resources such as exams could also be used to assess competence. Video techniques for certain procedures may be essential. The training needs for biomedical scientists are not being met in this current climate of organizational change. One of my aims is to develop a virtual learning programme that focuses on morphology and validation. This would serve as training and assessment tool which would be valuable in times where there are less staff .Easily accessible, a virtual programme could provide standardised learning materials. It would help build up competence and confidence in the trainee. It would take the burden of training off the laboratory and prevent them from each of them writing their own learning materials. This study has made me more supportive and patient while training trying to bridge theoretical and technical knowledge. The rushed nature of training has made me conscious of the relevance of training in a correct time frame and the alignment of experienced staff and trainees with the addition of a mentor. I use known case studies to build competence as well as breaking down things as simply as possible to promote understanding and apply the knowledge to real life situations. Known cases are particularly useful as patients are not affected. Having resources and learning materials in one place save the time and energy of trainees and trainers trying to collate the right level of theoretical and technical science in an easy to understand manner.

As well as this those in charge of rotas should ensure trainees are rotated appropriately in different sections. Staff numbers should be taken into account, not just to run a service but to provide training. Training times should be protected. Appropriate personnel should be allocated to trainees such as a mentor as well as aligning shifts with those who want to assist in training.

8.3 Contribution to knowledge

- A training programme based on the content of the specialist haematology portfolio covers all the topics necessary for the 24 hr shift.
- Virtual learning can be an asset while learning with relevant technical and theoretical information and learning resources like validation examples and morphology slides.
- Strong organization is required by management to ensure that trainees are rotated in relevant sections for the relevant amount of time with someone who is competent and willing to train.
- Staff who are training or being trained should not be considered as part of the team working the shift and managers must take into consideration staff numbers and skill mix to ensure a safe and efficient service.
- A mentor who can guide the trainee is viewed as very important.
- Trainees must be committed and must take responsibility for self-directed learning.
- Trainers must be dedicated and also be committed to training.
- Care must be taken to use a variety of methods, taking the time to develop both technical and scientific knowledge as well as personal qualities.
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8.4 Strengths of this research

The learning processes of biomedical scientists is an under investigated area and this study offers potential suggestions and ideas of how to implement learning. This study also offers a perspective of the effects of NHS reorganization on Haematology Laboratory and the impact of training on the new workforce. The method chosen was well suited as it involved senior members involved in training.

8.5 Limitations of the Current Study

From a recruitment point of view, there was little representation from those working in biomedical sciences at a university level.

Donohue *et al* . (2012) noted two main limitations of the e-Delphi as being challenging to those who are not computer literate as well as having to factor in experimental control such as time off for vacations or other time distractions. The former was a smaller issue in this project with some participants having difficulties scanning the consent forms. The latter reason was challenging to work around and added extra time to the study. The authors also noted the time commitment required to take part in the Delphi study. This study took a strong time commitment from the researcher and the participants with rapid turnaround to get the next round of questions set up after the successful analysis of previous responses.

Attrition was also noted to be a limitation of the Delphi Method (Hsu & Sandford, 2007).This did lead to the loss of one participant. Regular feedback and reminders to those who needed it were given to the participants to support retention.

Bias can also be introduced by the participants (Hallowell, 2009).The Delphi method is led by the participants' views. A key strength of the Delphi Method is that experts were chosen. .Albarquoni *et al* . (2018) performed a study to identify core competencies of health professionals yet they came from a range of professions and noted “they may not adequately represent the full spectrum of views held by individuals within a single profession ” (p. 9). This may be true of this study as well, as the majority of data has come from the training officers. Other relevant personnel like band 6s who train were underrepresented and their perspectives might give valuable insight into training techniques.

8.6 Future studies

It is important to undertake a study on newly trained Band 5s or at least get more scientists to fill out the questionnaire for the second study. However recruitment of newly qualified band 5s was challenging. Several points made by the band 5’s did not echo what the experts said especially about the qualities of a biomedical scientist and how to develop these.

