An exploration of the effect of simulation on perceptions of medical students' preparedness for professional practice; a mixed-methods, longitudinal study

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A study submitted in fulfilment of the requirements for the degree of Doctor of Medicine at Lancaster University

Lancaster Medical School

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Declaration of Authorship

I, Ciara Carpenter, declare that this thesis entitled: "An investigation into the effectiveness of simulation to prepare medical students for professional practice; a mixed-methods, longitudinal study", and the work presented in it is my own and has been generated by me as the result of my original research.

I confirm that:

1. This work is carried out under the auspices of Lancaster Medical School as the fulfilment of the requirements for the degree of Doctor of Medicine (MD).
2. Where any part of this thesis has been previously submitted for a degree or any other qualifications at this university or any other institution, this has been clearly stated.
3. Where I have used or consulted the published work of others, this is always clearly attributed.
4. Where I have quoted from the works of others, the source is always given. With the exception of such quotations, this dissertation is entirely my own work.
5. I have acknowledged all sources used for the purpose of this work.

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Abstract

Studies have shown that some medical students do not feel prepared to practice as a foundation doctor (FY1) once they graduate. Although there have been various reforms in medical education, levels of preparedness have remained static since 2012. Preparedness is vital to ensure patients are getting the best, safest care, and to avoid stress, anxiety and burnout in junior doctors. Technology-enhanced learning has become commonplace in medical education; with this, simulation has been introduced in wide-ranging ways. Although the evidence for simulation improving patient outcomes is clear across postgraduate and continuing professional education, studies have failed to systematically show the same outcomes for undergraduates, despite the widespread use of simulation in undergraduate medical curricula.

This mixed-methods, two-phase study was designed to explore the effects of simulation on perceptions of students' preparedness for professional practice. The study took a longitudinal format, over two academic years, gathering data (with questionnaires and interviews) from two participant groups; fifth-year medical students and key stakeholders. The study compared two diverse simulation formats; ward simulation and bleep simulation, both designed to develop the knowledge and non-technical skills required for the transition to professional practice.

The results of this thesis suggest that simulation has a role in preparing students for the knowledge required for professional practice and may result in a change in behaviour longitudinally. However, there is an apparent disconnect between stakeholder and student perceptions of preparedness, and while students may feel prepared, their supervisors and other stakeholders do not agree. Furthermore, despite feeling prepared, students still feel concerned and anxious about the transition to professional practice. The results also highlighted the difficulties in thoroughly preparing students for the complexities of becoming an independent practitioner and emphasises the importance of support and continued learning throughout the foundation years.

Acknowledgements

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A further thanks go to Tom Keegan. Although he has not converted me to the 'dark side' of epidemiology and statistics, his statistical assistance, tolerance of my ignorance and input into draft chapters was invaluable.

Never would I think that I would be pleased to go to (clinical) work for a 'break'! Thanks go to my clinical supervisor at LTHTR, Alison Gale, for believing a novice researcher could accomplish an MD and providing me with this amazing opportunity. I have, through this role, had the privilege to work with the best team of midwives, doctors, health care assistants, and theatre staff, who have become like a family over these three years.

Without the participants, there would be no thesis. A massive thanks go to the students and stakeholders who agreed to be part of the study and share their views and their precious time. For me, the most enjoyable part of this research was hearing their stories and experiences.

A final thanks go to Andy, who was upgraded from boyfriend to husband while writing this MD. He has been a welcome source of humour and a person to vent my frustrations to, despite him never fully understanding why I chose to add another three years to my postgraduate training! Our dog Jolie has provided much-needed pet therapy during the most frustrating and difficult periods of writing, without the both of them, our family and friends to keep me rational, I would have never seen this project to completion.

Contents

List of Figures

List of tables

GLOSSARY

ALERT – Acute Life-Threatening Events – Recognition and Treatment (simulation)

ABCDE – Mnemonic for patient assessment in an emergency; Airway, Breathing, Circulation, Disability, Exposure

ADR – Adverse drug reaction

ALS – Advanced Life Support training

ALSO – Advanced Life Support in Obstetrics

AMEE – Association for Medical Education in Europe

ARCP – Annual Review of Competence Progression

BEME – Best Evidence Medical Education (review)

BLS – Basic life support

CASP - Critical appraisal skills programme checklist

CBL – Case-based learning

CCT – Certificate of Completion of Training

CMT/CST – Core medical/surgical training

CPD – Continuing Professional Development

CPR – Cardiopulmonary resuscitation

CT1, CT2, CT3 – Core Trainee year 1, 2, 3

ECG – Electrocardiogram

ELHT – East Lancashire Health Trust; Royal Blackburn Teaching Hospital

E-Portfolio – Electronic portfolio

EWTD – European Working Time Directive

FY1/2 - Foundation year doctor 1/2

GMC – General Medical Council

GPST – General Practice Speciality Trainee (years 1-3)

HEE – Health Education England

Intern - Intern/PGY1/FY1 – the first postgraduate year. In some countries full registration or licencing will be awarded (with or without an examination) following this year.

KP1-4 – Kirkpatrick's levels 1-4

LMS – Lancaster Medical School

LTHTRTR – Lancashire Teaching Hospitals NHS Trust (Royal Preston Hospital)

MCQ – Multiple choice questions

MDT – Multidisciplinary team (within the hospital setting, often made up from nurses, doctors, physiotherapists and other ancillary staff)

MERSQI - Medical Education Research Study Quality Instrument

MLA – Medical licencing examination

MMC – Modernising Medical Careers

MMS – Manchester Medical School

NHS – National Health Service

OG2015 – Outcomes for Graduates – The GMC, 2015

OR – Odds ratio

OSAT- Objective Simulation Assessment Tool (in this thesis; outside of this thesis OSAT refers to objective structured clinical assessment)

OSCE – Objective Structured Clinical Examination

PBL – Problem-Based Learning

PIS – Participant information sheet

PRHO – Pre-registration House Officer (old term, replaced by FY1)

PROMPT – PRactical Obstetric MultiProfessional Training

PSA – Prescribing safety assessment

RCOG – Royal College of Obstetricians and Gynaecologists

RCS – Royal College of Surgeons

RCT – Randomised control trial

Resident/ Speciality trainee – period of training in a specific speciality e.g. obstetrics and gynaecology, paediatrics. Term used in many non-UK health settings

SBAR – Mnemonic for handover; Situation, Background, Assessment, Recommendation

SHO – Senior House Officer (old term – but may be used to describe any doctor more senior than an FY1 but junior to a registrar, for example, FY2, CT1-3, ST1-2, GPST1-2)

SJT – Situational judgement test

SpR – Speciality Registrar

ST1, ST2, ST3 – Speciality Trainee year 1, 2, 3

TAB – Team assessment behaviour form

TD09 – Tomorrow’s Doctors 2009, a report by the GMC

TeamSTEPPS - ‘evidence-based teamwork system to improve communication and teamwork skills among health care professionals’ developed and used by postgraduate healthcare professionals in the US

UHMBT – University Hospitals of Morecambe Bay NHS Trust (Lancaster Royal Infirmary)

UKFP – UK Foundation Programme

Participant acronyms
S (number suffix) – Student participant
SH (number suffix) – Stakeholder participant
FYD (number suffix) – Foundation Doctor participant
SFTQ – Student free-text questionnaire response
SHFTQ – Stakeholder free-text questionnaire response

1 Introduction: Simulation and the transition to professional practice

This thesis sought to explore the effects of simulation in undergraduate medical education on medical students' perceived preparedness for practice. This chapter presents the background to the rationale of the thesis. First, a brief background on medical education and the changes over the last 15-20 years are described to situate the reader in recent developments and how they have impacted preparedness. Following this, simulation is introduced, with a history of the technique, the educational theories informing simulation, a description of the essential components and the benefits and drawbacks of the method. An overview of Kirkpatrick's levels follows; the methodology used throughout this thesis to evaluate the effectiveness of educational interventions. Finally, the concept of preparedness for practice is introduced, along with a description of the interventions that have already been implemented to improve preparedness, and how simulation may help to improve preparedness.

1.1 Background

The fundamental purpose of medical education is to produce up-to-date, competent doctors who put patients' needs and safety first. Medical education has been transformed over the past 30 years from apprenticeship-style 'see one, do one, teach one' to integrated undergraduate curricula and an emphasis on objective workplace-based assessments (1 pg1-4, 37, 69-70). Modern medical education covers a continuum of undergraduate, postgraduate and continuing professional development (CPD) of clinicians.

The catalyst for these changes was the General Medical Council's (GMC) first "Tomorrows Doctors" (1993, updated in 2002 and 2009, replaced in 2015 and 2018 with Outcomes for Graduates) (2-6). These documents were reflections of the research-driven changes in educational methods. The first Tomorrow's Doctors marked a change in the form of the GMC's guidance on medical education, suggesting that undergraduate medicine be taught in an 'integrated' systems-based way, with early and sustained clinical content (6). The emphasis shifted from the previous stance that valued only knowledge acquisition to an educational programme focused on clinical reasoning and communication skills (6). Following this and its successor in 2002, there was pressure on medical schools to reform their curricula. Lecture-based 'traditional' curricula focused on basic science which contained little clinical experience were mostly replaced with problem- or case-based learning (PBL/CBL) integrated courses with an emphasis on communication and early clinical experience (see 1.4.2.3)(7). In addition to an emphasis on communication, non-technical skills have come to the forefront. The use of technology in medical education also intensified and alongside various digital technologies, simulation has been introduced in wide-ranging ways.

In addition to undergraduate reforms, postgraduate training was also affected, principally by the European Working Time Directive (EWTD, 2003). The EWTD limited the working week to an average of 48hrs (in contrast to previous practice, in which there were no restrictions on doctors' hours), with compulsory rest breaks and days (8). The directive thereby reduced doctors' hours and precluded the practice of 24-hour resident on-calls (8). At the time, there were concerns that the EWTD would affect continuity of care for patients and cause a reduction in training opportunities (9, 10). Following the introduction of the EWTD, developments in medical education and the move to a competency-based system, there was a pressing need to streamline training, accomplished by Modernising Medical Careers (MMC, 2005 (11)). MMC restructured postgraduate training across all specialities, created the Foundation Programme (UKFP) and resulted in a reduction in the overall length of training (

Figure 1-1), adding to concerns about training opportunities. The new UKFP replaced the old Pre-registration house officer (PRHO) year with two years of general training, with full registration to practice awarded by the GMC after the first year (11).