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Appendices

Appendix A. CASP Checklist

Appendix B. Study One Ethical Approval

Appendix C. Study One Participant Advert

Appendix D. Study One Participant Debrief

Appendix E. Study One   Ethical Consent

Appendix F. Study One First Delphi Round One Questions

Appendix G. Study Two   Ethical Approval

Appendix H. Study Two Participant Advert

Appendix I. Study Two Participant Debrief

Appendix J. Study Two   Ethical Consent

Appendix K.Study Two Questions

Appendix A

CASP Checklist

Score	
Yes	1
Partially	P
Can't tell	x

	Statement of aims	Qualitative method appropriate	Appropriate research design	Appropriate recruitment strategy	Data collection addressed research issue	Relationship between researcher and participants considered	Ethical issues	Rigorous data analysis	Clear statement of findings	How valuable is the research	Overall score (0-10)
Leung *et al* . (2015)	1	1	1	1	1	1	P	1	1	1	9.5
(Navarro *et al* ., 2019)	1	1	1	1	1	x	P	P	1	1	8

Appendix B

Study One Ethical Approval

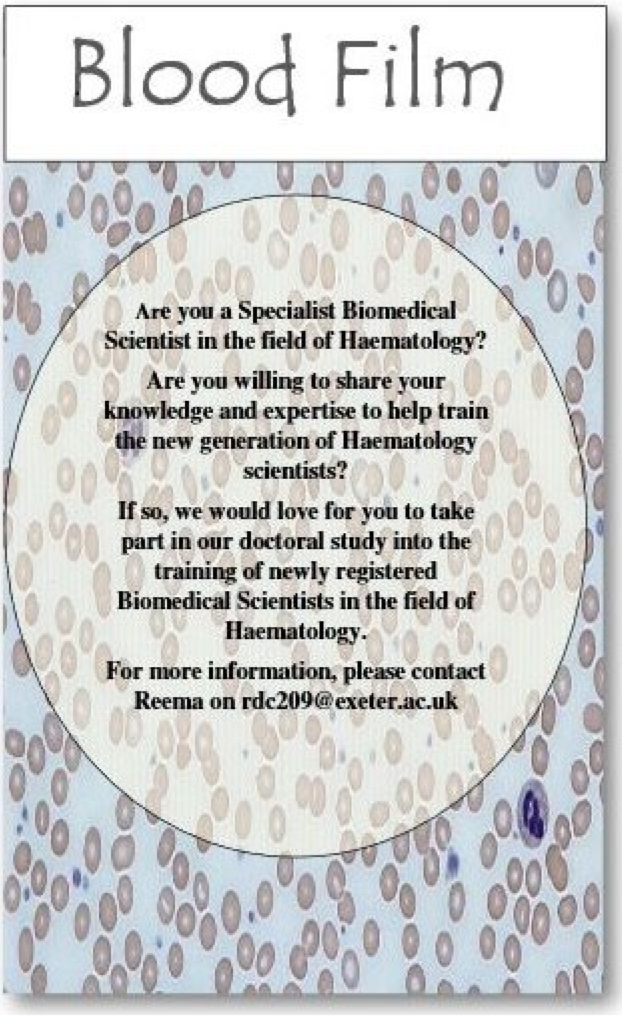
From: apache@exeter.ac.uk [mailto:apache@exeter.ac.uk] **On Behalf Of** Ethics Approval System
Sent: 07 June 2017 13:38
To: Knapp, Karen <K.M.Knapp@exeter.ac.uk>
Subject: Notification of ethical approval decision : accepted

---

This is to inform you that the application (2017/1681)
by Reema Chumun
Entitled
Evaluation of the training requirements of newly qualified Health and Care Professions Council registered biomedical scientists in the field of Haematology.
has been accepted

Appendix C.

Study One Participant Advert



Appendix D.

Study One Participant Debrief

Psychology
College of Life and Environmental Sciences
University of Exeter
Washington Singer Building
Perry Road
Exeter EX4 4QG
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Tel: +44 (0) 1392 724626
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Email: psychology@exeter.ac.uk

Version 29.04.18

Participant Information Sheet

How do you feel training can be improved for newly qualified HCPC scientists?

We would like to invite you to participate in a research study into training newly qualified Health and Care Professions Council (HCPC) scientists in the Haematology Laboratory. Taking part in the study is voluntary so before you make a decision, it is essential to understand why the research is being done and what it will involve. Please read the following information sheet and feel free to discuss it with other people to inform your decision.