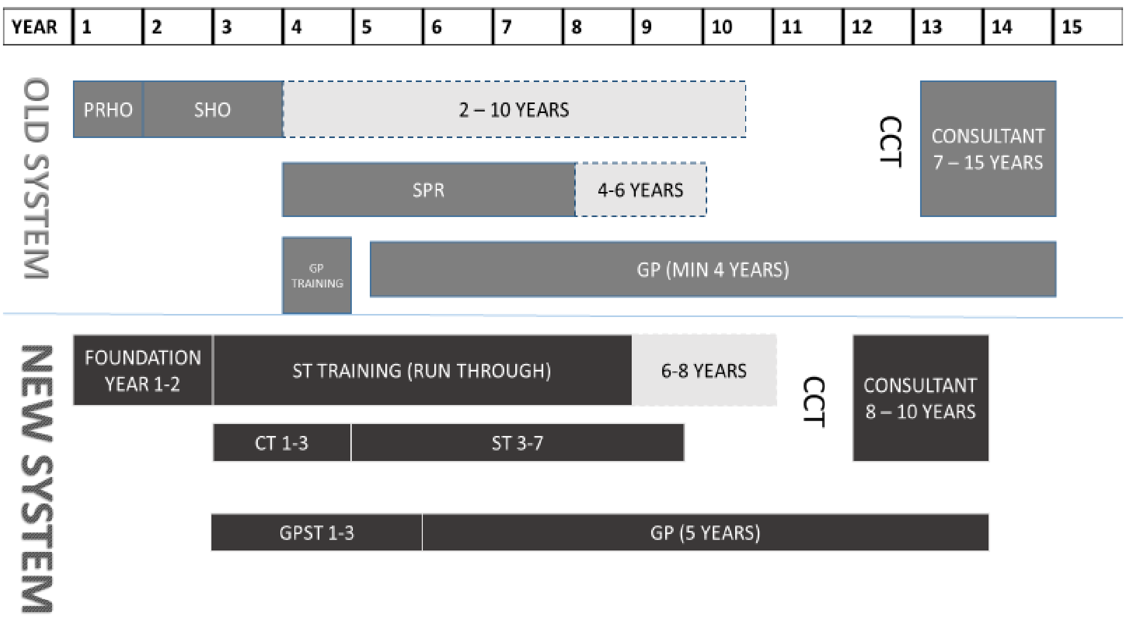


Figure 1-1 – Medical training before and after MMC (11, 12)

Alongside the changes in education, working time restrictions, staffing pressures, and financial austerity may mean that clinicians have less time and funding dedicated to training juniors. Many NHS trusts are now in significant financial deficit, and there are enormous burdens on our health service (13, 14). The rise in nurse practitioners and other ancillary staff delivering care that would have previously been a doctor's domain may have led to fewer learning experiences, compounding concerns about training opportunities. Furthermore, patient safety is at the forefront following the Francis and Kirkup reports on failings at Mid-Staffordshire NHS Foundation Trust and the University Hospitals of Morecambe Bay NHS trusts respectively (15, 16). In an increasingly litigious climate (15, 16), and with an increase in accountability, quality, safe, cost-effective medical education has never been more vital. Changes in medical education, with an increase in costs and resources needed, and substantial burdens on the NHS have undoubtedly put pressure on training provision. Simulation technology is a safe method of providing training, may be a way to address this issue, and has become routine throughout medical education.

Despite differences in healthcare systems, simulation is internationally recognised and used. Therefore, international studies will be considered throughout this thesis. Although the context of medical education in the UK is different from that in other countries, it is useful to consider international studies in this thesis, albeit with caution, given the unique nature of training and service provision in the NHS. Other countries' systems for medical education vary, and they have different terms for trainees at various stages, which can make them difficult to situate within the UK context (see Table 1-1 for medical education systems in the nations with papers included in this thesis).

Table 1-1 – Worldwide difference in medical training (17-21)

	Australia	**Canada**	**Europe**	**Southeast Asia**	**USA**	**UK**
Direct entry from secondary education	Yes, graduate entry also available	No, previous BSc required	Yes, graduate entry also available	Yes, some have pre-med component, graduate entry available	No, previous BSc required	Yes, graduate entry also available
Degree	MBBS, 5-6 years	MD, 4 years	MD, 5-6 years	MBBS 5-6 years	MD, 4 years	MBBS, MbChB, MB, 5-6 years
Internship	Yes, Postgraduate year one (PGY1)	No	Depends on country*	Depends on country*	No	Yes, two-year foundation programme (FY1-2)
Licencing	Automatically following PGY1	Licencing examination immediately after graduation			Licencing examination immediately after graduation	Automatically following FY1
Residency						
GP/Family medicine training	3-4 years	2 years	3-5 years		3 years	3 years
Speciality training	3-7 years May be split into basic/ advanced, most have an exit examination	4-6 years May be split into basic/ advanced	4-8 years May be split into basic/ advanced	4-6 years	3-7 years	5-7 years May be run-through or uncoupled, most split into basic/ advanced

*Germany – licensing exam at graduation, no intern year. Netherlands, Spain, Greece, Turkey – Automatic licensing at graduation, no intern year. Ireland – Intern year followed by licensing examination. Singapore – Intern year followed by licensing examination. Thailand – Licensing exam at graduation, followed by intern year (some specialities require 2-3-year internship). Korea – Licensing exam at graduation

1.2 Simulation in medical education

Simulation in medical education includes any scenario using mannequins, devices, computers or actors to recreate reality (1 pg164-165). Many different disciplines outside medicine use simulation technologies in training; the aviation industry in particular has used simulation to reduce human error and improve safety. In clear parallels with medicine, industry experts in aviation worried that “training in the real world would be too costly and dangerous” (22). Primitive wooden flight simulators from the early 20th century paved the way for expensive, state-of-the-art technology so advanced that users may now learn to fly an aircraft without leaving the ground (22). Non-technical skills team training was introduced in aviation in the 1970s, years before it was used for this purpose in medical education (23). Anatomical models have been used to train medical scholars for thousands of years, including life-sized bronze models for acupuncture in the 10th century (24), and various birth simulation models in the 18th century (24, 25). At this time, there were high levels of fetal and maternal mortality, reflecting the ethos of using simulation in high-risk areas where training, in reality, may be too dangerous.

The origins of medical simulation as it is known now began in the 1960s with Resusci-Anne, a basic resuscitation mannequin (26). The resuscitation movement was a catalyst for increasingly realistic, sophisticated simulators that provided feedback to the users, developed through the 1960-80s (27), precursors to the integrated mannequins seen in modern simulation (27). From its roots in anaesthetics and resuscitation, simulation is now used in almost every speciality, across the three levels of medical education (28).

In medicine, simulation (Figure 1-2) allows users to practise diagnostic reasoning, management, communication or non-technical skills before or alongside contact with real patients. A simulated patient is a person or actor trained to recreate the signs and symptoms of a real patient; they may be standardised, particularly as they are extensively used in assessment in undergraduate, postgraduate, and CPD medical education (29, 30). Realism or fidelity describes how ‘true to life’ the situation or equipment is; traditionally reflecting how advanced the technology was, categorised as low, medium or high fidelity (1 pg164-168, 31, 32). Over time, this classification was developed to avoid the inference that high-fidelity simulation was the best or most effective. Basic skills training (such as pelvic examination or venepuncture) requires less technical fidelity than that necessary for a multiprofessional advanced trauma course (Figure 1-2), but both may be equally appropriate and effective.

Type of simulation	Description	Technical fidelity: The technological complexity of the simulation(28)	Situational fidelity: How ‘true to life’ the simulation is	
			Environmental	How well the simulator presents other elements of the environment
			Engineering	How well the simulator or equipment imitates reality
			Psychological	How realistic the simulation is to the user
Part Task Trainers	Used to teach and practice technical skills in isolation	Task trainer/ low	Low situational fidelity	
	Examples: Venepuncture or cannulation arm, pelvic examination model			
Computer-Based Trainers	Virtual simulation via a computer program which allows for self-directed learning; may be related to basic sciences or more complex scenarios	High	Low situational fidelity	
	Examples: MicroSim suite (Laerdel©) – A computer program that simulates medical emergencies to develop users’ decision-making and critical thinking skills (10)			
Virtual Reality and Haptic Simulators	Computer-based representation of a task or environment which the user interacts with (similar to computer-based trainers) combined with haptic systems which provide a physical and tactile element	High	High environmental and engineering fidelity, psychological fidelity will depend on the user	
	Examples: Laparoscopic simulators for surgical skills, Endoscopic simulators			
Integrated Simulators	Combination of a mannequin with a computer that controls the physiology, which can be altered in response to actions by the user. The computer may fully control the mannequin, or a technician may be needed to control the system manually	High	High situational fidelity	
	Examples: Instructor driven; ‘SimMan’ (Laerdel©) Computer/model driven; ‘CAE Apollo’ (CAE Healthcare©)			
Simulated Patients	A well person, patient or professional, trained to recreate signs and symptoms of a disease; this may or may not be standardised	Low	May be high or low	
Simulated Environment	Contextualised simulation; overlaps with the fidelity of the simulation	May be high or low	High situational fidelity	
	Examples: Simulated ward, theatre			

Figure 1-2 - Types of simulation and fidelity (1 pg164-168, 31)

1.2.1 *Essential components, benefits, and challenges*

Various factors contribute to simulation's efficacy, applying to any style or type of simulation. The Best Evidence Medical Education (BEME) systematic review on high-fidelity simulation (updated in the Association for Medical Education in Europe (AMEE) guide) (32, 33) determined the essential components of simulation (shown below). Nearly half of all included studies cited feedback as the most important component of simulation, and therefore, debriefing is discussed further in 1.2.3.

1. Feedback (or 'the debrief')

In simulation-based learning, feedback from the simulator or instructors is the single most important characteristic (33). Feedback is a key feature of the theories discussed in 1.2.2 and allows learners to reflect on their performance and make changes towards improvement.

2. Repetitive/deliberate practice

Simulation provides an opportunity for users to participate in intensive, repetitive practice, which can improve competence and confidence. Repetition is vital for gaining and maintaining skills, but is difficult to recreate in the clinical domain (32).

3. Curriculum integration

Simulation is most effective when it is embedded into the curriculum: for example, a chest pain simulated scenario when learning about cardiac disease (34, 35) and used within the assessment of medical learners.

4. Range of difficulty level

Providing prior knowledge has been determined, users can start at an appropriate level and progressively ascend through the difficulty levels. Having a range of difficulty levels may be particularly crucial for procedural skills such as laparoscopic skills.

5. Multiple learning strategies

Simulation is adaptable to many learning strategies: large and small groups, individual learning, with or without instructors.

6. Clinical variation

A range of presentations containing different patients and diseases can be provided by simulation, in particular, rarer diseases not often experienced in reality.

7. Controlled environment

In a simulation, users may make decisions on diagnoses and treatment options in a completely standardised and safe environment, unlike real clinical settings, where patient safety prohibits this. Standardisation of scenarios allows equitable education for students, and due to the ability to standardise, simulation is now used extensively in medical examinations of all levels.

8. Individualised learning

Simulation provides learners with the opportunity to have active roles in patient care, stepping past the passive observer role that they might have in the real clinical environment. Learning can be individualised for each participant, depending on their needs.

9. Defined outcomes

Simulation can provide defined outcomes, for example, mastering basic suturing skills or procedural skills such as catheterisation or endoscopy. Users are more likely to achieve competence in skills if they have defined outcomes that are set at the right levels.

10. Simulator validity

Simulators provide realism/fidelity to recreate the clinical environment, which allows learning transfer to real clinical settings.

Communication, procedural and surgical skills are some of the skills increasingly taught using simulation technology (36-39). Patients now expect that clinicians have been trained to an acceptable level before providing care. Furthermore, patients may not want untrained students or doctors ‘practising’ on them (40, 41). While clinical experience is still fundamental to medical education, expertise can be maximised using both clinical experience and simulation. Finally, medicine is following the aviation industry with a focus on simulation for non-technical skills team training (23, 42-44). The empirical evidence for the benefits of simulation training is discussed in 1.2.4 and 2.2.

There are several challenges facing simulation and its use in healthcare. In the current financial climate, cost-effectiveness is at the forefront. Although there are many lower-cost options, cost may prohibit the use of the higher-fidelity integrated simulators (see Figure 1-2), particularly in lower-income countries. In addition to expensive mannequins, other overheads mean the cost of simulation can be difficult to estimate and is often not included in simulation studies (45). Zendejas et al found just 1.6% of all studies compared the cost of simulation with another educational modality (45). Nonetheless, if simulation training has beneficial effects on patient care, this may justify the cost outlay.

It is unclear exactly how much simulation is required for it to be effective, and how to balance experience with real and simulated patients. One study showed that junior medical undergraduates valued simulated patient experiences over real ones (46). However, some users find it more challenging to act as they would in clinical practice and find it hard to 'suspend disbelief'; these users are unlikely to find simulation beneficial. In addition, a previous good or bad experience with simulation may influence how useful simulation is for that individual. Simulation's effectiveness is as much reliant on the user as it is on the mannequin or simulated patient. No matter the fidelity, there will be some scenarios or topics that cannot be adequately taught with simulation. Given the cost, it is essential to focus simulation technology where it will be most effective and involve users who will gain the most from it.

1.2.2 Theoretical underpinnings of simulation

Simulation is underpinned by theories of how and why we learn, including mastery learning (47), the five-stage model of skills acquisition (48) behaviourism (1 pg169), deliberate practice (49) and experiential learning (50).

Mastery learning originated from research in schools, and is based on two key principles: 1. All learners have the chance to achieve educational excellence, and 2. Following the process of mastery learning, all learners would be expected to have attained similar outcomes (51, 52). The process of mastery learning has been applied in medical education and begins with a baseline assessment to establish appropriate learning objectives with increasing difficulty. The learning objectives and difficulty level would therefore in theory be different for different learners at different stages; for example, learning objectives for a 5th year medical student learning how to manage breathlessness would be different to a ST5 speciality registrar in respiratory medicine. Following the baseline assessment and learning objectives, the learner should "engage in powerful and sustained educational activities focused on reaching objectives" (51); in the context of this thesis, simulation. There are fixed standards that must be passed, with formative assessment and feedback to ensure learners advance to the next educational objective. Following this, there is repetitive, or deliberate practice (spending time on a specific task with repetition following structured feedback; see later in this section (49)) until 'mastery standard' is achieved (51). This kind of structure is the basis for mandatory courses such as Advanced Life Support (ALS).

The literature around simulation for mastery learning tends to focus on the acquisition of particular skills, for example ALS (53) and laparoscopic skills (52, 54), therefore, in the context of preparedness, mastery learning may not be the most appropriate theory to use. Preparedness comprises not just practical skills, but also confidence, readiness, and external factors such as the environment and support structures. In addition, the focus on a minimum passing standard is difficult in the context of preparedness because there is no validated measure of preparedness and there is so much focus on self-confidence or self-efficacy. Although mastery learning may be useful for specific skills that are important for the transition, for overall preparedness, a different approach may be necessary.

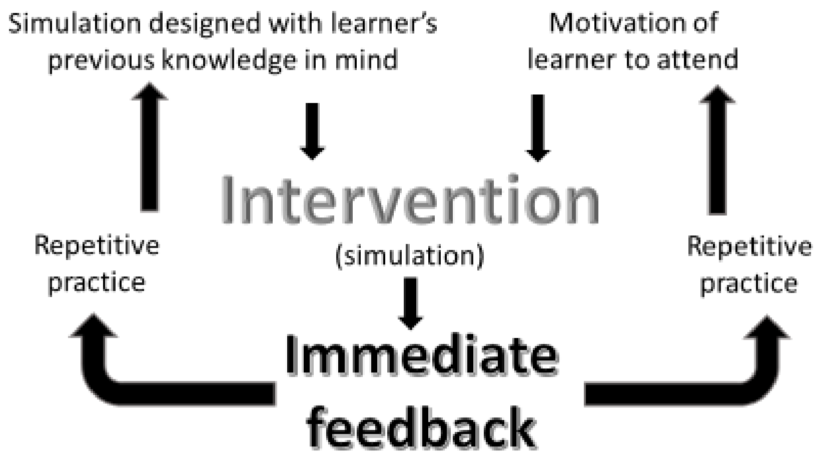
Mastery learning and deliberate practice are closely linked with another learning theory developed by Dreyfus: the five-level model of skills acquisition (48). According to Dreyfus, there are five stages of development; novice, advanced beginner, competent, proficient and expert; at each level the learner builds upon the skills from the previous level and moves through the stages, gaining knowledge, skills and experience which leads to changed behaviours (analogous to Kirkpatrick's levels discussed later in the chapter) (48, 55, 56). Novice learners have no experience. Therefore, to deal with a scenario, they are taught specific rules with which to deal with that scenario (48, 56). The advanced beginner has a small amount of experience and learns to recognise patterns or different contexts which may change the rules with which they can deal with that situation. Competency is attained when the learner sees their actions in the longer term and therefore can begin to prioritise situations and tasks. The proficient stage is characterised by the learner viewing scenarios as a whole, realising what typically happens and how to change plans in response to events. At the final expert level, the learner no longer relies on rules to interpret situations. Their experience allows them to have an intuitive grasp of the situation, they know what needs to be done and how to do it. The emphasis in this model of skills acquisition is on increasing experience changing knowledge and perceptions, which clearly overlaps with experiential learning and to some extent deliberate practice. There are several critiques of Dreyfus that make the levels less relevant to the research questions for this thesis (1.6). The presentation of the model as linear does not take into account the complexities of medical education and medical learners. In addition, novice learners may not necessarily be passive learners and may have experience that impacts their decision-making in certain scenarios (57). Furthermore, expert learners are not infallible; doctors make mistakes and come across situations where they do not know what to do at all levels of training. A further reason why Drefus's model is less relevant for this thesis is that the participants in this thesis are at the lower levels of Drefus's model and the simulation courses being studied do not allow learners to ascend Dreyfus's levels. Such simulation would need to be longitudinal over several years with repeated exposure, which would be beyond the scope of this thesis.

Simulation learning may also be linked to the theory of behaviourism. Behaviourists believe that learning is "a change in behaviour in the desired direction" (58); 'conditioning' feedback with encouragement for correct behaviour and criticism for incorrect behaviour is followed by repetition, more feedback and reinforcement for corrections (58). The approach is teacher-centred, with an emphasis on the learning environment to produce a specific response. Observable behaviour is the focus of learning, the environment shapes behaviour and reinforcement is essential (59). Behaviourism is the basis of competency-based education. However, as preparedness is not only about competence, but also confidence, and other external factors have a role in developing and maintaining preparedness, the behaviourist method may not be appropriate when considering simulation for preparedness. Furthermore, the concept of preparedness is about more than observable behaviours, therefore, behaviourism was not used, as applying this theory would not allow preparedness to be fully explored.

The two most relevant theories for considering simulation for professional preparation in medical education are Ericsson's deliberate practice (49) and Kolb's experiential learning (50) (Figure 1-3).

Deliberate practice

Deliberate practice involves spending time on a specific activity, task or skill to improve performance, with repetition following structured feedback (49). Rather than simply repeating the scenario, learners must receive feedback to focus on improving performance.



Experiential learning

First described by Kolb in 1984, this describes the theory that knowledge is gained from experiencing situations and reflecting on that experience (1 pg27, 50).

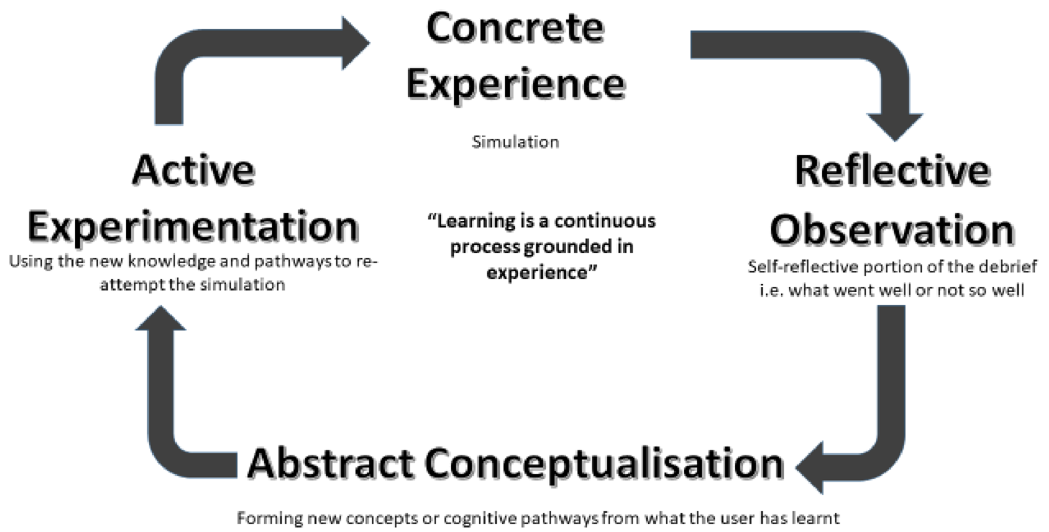


Figure 1-3 - Theoretical underpinnings of simulation (1 pg27, 69, 60 pg223-224)

Both deliberate practice and experiential learning reflect a fundamental concept of medical education: the concept of learning in the workplace (1 pg27, 69). Nonetheless, allowing undergraduates full responsibility for patient care is not ethically acceptable. Simulation may, therefore, provide opportunities for experiential learning in a safe environment, prior to and alongside patient interactions. The debrief portion of simulation perfectly illustrates the 'reflective learning' element of Kolb's theory and is an essential part of Ericsson's deliberate practice (see 1.2.1 (33, 61)). Repetition of tasks to cement knowledge is a central feature of deliberate practice and experiential learning and may be provided in a standardised way in simulation.

There are multiple similarities between the theories discussed in terms of how learners acquire knowledge with repetition, actual experience and meaningful feedback. In all the theories, active involvement of the learner is paramount, and this is reflected in the empirical data from this thesis. Furthermore, the essential components of simulation described in 1.2.1 link into experiential learning and deliberate practice; this helps to describe how the mechanisms of action of simulation training links into the theories of how and why people learn from simulation. In particular, feedback is essential for both theories to ensure reflection on performance and development of knowledge to improve subsequent performance. In addition, allowing repetitive practice with different simulation scenarios at different difficulty levels allows learners to develop knowledge and skills over time.

For undergraduates, simulation allows independent experience of assessing medical emergencies. By gaining ‘concrete experience’ in such scenarios, with a debrief allowing reflection on their performance, and repetitive practice with repeated scenarios of increasing difficulty, students may improve their diagnostic abilities and correct errors in management, so by the time it comes to dealing with a medical emergency in the clinical environment, they have the necessary skills and confidence. In a similar way, simulation scenarios can be designed to introduce and develop students’ non-technical skills. Educators may design a scenario in which, to succeed, participants must work as a team, prioritising and managing their time effectively. By using feedback, participants may hone and develop their non-technical skills by repeating scenarios and tackling new scenarios, thereby solidifying their knowledge and utility of non-technical skills prior to independent practice.