Thank you for taking the time to read this information.

What's involved?

In the past few years there have been many changes in Trusts due to Agenda for Change. Previously staff were paid twice their day rate to do night duty and in many Trusts night duty was a voluntary aspect. Agenda for Change has led to many trusts getting rid of the high pay rate and introducing compulsory 24 hour shifts. There are limited finances and resources in the current National Health Service (NHS) yet large numbers of undertrained staff are being hired. As there is no guarantee that a HCPC qualified scientist will have experience in the field they are currently working in there is a need to train newly qualified biomedical scientists to the standard required to perform competently.

Training professionals in specialised fields has always had its challenges. Yet in a time and resource-limited environment like the current NHS this has become even more difficult.

The proposed project will investigate whether there is a need for a haematology training programme for newly qualified biomedical scientists and may have the potential to set up such a programme.

IBMS Training officers and scientists responsible for training have been interviewed and the data has been used to help construct this questionnaire.

What would taking part involve?

We have invited you to take part because we are looking for biomedical scientists in the field of Haematology who have qualified recently to take part in our questionnaire based study. If you agree to take part you will be asked to sign a consent form stating that you are happy to take part.

This research project involves a single questionnaire that should take no more than 40 minutes. You will be given a personalised email via Qualtrics which will contain a link to the questions.

What are the possible benefits of taking part?

The main benefits of the proposed research are educational and there will be limited personal benefit to you. However, the results will increase our understanding of training newly qualified HCPC scientists in the Haematology Laboratory.

What are the possible disadvantages and risks of taking part?

A challenge to doing this study might be the time taken.

Further supporting information

Do I have to take part?

Please remember that participation in this study is entirely voluntary. If you decide to take part you are free to leave the study at any time without giving a reason as to why you wish to do so. If you do decide to participate in this study you will be asked to sign a consent form before you start. You will be given a copy of the consent form and this information sheet for your own records.

Are my results confidential?

If you consent to take part in this study you have a right to privacy. Your name will be linked to an ID number on a password protected database and only these IDs will be used.

What will happen to the results of this study?

The results will increase our understanding training newly qualified HCPC scientists in the Haematology Laboratory. We will aim to publish the findings in research journals and to present them at conferences in the UK or abroad. Your data will always remain anonymous and your name will not appear on any results.

Who has reviewed this study?

All research activity at the University of Exeter is examined and approved by an ethics committee to protect your interests. This study has been approved by the Ethics Committee of Psychology, College of Life and Environmental Sciences, University of Exeter.

Contacts for further information

If you would like more information or if you have any further questions about the study please contact the investigator using the details below.

Reema Chumun
Psychology **College of Life and Environmental Sciences** **University of Exeter** **Washington Singer Building** **Perry Road** **Exeter EX4 4QG** **United Kingdom**
Tel: 07715638102
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Research Supervisor
Dr Ian Frampton
Psychology **College of Life and Environmental Sciences** **University of Exeter** **Washington Singer Building** **Perry Road** **Exeter EX4 4QG** **United Kingdom**
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CLES Psychology Ethics Chair
Dr Lisa Leaver
Psychology **College of Life and Environmental Sciences** **University of Exeter** **Washington Singer Building** **Perry Road** **Exeter EX4 4QG** **United Kingdom**
Email: L.A.Leaver@exeter.ac.uk

Appendix E.

Study One Ethical Consent

Psychology
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Study: Evaluation of the training requirements of newly qualified Health Care and Professions Council registered biomedical scientists in the field of Haematology.

Researcher: Reema Chumun

Organisation: The University of Exeter

Version: 1. 29.04.18 reviewed by The University of Exeter ethics committee

.