1.2.3 Feedback and ‘the debrief’

As discussed in 1.2.1, a vital part of simulation training is immediate feedback, known as a debrief. While there is an extensive literature on the many different types of debrief and on the effectiveness of each, a detailed discussion of that topic is beyond the scope of this thesis. Instead, a concise summary of the essential characteristics of a debrief is presented below.

Debriefing allows users to identify strengths and weaknesses in their performance, with guidance from a facilitator (expert in the clinical scenario and in giving feedback), and then re-attempt the scenario to consolidate the new knowledge or skill (62). It ensures that potential bad practice is not repeated, but also allows the user to ‘de-role’ or let go of the responsibility they may have taken on during the simulation (62). Furthermore, feedback ensures that learning goals are achieved and any questions are discussed (32). In some cases, the simulator can give feedback data, particularly in the case of simulated patients, and therefore, students may value simulated patient interactions more than real patient interactions (46, 63). Video feedback may be used to provide real-time examples of good and bad practice.

Planning, pre-brief, and the provision of feedback (the ‘three Ps’ (32)) are considered to be the three most important aspects of debriefing. Planning for the feedback to be in line with the learning goals of the session and adopting a flexible approach as to when and how the feedback should be given in line with the learning goals of the session, with flexibility, allows learners to add objectives if they arise. Priming or 'pre-briefing' informs learners of the non-threatening, safe nature of the simulation and covers rules and expectations (32). Finally, various models are available to guide feedback. Most models arise from the natural process of experiencing, reflecting, discussing and then learning and changing behaviours as a result (64). As reflection may not occur naturally, or even at all, having a structured debrief enables learners to focus on the reflective process. Three key debriefing models come from Thatcher and Robinson (65), Lederman (66), and Petranek (67). Feedback, "the heart and soul of simulation training", (68) is a critical part of many of the learning theories underlying simulation, and many authors have described its importance (32, 69).

Through an effective debrief, and the other essential components (1.2.1) simulation can be effective across specialities for a diverse range of topics. In particular, simulation has proven effectiveness in the postgraduate domain, described in the following section.

1.2.4 Simulation in postgraduate medical education

Simulation is well established in the postgraduate education domain and is used in compulsory courses, competency assessments and also in postgraduate examinations (70). The Royal College of Surgeons (RCS) suggests that simulation should be "embedded and enhanced within the surgical curricula", (71) and furthermore, a recent Health Education England (HEE) report suggests that practical procedures should be taught with simulation technologies throughout core medical training (CMT) (36).

In laparoscopic surgery, simulation training can improve surgical skills, translating into reduced training and operating time (72-75). Reduced operating time may result in improved patient outcomes because longer operating times result in increased rates of postoperative infection and length of hospital stay (76-78). Equally, shorter operating times may result in less blood loss, reduced length of stay and improved efficiency of theatre lists with a quicker turnover of patients. Although simulation training for laparoscopy has brought about reduced error rates in the simulation setting, this has not yet been proven in the operating room (79).

Obstetrics is a procedure-based, high-risk speciality, with high litigation and cost of claims (80). Teamwork failure contributes to adverse outcomes for mothers and babies (81); good multiprofessional teamwork is essential to provide quality care (82). Team simulation training in obstetrics has been associated with improved technical and non-technical skills and a change in behaviours, which resulted in a reduction in neonatal injury (83-86). PRactical Obstetric Multiprofessional Training (PROMPT), an evidence-based multiprofessional simulation course, has been shown to improve neonatal outcomes following obstetric complications (85-87) and is now widely used internationally.

Resuscitation was the catalyst for the simulation movement, and in this field, simulation training results in decreased deaths after cardiac arrest and an increase in survival to discharge (88-91). It is, therefore, not surprising that many of the medical colleges have compulsory resuscitation simulation courses within their postgraduate curriculum (92). Furthermore, the GMC requires that all FY1 doctors undertake simulation training in Immediate Life Support (ILS) and Foundation year 2 (FY2) doctors in ALS (93).

Considering this high-level evidence for simulation training, for postgraduate doctors, simulation results in better patient care and outcomes. Whether these benefits can cross over to the undergraduate domain remain to be seen; however, this evidence provides promising results that have attracted attention.

1.3 Assessing the impact of simulation

1.3.1 Kirkpatrick's training evaluation model

In 1959 Donald Kirkpatrick proposed four levels at which training programmes may be evaluated; Reaction, Learning, Behaviour, and Results, labelled KP1-4 (Figure 1-4). These levels may be applied to any training programme in any discipline, but have particular relevance in healthcare due to the ambition to improve patient care (level 4 – 'Results') (94 pg25). As the levels ascend, the evaluation process becomes more difficult and time-consuming; no levels should be bypassed in the evaluation process (94 pg23). Each is important and interacts with the others. For example, if learners are not satisfied with the programme (Reaction-KP1), they will not be motivated to learn (Learning-KP2); if they do not learn, they cannot change their behaviours (Behaviour-KP3)(94 pg23).

The literature on educational interventions often refers to Kirkpatrick's levels when evaluating outcomes and they or an adaptation are often used in medical education research to determine what impact an intervention has had (33, 95).

KP1. Reaction: Learner satisfaction levels
If learners are not satisfied with a course, they will not be motivated to learn.
For example, when compared with lectures, students undertaking a simulation course reported significantly increased satisfaction

KP2. Learning: Change in attitudes or acquisition of knowledge/skills
For example, when compared with lectures, students undertaking a simulation course performed significantly better in their end of placement assessment

KP3. Behaviours: Change in behaviour; usually over time
Learners must satisfy level 2 to bring about a change in behaviour and also must

- Want to modify their practice (related to satisfaction and self-efficacy)
- Have knowledge of the requirements and how to achieve them (related to learning from the programme)
- Have a positive and encouraging work climate (refers directly to supervision or support offered in the workplace)
- Be rewarded for changing (intrinsic sense of achievement, extrinsic feedback from supervisor/promotion)

For example, when compared with lectures, students who undertook a simulation course were shown to use the information learned in clinical practice

KP4. Results: Benefits to organisation/patients
For example, whether clinical incidents or drug errors were reduced

Figure 1-4 - Kirkpatrick's training evaluation levels(94 pg21-26, 95, 96) (KP1-4)

There are similarities between the KP levels and Miller's 1990 'Pyramid' which was developed specifically for medical education (97). However, Miller focuses on trainee assessment rather than training programme evaluation and fails to step beyond learner outcomes towards patient outcomes. Therefore, Kirkpatrick's levels are more relevant to this thesis.

The BEME group uses Kirkpatrick's levels (in their pure form or adapted) in many of their reviews, particularly those focusing on the efficacy of an intervention. KP levels give a distinct grading of effects and explicit associations between learning and outcomes, essential for developing an effective educational intervention (33, 95, 98, 99). Other conceptual models exist, often developed from Kirkpatrick, including Barr et al (100), which includes subsections for levels KP2 (a. modification of attitudes and b. acquisition of knowledge/skills) and KP4 (a. change in organisational practice and b. benefits to patients). Belfield and colleagues (99) also developed a modified version, highlighting the difficulties of outcome-based research in medical education, as effects on patients (KP4) may only become apparent after several years (99, 101). It is also evident that despite having specified levels, the heterogeneity of medical education research often makes it difficult to make comparisons. No study has compared these classifications.

The main criticism of the Kirkpatrick levels is that it is a hierarchy and implies that KP4 outcomes are more important than those at KP1. Yardley (96) also argued that medical education is much more multifaceted than the original context in which Kirkpatrick developed the levels (business), and also that some methodologies used in medical education research are not suited to analysis with these levels (96). Some argue that the use of levels may influence how an intervention is designed (101).

Despite criticisms, frameworks using Kirkpatrick's levels or variations are used throughout medical education literature (32, 33, 98, 102, 103). They provide a helpful framework to analyse literature and outcomes in this thesis, referred to by KP1-KP4 (Figure 1-4).

1.4 Transitions in medical training and 'Preparation for Practice'

A key feature in ensuring patient safety is preparing clinicians for major transitions within training. It is essential that, when doctors take on more responsibility, they are safe and prepared for the role. Concern that patient care may suffer during medical staff transitions may not be a result of lack of experience alone; other factors include a change in geography and organisational procedures (104). A large Australian study showed that when anaesthetic trainees commence work at the start of the academic year, there is an increase in adverse events and near misses, regardless of seniority (104).

Transitions happen throughout medical training, not only from undergraduate to postgraduate but at all stages of training; SHO to registrar, junior doctor to consultant. The greater the increase in responsibility, the more effect the transition has on confidence (105). Doctors must be supported through transitions in order to be able to acquire the necessary new knowledge and skills; transitions are a dynamic process which rely on doctors having appropriate coping strategies in order to succeed (106). Part of the dynamic process involves re-examining one's skills, competence and confidence, which may lead to feelings of uncertainty, and it is vital that educators and supervising doctors ensure juniors are able to recognise and seize these learning opportunities (106).

Arguably, the most significant transition of any doctor's life is the transition from medical student to doctor. In the UK, all new graduates start work on the first Wednesday of August; nicknamed 'Black Wednesday', due to evidence that patient mortality increases [1](107). It is

[1] In a retrospective study of mortality rates in UK hospitals the rate on the first Wednesday in August compared to the rate on the previous Wednesday was 6% higher (p=0.05).

not difficult to contemplate the difficulties transitioning from the sheltered undergraduate level to independent practice. Direct responsibility for patients' lives adds immense pressure and expectation, and unsurprisingly levels of anxiety and stress are high (108-110). During this highly stressful time, coupled with maintaining patient safety, it is essential to protect new doctors' physical and mental health (111, 112). Stress has been shown to detrimentally affect the performance of doctors (113, 114), and must be managed to avoid anxiety, depression, and burnout, which are prevalent amongst medical professionals (115, 116). While a certain amount of apprehension is expected, new FY1s must make sound clinical decisions, which requires confidence in one's own knowledge and skill. To protect patients and doctors, it is essential that new graduates are both confident and competent; that they feel prepared. The enormity of this transition and the resulting stress highlight the need to better facilitate this challenge and find new ways to support the transition (117)

Preparation for practice is a complex concept that has been described in many ways. In 2014, the GMC (118) highlighted "professionalism, employability, competence, readiness, fitness for purpose and fitness to practice" as key to preparedness, and described preparedness for practice as "both a long- and short-term venture" (119). Preparedness is based not only on knowledge or competence but also on the individual student's (and stakeholder's) life experiences (118). The GMC acknowledges that "it is particularly difficult to define a precise boundary between being prepared and not" (120), and there is no 'one way' to measure preparedness. Preparedness is equally dependant on actual competence and perceptions of competence and confidence, and while all medical schools should train students to the same level of competence, perceptions of competence may vary widely for each student. There are also other factors that contribute to preparedness, such as resilience, familiarity with local protocols and procedures, and support, both professionally and personally (109, 121-123).

When assessing preparedness, differentiating between self-reported confidence and objective competence is difficult. Evidence suggests that clinicians are not good at self-assessment, yet it is a key responsibility for doctors (3, 124). Furthermore, some studies have shown that the correlation between stakeholder and student judgements on preparedness varies, further highlighting the complexities of assessing preparedness (110, 125). Therefore, obtaining an accurate judgement of how prepared graduates are is complex, and is likely to require multiple sources: self-assessment, stakeholder assessment and objective assessments such as the situational judgement test (SJT) (126) (introduced into the UKFP application). Despite a drive for more objective measurements of preparedness, the importance of graduates' self-reported efficacy must not be underestimated. A key component of preparedness is confidence, which can only be self-reported. This is reflected across the preparedness literature, with the majority of studies using self-report data, discussed in 1.4.2.

1.4.1 Scope of the preparedness problem

Studies over the years have shown repeatedly that new graduates do not feel prepared for professional practice (127, 128). Just 36% of 1999-2000 graduates felt that their medical school prepared them well for practice (129, 130), increasing to 58.2% in 2005, but this percentage declined on follow-up (130). By 2008-2009, preparedness had dropped slightly (53% and 49% respectively), but the numbers feeling unprepared had declined (31% of 1999-2005 graduates, 19% of 2008-09 graduates). By 2014, data collected by the GMC suggested that 69.8% of students felt prepared. Since then, there have been no improvements in perceptions of preparedness (69.9% in 2018) (131). Furthermore, data showed substantial differences in students' preparedness between medical schools: the gap between the most prepared and least prepared is considerable (118).

Further work has revealed that, although students and new FY1s feel prepared for history-taking and examining patients (119, 132-134), they feel unprepared for emergencies (134-137). Assessing a medical emergency is a vital aspect of doctors' professional practice. In situations where a patient is deteriorating, decisions must often be made quickly; delayed management due to underconfidence may have catastrophic outcomes. FY1 doctors are often the first to assess such patients. Therefore, they must feel confident and competent to do so.

Non-technical skills are the skills required to interact with colleagues and the work environment (138) and relate to the perception of a setting and communication, rather than clinical knowledge. Non-technical skills include working in a multidisciplinary team (MDT), prioritisation, time management, and situation awareness. Poor performance in these domains can lead to clinical error and therefore impact patient safety. It is essential that new FY1s have non-technical skills to cope with their new responsibilities, but studies have shown that new FY1s do not feel prepared for using non-technical skills (108, 110, 139).

The day-to-day administrative tasks of an FY1 have been a source of concern (110, 129, 130). These administrative skills have continued to cause concern, which has not improved over time (129), and prescribing continues to be an area that students and stakeholders feel graduates are ill-prepared for (110, 119, 133, 140, 141). Furthermore, two large-scale studies found that prescription errors were highest amongst FY1 and FY2 doctors compared to more senior doctors (142, 143). It is clear from these findings that there are many facets to preparedness, and that there is some work to be done to ensure new doctors are fully prepared for professional practice. This thesis will consider some of these specific aspects of preparedness (assessing medical emergencies and non-technical skills) in relation to simulation. Preparedness for prescribing has not been focused on in this thesis, as since the PROTECT (142) and EQUIP(143) studies, there has been a national drive to improve prescribing, described below in 1.4.1.1. Simulation may be a useful adjunct to prepare students for prescribing; prescribing tasks can be integrated into simulation for assessing medical emergencies, non-technical skills and other scenarios focused towards preparing students for professional practice.

In addition to protecting patients' and foundation doctors' physical and mental health, a lack of preparedness in FY1 doctors has been associated with poorer Annual Review of Competence Progression (ARCP) outcomes (118). Overall, 70% of FY1s with satisfactory outcomes felt adequately prepared, with 8.3% disagreeing, but of those FY1s with an inadequate ARCP result, 49% agreed they were prepared, and 25% disagreed (118).

1.4.1.1 Tomorrow's Doctors 2009 (TD09) and the Prescribing Safety Assessment (PSA)

An important element of overall preparedness is feeling prepared for individual competencies that are vital for new graduates. For the first time, TD09 formalised the GMC's expectations of graduates by including "Outcomes for Graduates" (2). UK medical schools must ensure new graduates meet these competencies, thereby proving that their graduates are 'fit to practice'. TD09 (2) was superseded by Outcomes for Graduates 2015 (OG2015) (3), which has been used as a blueprint for preparedness throughout this thesis[2]. Unlike the subsequent documents (OG2015(3) and 2018(5)), TD09 also set standards for medical curricula, with emphasis on "ensuring that students derive maximum benefit from their clinical placements" (2). In response to concerns about students' preparedness, TD09 highlighted two areas that needed to be developed or improved: student assistantship (1.4.2.1) and prescribing (2). The Prescribing Safety Assessment (PSA) was developed by the British Pharmacological Society and the Medical Schools Council to allow graduates to show

[2] Since the start of this thesis, OG2015 has been superseded by Outcomes for Graduates 2018.

the competencies set out in TD09 (2). Becoming compulsory in 2014 for fifth-year medical students, candidates answer questions regarding drug prescriptions, review, monitoring or calculations, and 'prescribe' specific drugs in an online assessment (144). As this intervention is new, there are no empirical studies on its effects on FY1s' prescribing or preparedness.

1.4.2 Interventions to improve preparedness

Since the evidence from the literature described in 1.4.1 suggests that new FY1 doctors do not feel prepared for practice, several interventions have been introduced to improve preparedness, including student assistantship, shadowing and structured induction, curriculum reforms and simulation. Simulation for preparedness for practice is covered in the literature review (2.2).

1.4.2.1 Student assistantship

Student assistantship and shadowing are sometimes used interchangeably. As they are designed to develop different skills, the GMC has distinguished between the two (Figure 1-5).

"A *student assistantship* means a period during which a student acts as an assistant to a junior doctor, with defined duties under appropriate supervision" (2 pg55). During the student's fifth year of medical school, which may or may not be the same job or the hospital they will be for FY1.	"The *shadowing* period allows students to become familiar with the facilities, the working environment, and working patterns, and to get to know their colleagues" (2 pg55). This ideally should be shadowing the job that they will be undertaking immediately before commencement.

Figure 1-5 – Differences between student assistantship and shadowing

Before TD09 (2), there was no formal requirement for assistantship (although most medical schools had a shadowing element in the fifth year). TD09 standardised assistantships and emphasised the differences between student assistantship and shadowing (2).

An assistantship allows students to assess medical emergencies, practice prioritisation and clerk patients (145), and can increase confidence in a range of practical domains, particularly dealing with emergencies and making clinical decisions (KP2) (146). Following an assistantship, students feel better prepared for practice (KP2) (134, 147), particularly if it is aligned with future FY1 posts. There has been a suggestion to develop a national collaborative programme to allow alignment (136, 148, 149); however, given the distinction between shadowing and assistantship, assistantship should be effective despite the location as the focus is on involvement in patient care rather than becoming familiar with the working environment (Figure 1-5). Despite some promising results, there are few studies looking at the effect of student assistantship on students' preparedness, with modest sample sizes and response rates, and all self-report data. There is also a lack of high-quality studies due to the difficulties of designing an RCT based on an educational intervention that has been so widely adopted.

1.4.2.2 Shadowing and structured induction

Following the formalisation of shadowing (4), a mandatory paid shadowing period was introduced prior to FY1 to enable graduates to shadow the FY1 job they will commence. On average, approximately 50% of students will not work in their local deanery after graduation (150); therefore, this shadowing period is a crucial element of preparedness to allow graduates to become familiar with the local procedures, policies, and structures.

The purpose of induction is similar to shadowing, but includes a non-clinical element, to ensure new workers understand local policies and procedures (151). Induction is a core requirement of Good Medical Practice (core guidance from the GMC on good practice for all registered doctors) (152), and a good-quality induction has been shown to benefit doctors and patients (153).

Shadowing has been associated with students feeling better prepared for starting work, as it allowed them to develop familiarity with the ward and created learning opportunities (154, 155). However, there are few studies looking at shadowing alone, and all are fairly small and retrospective so may not give an accurate impression of the efficacy of shadowing. Most studies including shadowing examine more heterogeneous induction interventions that feature shadowing alongside other methods. This makes it very difficult to associate shadowing alone with preparedness.

An extended structured induction, combining induction with shadowing and other training, leads to improved self-confidence in clinical skills (156), maintained after one month, and improved preparedness for practice (KP2) (154, 155, 157, 158). Furthermore, when a structured induction course was made compulsory, this course resulted in a 45% reduction in self-reported clinical incidents (KP4) (158). This data is limited by a lack of triangulation of the self-report data, and multiple other confounders affecting learning, including clinical experience as an FY1.

1.4.2.3 Curriculum

Medical curriculum reform following Tomorrow's Doctors (1993 and 2002(4, 6)) has resulted in many medical schools adopting an integrated PBL or CBL approach (see 1.4.1.1). PBL is a teaching method that uses patient problems (or cases; CBL) as a basis for students to gain knowledge about basic and clinical science (1) pg37-39). More recently in some medical schools, PBL design has been supplemented by lecture/didactic learning (1) pg37).

When compared to traditional curricula, graduates from the medical schools with newer, integrated curricula feel significantly more prepared for professional practice (KP2) (157, 159, 160). These findings are maintained longitudinally (up to 6 years in one study) (KP2) (7, 127, 161), but response rates varied and were sometimes below 50%. From the supervisors perspective, students from PBL-based courses are better prepared for practice (KP2) (159), but may not have a good knowledge of basic science (KP2) (162). Other studies of differences between PBL and traditional courses have found fewer differences (133). A GMC-commissioned study comparing three medical schools found minimal differences, but failed to include a school with a traditional curriculum(140). This GMC study suggested that it was the quality of clinical experience that affected preparedness, irrespective of curriculum design. Other studies also found this, despite not having curriculum design as the main focus (108, 157, 163) (KP2) (140). For all studies, changes in working practices, environments and demographics may have affected the results, meaning that favourable results may not be due to the PBL curriculum alone (KP2) (127). In addition, several studies compared new curricula with old in the same institution and used a retrospective design; this may be associated with bias. Again, all studies used self-report data but few triangulated the self-report data with other sources to strengthen the results; where triangulation was used, few differences were observed (128, 140)

1.4.2.4 Preparedness courses

Preparedness for practice is multifactorial and, therefore, several interventions may be used to achieve complete preparedness, given the effectiveness of the various methodologies described above. In the literature, some studies examine a 'preparedness for practice' course, often using various interventions such as a structured induction incorporating shadowing, simulation, and tutorials (139, 158, 164). The American Board of Surgery suggests that students who undertake preparedness courses have increased confidence and feel more prepared for practice (165). Despite undergraduate and postgraduate training in the US being substantially different from that of the UK, this is a significant endorsement of such courses. These courses are discussed elsewhere in this thesis (2.2)

1.5 Summary

This chapter has introduced simulation in medicine and described its history, uses, benefits, and drawbacks. Simulation has been used in some form in medicine for centuries, but has expanded rapidly over the past 15-20 years, and is now embedded into most postgraduate medical specialities for training and assessment (70, 166). Given the good evidence for benefits to patients from its implementation in postgraduate training, it is easy to imagine the possibilities for its use in undergraduate education. Several factors are responsible for the popularity of simulation, particularly the benefits for patient safety, allowing users to practise without harming patients in combination with working time restrictions and medical workforce issues meaning that clinicians have less time to teach and learn. Simulation also allows standardisation, which provides users with equal opportunities for learning; particularly important with rare diseases or clinical scenarios that are infrequent but life-threatening.