Informed Consent form for participants

Please initial box

I confirm that I have read and understand the Information sheet Version: 1. 29.04.18 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐

I understand that any information given by me may be used in future reports, articles or presentations by the research team. ☐

I understand that my name will not appear in any reports, articles or presentations. ☐

With no restrictions ☐

Or,
With the following restrictions: ________________________________
____ ☐

I agree to take part in the above study. ☐

Name of Participant Date Signature

Name of Researcher	Date	Signature

Appendix F

Study One First Delphi Round One Questions

To what extent is current training in the laboratory is adequate for newly qualified HCPC scientists working in Haematology?
How do you feel that NHS and Organization change have affected training?
Is the accredited IBMS degree enough to support the profession? In what way does the degree support/not support the profession?
What core competencies are required for Haematology and Coagulation for working the 24h shift?
How would you develop these competencies to enable full understanding knowledge and technique?
What are the necessary IT skills needed for 24h shift?
What qualities and interpersonal skills do you feel are necessary for the 24hr shift?
Anything else about proficiency you would like to add?

Appendix G

Study Two Ethical Approval

Dear Reema Chumun,

Application ID:	**eCLESPsy000678 v4.1**
Title:	**Evaluation of the training requirements of newly qualified Health Care and Professions Council registered biomedical scientists in the field of Haematology**

Your e-Ethics application has been reviewed by the CLES Psychology Ethics Committee.

The outcome of the decision is: **Favourable**

Potential Outcomes

Favourable:	The application has been granted ethical approval by the Committee. The application will be flagged as Closed in the system. To view it again, please select the tick box: View completed
Favourable, with conditions:	The application has been granted ethical approval by the Committee under the provision of certain conditions. These conditions are detailed below.
Provisional:	You have **not** been granted ethical approval. The application needs to be amended in light of the Committee's comments and re-submitted for Ethical review.
Unfavourable:	You have **not** been granted ethical approval. The application has been **rejected** by the Committee. The application needs to be amended in light of the Committee's comments and resubmitted / or you need to complete a new application.

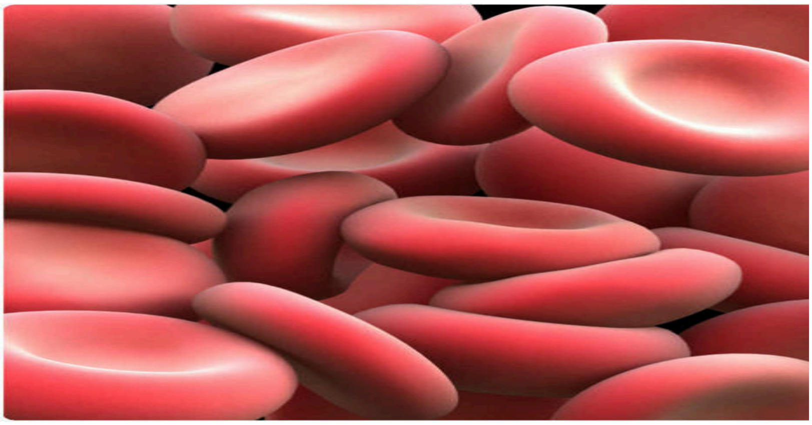
Please view your application here and respond to comments as required. You can download your outcome letter by clicking on the 'PDF' button on your eEthics Dashboard.

If you have any queries please contact the CLES Psychology Ethics Chair:
Lisa Leaver L.A.Leaver@exeter.ac.uk

Kind regards,
CLES Psychology Ethics Committee

Appendix H

Study Two Participant Advert



Looking for all newly qualified Band 5 biomedical scientists who have worked in Haematology.

Do you want to help influence training in Haematology Labs?

If so, would you like to take part in an online questionnaire that will take no more than 40 minutes?

I am doing a doctoral project involved in training scientists in Haematology with the University of Exeter and would love your assistance.

For more information please contact

Reema at rdc209@exeter.ac.uk

Study Two Participant Debrief

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Version 1 June 2017

Participant Information Sheet

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The proposed project will investigate whether there is a need for a haematology training programme for newly qualified biomedical scientists and may have the potential to set up such a programme.

What would taking part involve?

We have invited you to take part because we are looking for experienced biomedical scientists in the field of Haematology to take part in our questionnaire based study. We will be inviting at least 20 professionals to take part.

If you agree to take part you will be asked to sign a consent form stating that you are happy to take part.

This research project involves the Delphi Method. This method is a structured communication technique used to affirm consensus among experts. It involves asking experts to give opinions, read summarised versions of other panel members, to then revisit their opinions in light of others opinions and to give reasons for their judgements. The first round of questions will use structured questions. This will allow panellists to state their opinions.The second round questionnaire will be constructed from the data gathered from the first questionnaire. A quantitative, 'tick-box' style survey using Likert type agreement scales will be used. On receiving data from questionnaire 2, descriptive data analyses will be done so percentages can be fed back to give a more visual presentation to panellists. The third round questionnaire is to invite panellists to consider their scores in the light of the group response and decide whether they want to change any of their responses. Percentages will be fed back and individual round scores will be provided for every item.

You will be given a unique username and password to access the questions for this research project via Survey Monkey.

Each round of testing will take no more than 40 minutes and must be completed in 3 weeks. At this stage 4 rounds of questioning is expected.

What are the possible benefits of taking part?

The main benefits of the proposed research are educational and there will be limited personal benefit to you. However, the results will increase our understanding of training newly qualified HCPC scientists in the Haematology Laboratory.

What are the possible disadvantages and risks of taking part?

A challenge to doing his study might be meeting the deadline every 3 weeks.

Further supporting information

Do I have to take part?

Please remember that participation in this study is entirely voluntary. If you decide to take part you are free to leave the study at any time without giving a reason as to why you wish to do so. If you do decide to participate in this study you will be asked to sign a consent form before you start. You will be given a copy of the consent form and this information sheet for your own records.

Are my results confidential?

If you consent to take part in this study you have a right to privacy. Your name will be linked to an ID number on a password protected database and only these IDs will be used.

What will happen to the results of this study?

The results will increase our understanding training newly qualified HCPC scientists in the Haematology Laboratory. We will aim to publish the findings in research journals and to present them at conferences in the UK or abroad. Your data will always remain anonymous and your name will not appear on any results.

Who has reviewed this study?

All research activity at the University of Exeter is examined and approved by an ethics committee to protect your interests. This study has been approved by the Ethics Committee of Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter.

Contacts for further information

If you would like more information or if you have any further questions about the study please contact the investigator using the details below:

Reema Chumun
Psychology **College of Life and Environmental Sciences** **University of Exeter** **Washington Singer Building** **Perry Road** **Exeter EX4 4QG** **United Kingdom**
Tel: 07715638102
Email: rdc209@exeter.ac.uk

Appendix J

Study Two   Ethical Consent

Psychology
College of Life and Environmental Sciences
University of Exeter
Washington Singer Building
Perry Road
Exeter EX4 4QG
United Kingdom

Tel: +44 (0) 1392 724626
Fax: +44 (0)1392 724623
Email: psychology@exeter.ac.uk

Study: Evaluation of the training requirements of newly qualified Health Care and Professions Council registered biomedical scientists in the field of Haematology.

Researcher: Reema Chumun

Organisation: The University of Exeter

Version: 1. 01.06.17 reviewed by The University of Exeter ethics committee

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Informed Consent form for participants

Please initial box

I confirm that I have read and understand the Information sheet Version: 1. 01.06.17 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐

I understand that any information given by me may be used in future reports, articles or presentations by the research team. ☐

I understand that my name will not appear in any reports, articles or presentations. ☐

With no restrictions ☐

Or,
With the following restrictions: ________________________________
____ ☐

I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Name of Researcher	Date	Signature

Appendix K

Study Two Questions

Question 1

Is there anything you would like to add/remove to the list of competencies?

Haematology Competencies

Using and maintaining (including Quality Control performance and troubleshooting) analysers for:

Full Blood Count

Erythrocyte Sedimentation Rate/Plasma Viscosity

Using and maintaining (Including Quality Control performance and troubleshooting) equipment for

Glandular Fever

Sickle cell test

Glucose -6- Phosphate Dehydrogenase

Rapid Diagnostic Tests for Malaria Parasites.

Validation and Interpretation of results for all the above tests

Making and staining blood films (including Malaria films) manually or via automation

Blood Film Morphology especially

Blasts

Haemolysis features

Leukaemia

Schistocytes

Positive Malaria Identification

Appropriate Film referral to Haematology Consultants

Recognising a clinical emergency

What actions to take for a clinical emergency.