Preparedness for practice is multifactorial; an essential part of preparedness is clinical experience, but there are many other factors and interventions involved, shown by the variety of studies in this area that have been discussed. The importance of this transition from student to doctor must not be underestimated (1.4), and although a relative amount of trepidation is to be expected, it is essential that graduates feel ready for the challenges of the workplace. This matter has been brought to the forefront by multiple papers suggesting that graduates do not feel prepared to start work (125, 127-130, 167, 168). While there is no substitute for real patient encounters, when this is not safe or feasible, simulation may play an important role, particularly in the preparedness to practice domain. Some of the most common areas that students feel unprepared for are non-technical skills and assessing a medical emergency (109, 110, 125, 128, 135, 139, 169). These skills may be more difficult to develop independently as an undergraduate and may lend themselves readily to the use of simulation. Given the evidence presented that doctors' self-assessment is sometimes not accurate, there is a gap in the literature for a study to assess student and stakeholder's views across this important transition.

1.6 Aims, objectives and research questions

This chapter has described the background to medical simulation, transitions in medicine and preparedness for professional practice. It has highlighted a gap in the literature (further described in the following literature review) for a multiple-participant longitudinal study evaluating the effects of simulation on preparedness for practice, and for assessing the role of simulation in preparing medical students for medical emergencies and training them in non-technical skills.

The original rationale for the study was to provide evidence for a particular type of simulation which, if implemented, might improve the preparedness of UK medical students for professional practice. The focus changed over the course of my research (due to limitations on available data and pragmatic decisions; see methods chapter 3) and became an exploration of simulation and its contribution to self-reported preparedness for practice alongside the other training offered in the 5th year of the medical degree course.

As a result, the final aim of this thesis was to explore the role of simulation in preparing medical students for the transition from medical school to professional practice. This aim gave rise to the following research questions:

1. How does simulation affect students' views of their preparedness for the transition to professional practice?
    a. What role does simulation play in improving undergraduate medical students' self-reported knowledge and skills around assessing medical emergencies at the point of transition to professional practice?
    b. What role does simulation play in improving undergraduate medical students' self-reported knowledge and skills around non-technical skills at the point of transition to professional practice?

2. What are stakeholders' (those providing undergraduate education) views on students' preparedness for professional practice and how simulation contributes to preparedness?

The aims and the research questions were addressed by the following objectives to:

- Review the current literature on undergraduate medical education in the UK, with a focus on the development of medical simulation (including its theoretical underpinning, typology and use in postgraduate medical education); the concept of preparedness for practice, including interventions introduced to improve preparedness (Chapter 1); and simulation in undergraduate medical education for preparation for practice, advancement of non-technical skills, and preparation for medical emergencies (Chapter 2).

- Investigate whether simulation is associated with self-reported confidence in the knowledge and skills required for the transition (OG2015(3)) to professional practice, using questionnaires as part of a mixed-methods study design (Chapters 4 and 5).
- Explore whether type of simulation is associated with better self-reported confidence by comparing two different simulation courses designed to prepare students for the transition to professional practice, using questionnaires and qualitative interviews with medical students (Chapter 4).
- Understand how students and stakeholders conceptualise preparedness, using qualitative interviews (Chapter 4)
- Explore the effect of the transition to professional practice on students' views of their own preparedness, before, during and after the transition, using questionnaires and qualitative interviews (Chapter 4)
- Examine the interaction between simulation and other educational aspects of the curriculum to understand how these elements contribute to students' perceptions of preparedness, using qualitative interviews (Chapter 5)
- Relate the results to the literature to determine how simulation may address the preparedness issue (Chapter 6) and make preliminary recommendations regarding the use of simulation for preparedness for practice, including areas for further development and research (Chapter 7).

2 Literature review: Simulation in undergraduate medicine

Simulation training has been shown in studies set in postgraduate medical education to improve patient outcomes (1.2.4). Despite the widespread introduction of simulation training in undergraduate curricula, the advantages in that setting are less clear.

In chapter one, simulation was introduced as an educational method (1.2), followed by a discussion regarding preparedness for practice (1.4). Interventions introduced to improve preparedness were also described, with simulation discussed in that setting. Graduates and stakeholders are concerned about preparedness for the transition to practice. In particular, graduates and stakeholders are concerned about preparedness for non-technical skills and assessing a medical emergency; essential skills for new doctors.

This chapter will focus on the evidence for the use of simulation in undergraduate medical education and explore the gaps in knowledge. This review set out to describe the literature currently available to answer the research questions (see 1.6) and demonstrate the gaps in knowledge which this thesis aims to fill. As the original aims and objectives of this thesis sought to establish whether simulation brought about an objective change in the knowledge and skills required for the transition to professional practice, both objective and self-report data has been included in this review. Therefore, the literature review aims to assess:

- How simulation affects students' objective preparedness and perceptions of their preparedness for the transition to professional practice.
- What role simulation plays in improving undergraduate medical students' knowledge and skills and perceptions of their knowledge and skills around assessing medical emergencies at the point of transition to professional practice.
- What role simulation plays in improving undergraduate medical students' knowledge and skills and perceptions of their knowledge and skills around non-technical skills at the point of transition to professional practice.

As described in 1.2, simulation in medicine covers a broad range of activities. The initial literature searches for this review further highlighted the broad simulation evidence base, and, therefore, to examine the use of undergraduate simulation in its entirety would be beyond the scope of this thesis. Considering the focus of this thesis (preparedness), this literature review has described the evidence for the use of simulation for preparedness in depth. When examining preparedness in more detail, the two major concerns from students and stakeholders appear to be non-technical skills and management of acutely unwell or deteriorating patients (108, 128, 139, 170). As the simulation courses under investigation in this thesis focus on preparedness, assessing medical emergencies and non-technical skills, this further justifies focusing the literature review on these three areas.

Preparation of medical students for professional practice

Preparation for practice is a complex concept that has been discussed in detail in 1.4. To be prepared for practice, new doctors must feel both competent and confident in their abilities to tackle the problems and tasks they may face as an FY1. Studies included in this section use simulation either alone or in combination with other modalities to make students more prepared for professional practice.

Assessing a medical emergency

Students feel unprepared for assessing a medical emergency (1.4.1). There are multiple simulation courses targeted at this skill, including Acute, Life-threatening Events Recognition and Treatment (ALERT) and Advanced and Intermediate Life Support (ALS/ILS). Studies included in this section deal with a variety of acute situations, for example, a patient with anaphylaxis, acute dyspnoea, or hypovolaemic shock.

Non-Technical Skills

Non-technical skills and students' preparedness are discussed in 1.4.1. Simulation for non-technical skills may include scenarios that require students to work and communicate as a team while being given multiple tasks to complete and having to prioritise (171-173). It also may include the introduction of distractors to test and develop situation awareness (such as the ward simulation in this study, see 3.4.1.2). Studies included in this section incorporate ward and bleep simulations designed to develop situational awareness and prioritisation skills, and interprofessional simulations designed to enhance team-working and communication.

Non-technical skills and assessing medical emergencies are commonly cited as areas for which graduates feel unprepared (108, 128, 139, 170). There is some overlap in the literature between these categories; many of the studies looking at non-technical skills and preparedness for practice also use deteriorating patient scenarios, so the papers have been sorted according to their primary focus, such as non-technical skills or preparedness for practice.

Throughout this review, as in the introduction, Kirkpatrick's levels will be used to illustrate outcomes (see Figure 2-1 and 1.3).

KP1. Reaction: Learner satisfaction levels
KP2. Learning: Change in attitudes or acquisition of knowledge/skills
KP3. Behaviours: Change in behaviour; usually over time
KP4. Results: Benefits to organisation/patients

Figure 2-1 – Kirkpatrick's levels of evaluation (see 1.3 for more information)

Initial searches for the literature review highlighted a body of evidence whose consensus was that simulation at the undergraduate level increases student satisfaction (KP1) and is evaluated as having positive effects. While student satisfaction is important, to justify the costs of simulation, there needs to be evidence that it improves knowledge (KP2), changes behaviours (KP3) and ultimately impacts on patient care (KP4). Therefore, papers analysing ONLY satisfaction or basic evaluations were excluded from this review (KP1). Papers analysing KP1 in addition to levels KP2-4 were included.

2.1 Search strategy

2.1.1 Inclusion/exclusion criteria

Articles were included if they met all the criteria listed in Table 2-1.

Table 2-1 Inclusion/exclusion criteria and justification

Criteria	Inclusion	Exclusion	Justification
Demographics	Studies from 2000-present Human studies in the English language	Pre-2000 papers Conference abstracts	The second 'Tomorrow's doctors' (4) was published in 2002, prompting significant changes to UK medical education
Population	Medical students; either in isolation or in combination with undergraduate students of other healthcare disciplines	Postgraduate or mixed under- and postgraduate participants	This thesis is investigating the effects of simulation in undergraduates; postgraduate use of simulation or mixed under and postgraduate is beyond the scope of this review
Intervention	Simulation focusing on the development of non-technical skills, assessing a medical emergency or preparedness for practice	Simulation focused on developing clinical skills, speciality specific (e.g. obstetrics, paediatrics, psychiatry), surgical	The simulation courses under investigation in the empirical data focus on non-technical skills, assessing a medical

		skills, ultrasound, procedural skills	emergency and preparation for practice
	Studies focusing on the efficacy of simulation	Studies focused on feedback/debrief element of simulation, testing or validating tools, the fidelity of simulation or the use of simulation for assessment	The focus of this thesis is the efficacy of simulation, i.e. effects on knowledge, skills, behaviours and patient care
Comparison	Simulation compared with other teaching modalities or evaluated alone	Studies not comparing simulation or not involving simulation	The focus of this thesis is the efficacy of simulation
Outcomes	KP levels: Learning (KP2), Change in behaviours (KP3), Effects on patients/patient care (KP4)	Student satisfaction (KP1) only	There is a great deal of evidence at KP1 level, to justify use evidence must be presented at higher KP levels

Studies involving undergraduate medical, nursing, physician associates, physiotherapists, and pharmacists were included, but having medical students in the study population was an essential prerequisite. Both graduate and undergraduate medical courses were included (In the US and some UK medical schools, medicine is a graduate course, Table 1-1). Studies were included up until the commencement of participants' first post-graduation professional post; in the UK, FY1, in the US, internship or residency.

Simulation is any scenario using mannequins, devices, computers or actors to recreate reality (1 pg164-165). In the literature included, this encompasses simulated patients, mannequins, and computer-based simulation. Additionally, simulation is often used in association with other teaching modalities in courses; to be included in this review, simulation must be the focus of the intervention and not used only for assessment.

For this review, desired outcomes were as per Kirkpatrick's levels as previously discussed in 1.3 and Figure 2-1.

Primary research studies that included relevant data meeting the inclusion criteria were included. Conference abstracts were excluded as full data could not be obtained. Descriptive articles without evaluative data were also excluded.

2.1.2 Search methods

Studies were identified using the following electronic databases: MEDLINE, EMBASE, CINAHL, and Pubmed via the NICE Health Databases Advanced Search (HDAS) website based on the search terms ‘simulation’ and ‘medical students/medical undergraduates’. The initial search was conducted on 21st March 2017, with an update on 19th September 2018 and 7th May 2019 (see Appendix 1). The broad search terms returned many irrelevant articles, so many papers were excluded on the title alone, leading to further, more specific searches under the separate themes; ‘non-technical skills’ and ‘human factors’, ‘management of deteriorating patients’ and ‘preparedness for practice/internship’. Reference lists and index lists of ‘The Clinical Teacher’ and ‘Medical Education’ were also hand searched for relevant studies.

To be included for ‘preparedness for practice’, the primary aim of a study had to be to improve students’ confidence concerning becoming a doctor. Some papers which reported on simulation in US training programmes for very specific surgical skills for example orthopaedic simulation were considered too specialist and too different from the broader simulation for preparedness evidence base and were excluded from the analysis.

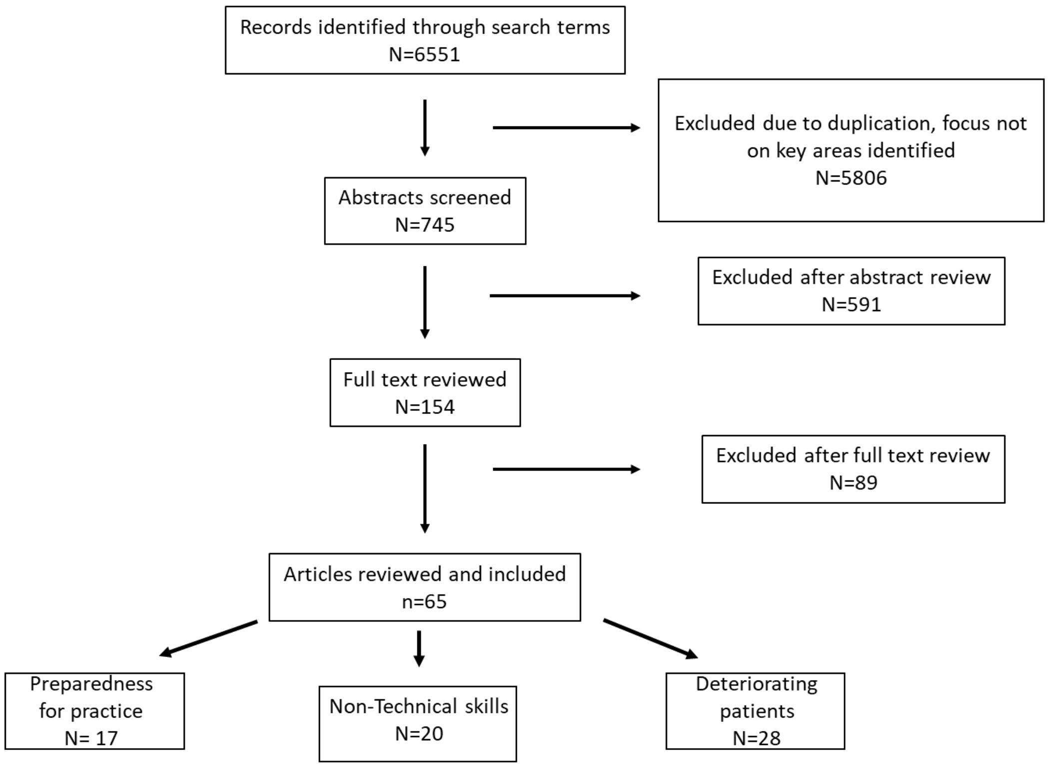


Figure 2-2 – Literature search results

2.1.3 Data extraction

The following data (Table 2-2) was extracted for all articles and is tabulated at the end of each section (non-technical skills, assessing a medical emergency and preparation for practice).

Data extraction was carried out by the lead researcher, with discussion with supervisors over any queries. Data was collated onto a Word document and into an Excel spreadsheet to enable analysis.

Table 2-2- Data extracted from papers.

Author	
Year Published	
Location of study	
Design	Randomised control trial (RCT), Case-control, Observational, Qualitative, mixed-methods
Simulation intervention described	How simulation has been used, whether alone or with other teaching methods, amount of time dedicated to the intervention,
Comparison or control group?	Including what the control group received instead of simulation (if anything)
Sample size	Including participants year of study and discipline in the interprofessional studies
Methods used to evaluate intervention	What tools were used, e.g. questionnaires, OSCE scores, MCQs, simulation scoring checklists, and whether they have been validated
Whether data was a self-report or objective assessment	i.e. self-report questionnaires or objective OSCE scores or MCQ
Findings	In favour of simulation or another teaching method, pre/post-test improvements in knowledge or confidence, long-term maintenance and/or effects on patient care

OSCE= Objective Structured Clinical Assessment, MCQ= Multiple choice questions

2.1.4 Quality appraisal

A quality appraisal template specific to education research (Medical Education Research Study Quality Instrument – MERSQI) was chosen to appraise the evidence in this study (174, 175) Table 2-3). MERSQI has less focus on RCTs (compared to the National Collaborating Centre for Methods and Tools (176)) as there are so few of these in educational research, thereby making it more relevant. Other templates are available (98, 177) but MERSQI has more specific definitions and scoring (174), and uses KP levels, which links with how the evidence has been graded throughout this thesis. The total score ranges from five to a maximum of 18. Although there is no guide to what constitutes a ‘good’ MERSQI score, two previous studies have used >14 as a cut off (178, 179). As the maximum score for studies included in this review was 14, for the purposes of this review, a score of >11 is classed as a high-quality study.

Table 2-3 MERSQI (174)

Domain	Response option	Score	Definitions
Study design	Single-group cross-sectional or single-group post-test only	1	
	Single-group pre and post-test	1.5	
	Non-randomised	2	Case-control/ cohort studies
	RCT	3	
Sampling: Institutions	1 institution	0.5	
	2 institutions	1	
	3 or more institutions	1.5	
Sampling: Response rate	NA	0	Proportion of those eligible who completed the post-test
	<50% or not reported	0.5	
	50-74%	1	
	>75%	1.5	
Type of data	Self-assessment	1	
	Objective assessment	3	Observer ratings are considered objective
Validity evidence for evaluation instrument	NA	0	If no instrument to rate
	Content	1	Using theory, guidelines, experts and existing instruments to identify or refine the instrument
	Internal structure	1	All reliability (internal consistency, interrater, test-retest) and factor analysis
	Relationships to other variables	1	Expert-novice comparison, concurrent or predictive correlation with other variables
Data analysis sophistication	Descriptive analysis only	1	Frequency, mean, median
	Beyond descriptive analysis	2	Any statistical tests
Data analysis appropriate	Data analysis appropriate for the type of study and data	1	
Outcome	Satisfaction/attitudes/ perceptions/	1	
	Knowledge, skills	1.5	In a test setting
	Behaviours	2	Physician actions with real patients in a clinical context or other activities in a real context
	Patient/health care outcome	3	Actual effects on real patients, programmes or societies

MERSQI was not designed for qualitative studies; therefore, the critical appraisal skills programme (CASP) checklist was used for assessing the quality of qualitative studies. CASP has been devised by a group of experts and developed for qualitative studies (Figure 2-3) (180).

Was there a clear statement of the aims of the research?
Is a qualitative methodology appropriate?
Was the research design appropriate to address the aims of the research?
Was the recruitment strategy appropriate to the aims of the research?
Was the data collected in a way that addressed the research issue?
Has the relationship between researcher and participants been adequately considered?
Have ethical issues been taken into consideration?
Was the data analysis sufficiently rigorous?
Is there a clear statement of findings?
How valuable is the research?

Figure 2-3 - CASP qualitative checklist; each main question may be answered yes/no/can't tell

Although the authors of CASP do not recommend assigning a score to qualitative papers based on the checklist, it enables the user to determine the strength of a study; in this review, papers will be assessed as low, medium or high-quality with the CASP checklist in conjunction with the MERSQI score. Mixed-methods papers will be assessed with the MERSQI.

2.2 Literature review results

2.2.1 Overview

After exclusions, 65 studies were included in this review. The papers have been divided into three types; those reporting on preparation for practice (N=17), those assessing a medical emergency (N=28) and those reporting on non-technical skills (N=20).

All studies included used integrated mannequins, simulated patients, or a mixture of the two, except for the studies looking at computer-based simulation. From the description of the interventions, all the simulation interventions included in this review appear to have high situational fidelity. Although the interventions vary, overall they may be divided into three categories: studies using small-group simulation scenarios, either alone or with other modalities, ward-based simulation and computer simulation. This classification will be used to organise the literature and assess the evidence. Furthermore, the studies have been divided into those provided objective evidence and those providing self-report evidence; some provide both and are, therefore, discussed in both sections.

The included studies were mostly quantitative (56 of 65) and were published from 2002 to 2019 (Figure 2-4). Most (75%) were published from 2010 onwards (Figure 2-4). Papers originate most commonly from the USA (29 papers), UK (14 papers), Europe (10 papers), Australia/New Zealand (6 papers), South-East Asia (3 papers) and Canada (3 papers). These relative sizes of these country-specific literatures were similar in the subsections except for 'preparation for practice' where the split was more even (6 USA, 8 UK, rest of world 3).

As discussed in 1.3, Kirkpatrick's levels is used to grade the evidence throughout, with KP1level-only studies excluded; the evidence in this area is mostly limited to KP1-2, with three papers investigating KP3-4. Most study outcomes were classified as KP2, and so it was not practical to use KP levels as a structure to organise the literature review. The lack of KP3-4 evidence may be due to the difficulties with longitudinal studies using medical graduates, as 50% or more graduates may move away from their home institution to commence professional practice (150). While many of the studies included describe longitudinal simulation courses, longitudinal participant follow-up is needed to investigate evidence of change in behaviours (KP3) or impact on patients (KP4). The longest follow-up in included studies is 18 months (181, 182), with ten other longitudinal studies, ranging from 5 days to 18 months.