Coagulation Competencies

Using and maintaining (Including Quality Control performance and troubleshooting) analysers for:

Coagulation screen

D-Dimer Testing

Anticoagulant monitoring screens including international normalized ratio, Anti-Xa assay and New Oral Anticoagulants.

Factor assays

Van Willebrands Screen

Using, maintaining (Including Quality Control performance and troubleshooting) and troubleshooting equipment for

Manual Coagulation

Sample separation

Validation and Interpretation of all above test results

Recognising a clinical emergency

What actions to take for a clinical emergency.

General Laboratory competencies

Direct Doctors to the appropriate pathway for requesting for specialist tests

Performing all tests within Department l turnaround times.

Mandatory training according to Hospital policy.

Specimen reception-booking in samples and preparing samples according to tests requests.

Use of Courier services-booking couriers, knowledge of specialised tests and where they are performed.

Use of Laboratory Information Management System-booking in samples, adding and deleting tests, validating results, adding and deleting information to records. Basic troubleshooting.

Basic Using and Troubleshooting Interfaces.

Use of Quality Management Software to access relevant documentation.

Use of Patient administration systems- Basic log in and access to check patient history and records

Use, maintenance and basic troubleshooting of automated or manual sample tracking system.

Question 2

The most popular ways of training are

Shadowing Experienced Scientist prior to lone working.

Case studies-EQA, Internal and those which give equivocal results.

Mentor system: 1-1 meetings, review training at regular intervals.

Digital Morphology Scheme or Lab own morphology training scheme

Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test

If no what 5 ways would you pick instead?

Case studies-EQA, Internal and those which give equivocal results.

Seminars

Tutorials

Training opportunities from NEQAS and Haematology/Coagulation Automation Companies.

Lectures in relevant topics

Workshops

Placements

Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test

Observation

Examination Audits

Mentor system: 1-1 meetings, review training at regular intervals.

Shadowing Experienced Scientist prior to lone working.

Team input-Info/knowledge from Managers and Consultants as well as Heads of department.

Digital Morphology Scheme or Lab own morphology training scheme

In-House Structured training programme

Self directed learning/Ownership of own development

Witness statements

Specialist IBMS portfolio

Read SOP watch/observe, write, do, and review

Use of Training folder

Working FlowCharts to enable staff to look up necessary information

Question 3

Would you pass on specialised knowledge to scientists in the same way?

If no what 5 ways would you pick instead?

Case studies-EQA, Internal and those which give equivocal results.

Seminars

Tutorials

Training opportunities from NEQAS and Haematology/Coagulation Automation Companies.

Lectures in relevant topics

Workshops

Placements

Competency assessment-exams, thorough questions that demonstrate understanding, checking test result examples with known outcomes and action comments, blind morphology test

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Read SOP watch/observe, write, do, and review

Use of Training folder

Working FlowCharts to enable staff to look up necessary information

<u>Question 4</u>

These personal qualities were the most important

Communication

Working under pressure

Time management

<u>Do you agree that these are the most important qualities?</u>

<u>If no then what 3 would you choose instead?</u>

Reliable
Ability to know where personal knowledge and experience is exceeded and what to do
Ability to work alone
Able to multi-task
Approachable
Attention to detail
Confidence in own abilities
Cope with a lack of sleep
Efficiency
Firm
Flexibility
Good problem solving skills
Good understanding of hospital policies
Knowledge of scientific language for conversations with medical staff
Team Worker
Patience
Patient conscious
Polite
Professional
Organisation skills
Work on own initiative

Which 5 methods would you use to develop qualities in the laboratory?

Experience, Everyday working
Workshops/role playing that mimics real life scenarios
Assessments testing real-life knowledge in a time limited scenario
Shadowing an experienced scientist
Mentoring-one to one training, coaching
Incorporated in Laboratory training.
Personal reflection
Daily tick-sheet for completing specific tasks in specific times.
Training Courses
After shadowing a scientist on a weekend shift, trainee BMS is left alone in the laboratory with trainer BMS out of lab but nearby enough for trainer to come in if needed. The trainee BMS is also shadowed by a trainer BMS on the first night shift. Meetings to ensure trainee BMS is confident after these scenarios to work alone.

Question 5
Anything else you would like to add?