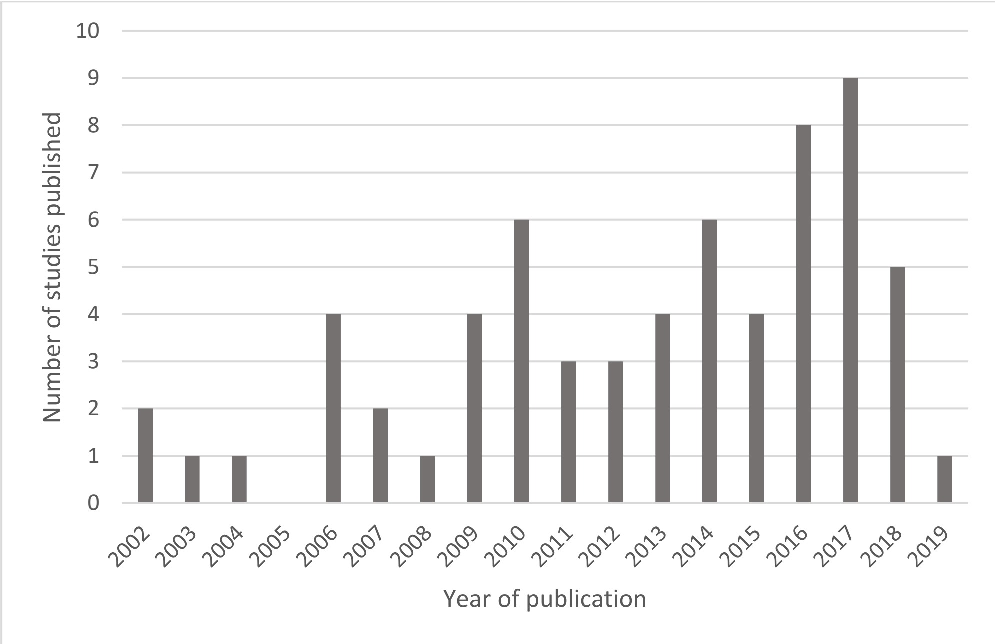


Figure 2-4 - Year of publication for included papers

The sample sizes were varied (16-310), with approximately two-thirds having a sample size of >50 participants. These proportions were similar in each sub-group.

Twenty-seven papers use self-reported data, 27 use objective data (for example, knowledge tests, OSCEs, and observations with checklists), and 11 use a combination of the two. Some concepts, such as preparedness and confidence, may be best assessed using self-report, whereas knowledge may be more objectively measured with knowledge tests or OSCEs. This is illustrated by the papers in the 'preparedness for practice' section having mostly self-report data (11 out of 17 papers) and the papers in the 'dealing with acute patients' section having largely objective measures (19 out of 28 papers). How outcomes are assessed throughout the literature is diverse, including questionnaires/surveys, direct observations using checklists, qualitative interviews and focus groups, OSCE and exam scores, and knowledge tests. Of the tools used, some were validated, but others were unvalidated (Table 2-4).

Table 2-4– Ways in which simulation is evaluated throughout the literature included in this review

Evaluation tool	Objective	Self-report	Validated
Attitudes questionnaire (137, 139, 158, 164, 171, 181-203)		Yes	No
Attitudes towards healthcare teams scale – AHCT (204)		Yes	Yes
Attitudes, Motivation, Utility and Self-Efficacy questionnaire – AMUSE (205)		Yes	No
Clinical performance examination – CPX (206)	Yes		No
Collaborative healthcare interdisciplinary relationship planning scale – CHIRP -Teamwork attitudes scale (207)	Yes		No
Commitment to change tool. Participants write down 'commitments' and are followed up after 2 months (208)		Yes	Unclear
Communication and teamwork skills assessment instrument – CATS (209)	Yes		Yes
Communication challenge video vignettes (188)	Yes		No
Dundee ready educational environment measure (DREEM) (210)	Yes		Yes
End of year exam results (211)	Yes		No
Focus groups (137, 139, 173, 203, 212)		Yes	No
High-performance teamwork scale – MHPTS (209)		Yes	Yes
Interprofessional teamwork scale (IPT) (213)		Yes	Yes
Oral examination – OE (214)	Yes		No
OSCE (190, 215-218)	Yes		No
Questionnaire – supervisor/stakeholder (185)	Yes		No
Readiness for interprofessional learning scale – RIPLS (204)		Yes	Yes
Self-efficacy measure for interprofessional competencies (219)	Yes		
Self-reported clinical incidents (158)		Yes	No
Semi-structured interview (172, 212, 220)		Yes	No
Simulation experience survey – SESS (220)		Yes	Yes
Simulation scoring (181, 195, 196, 203, 207, 211, 221-228)	Yes		Unclear
Team performance evaluation form (performance in simulation) (219)		yes	Unclear
Team STEPPS fundamentals examination (tests knowledge of team STEPPS principles) (219)	Yes		
Team STEPPS performance observation tool (TPOT) (220)	Yes		Yes
Teamwork assessment scale – TAS (209)	Yes		Yes
Teamwork attitudes questionnaire – TAQ (205)		Yes	Yes
Teamwork knowledge test (207)	Yes		No
Written assessment of team-working and work-life balance (188)	Yes		No
Written knowledge test (190, 193, 194, 210, 211, 223, 224, 229-234)	Yes		No

The studies included vary in what they study, the methods they used and, in the time dedicated to the simulations. This heterogeneity makes some of the studies difficult to compare and contrast; some studies have just one 15 minute scenario (184, 235) while others use weeks of immersive simulation where participants are interacting with simulators for several hours a day (186, 211).

While no studies have been excluded because of it, quality varies widely; the average MERSQI score is 10.4 (range 6-14), with the higher-quality studies found predominantly for assessing a medical emergency, and poorer quality studies examining preparation for practice.

These differences illustrate how diverse simulation is and will ultimately affect what conclusions may be drawn from the research in this area.

2.2.2 Simulation for preparedness for practice

The concerns raised both in the UK and internationally about how prepared medical graduates are to enter professional practice were discussed in 1.4; feelings of preparedness have risen from 49% in 2009 (129) to 70% in 2014 (118), but 30% either feel neutral or unprepared. Lack of preparedness and therefore confidence can be associated with stress and anxiety (110), and there is also evidence of increased patient morbidity and mortality when the new doctors begin work in July (USA) (236) and August (UK) (107)

Alongside other methods discussed in 1.4.2, some educators utilised the technology of simulation to try to improve this. These 17 mostly self-report quantitative studies examined the effects of simulation on preparing medical students for professional practice; 2.2.2.1 covers the objective evidence from six studies, 2.2.2.2 covers the self-report data from 14 studies.

2.2.2.1 The role of simulation for improving medical students' knowledge and skills around preparedness for practice

Small-group simulation training

Three studies provided objective evidence for small-group simulation training (196, 203, 211).

Two, week-long simulations in the 3rd and 4th year of medical school (Clinical Learning through Extended Immersion in Medical Simulation; CLEIMS) were studied in a high-quality

RCT (MERSQI 13.5) (211). This study found that students who took part in simulation training performed significantly better than controls in a prescribing test both immediately after the intervention (mean score 75.4/100 vs. 70.1/100, p= 0.02), nine months later (mean score 77.9/100 vs. 70.4/100 p= <0.01), and following the second week of the simulation (mean score 70.8/100 vs. 62.4/100, p= <0.01). Students who took part in the simulation were also significantly faster at initiating CPR in a simulated scenario (immediately after the simulation; 70.1sec vs. 29.1sec p= <0.01), but this was not maintained on follow-up (KP2). Despite these improvements, there were no significant differences between the groups in an MCQ knowledge test or end of year exam results.

In the wider literature, students have reported feeling particularly unprepared about out of hours working (140, 158), so researchers in the studies described here have based the simulations in the out of hours setting. Holding a ‘bleep’ is a central component of working out of hours and may be added to simulation training to increase fidelity and to develop telephone communication skills. Unexpected Medical Undergraduate Simulation Training (UMUST) was developed in two teaching hospitals in the North-West of the UK in 2009 to recreate dealing with medical emergencies for fifth-year medical students (MERSQI 7) (203). Students were given a bleep for a week at a time (4 weeks in total over one year) and were called to the simulation centre to deal with an emergency in groups once each week. Simulations were scored on an Objective Simulation Assessment Tool (OSAT) assessment tool, and although most scores improved over time, some got worse (KP2). The authors felt that this may have been due to participant attrition or increasingly complex scenarios. Contrary to this, a ‘mock page’ simulation study, which was conducted entirely by telephone was associated with significantly higher mean simulation checklist scores (compared to controls) for clinical decision-making across three scenarios (transfusion reaction 37% vs. 28% p=0.01, pulmonary embolism 53.7% vs. 30.9%, p= <0.001, patient pain 45.6% vs. 28.9%, p= 0.003)(KP2) (196). The simulation was conducted over a four-week period where participants would be bleeped at unannounced times to deal with clinical scenarios.

<u>Small-group simulation training in association with other educational methods</u>

Two studies used simulation training in association with other educational methods, including didactics and shadowing (158, 218).

The ‘from scared to prepared course’, developed in 2008 in the South-West UK combined induction with group exercises, shadowing and simulation. This high-quality study (MERSQI 11.5) found that completing the course was associated with a lower self-reported incidence of critical incidents (the risk of clinical incident in those who did not attend course was 0.44 compared to 0.03 for those that did attend RR 14.7, p value not stated in original paper, KP4) (158). When this course was introduced as a compulsory element, there was a 45% reduction in critical incidents, and now all students about to commence FY1 in the Severn Deanery (South-West UK) receive this training (158). Although this is an important finding, at KP3-4, it is self-reported incidents; therefore, it may not truly reflect the actual number of incidents.

In a US study, a two-day simulation-based boot camp to develop the skills necessary for internal medicine residency was associated with significantly higher scores on skills tests compared with controls who had not taken part in the course (scores of >90% compared with 33-76%, p= <0.01, KP2, MERSQI 12.5) (218). The improvements were found across a variety of skills, including paracentesis and lumbar puncture. There were also improvements in assessing a medical emergency and communication with patients and families; scenarios chosen following feedback that these were areas new graduates struggled with from trainees and stakeholders (218).

These studies have shown positive results for the use of simulation to prepare students for practice; however, it must be considered that the findings may be due to the other components of the course including group-based exercises and shadowing.

<u>Computer-based simulation training</u>

Video-simulation based multimedia module (WISEOnCall), has been shown to increase students' clinical reasoning (as assessed by clinicians in a simulated scenario) significantly; pre-test score 0.94/3, post-test score 1.35/3, p= <0.05 (KP2, MERSQI 11) (237). However, despite these improvements in clinical reasoning, the simulated patients who took part in the study rated the student's professionalism significantly lower following the intervention (2.57/4 vs. 2/4, p <0.001).

*Table 2-5- Studies included demonstrating objective evidence for simulation training for preparedness for practice.*denotes RCTs. **indicates length of simulation not specified. 'Survey' and 'questionnaire' were referred to interchangeably throughout the literature, therefore for clarity are referred to by questionnaire. Y1-5 denotes the year of study for students; if missing this was not specified in the study.*

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training (multiple scenario)						
Frischknecht et al USA (196)	14 'mock pages' – 90min simulations at unannounced times over 4 weeks. Various emergency scenarios, either doctor-patient interaction or doctor-nurse	Standard teaching	178	Simulation scenario scoring	Intervention group scored significantly higher mean scores for (transfusion reaction 37% vs. 28% p=0.01, pulmonary embolism 53.7% vs. 30.9%, p= <0.001, patient pain 45.6% vs. 28.9%, p= 0.003), effect sizes 0.46-1.66.	13.5
Rogers et al Australia (211) *RCT	Clinical learning through Extended Immersion in Medical Simulation (CLEIMS) at university in Australia, 1 week in 3rd year and 1 in 4th year, 8 simulated patients/scenarios play out over the week, with one night 'on call'	Lectures/seminars	84	MCQ prescribing test	Students who had simulation performed sig better than controls both immediately after the intervention (mean score 75.4/100 vs. 70.1/100, p= 0.02), nine months later (mean score 77.9/100 vs. 70.4/100 p= <0.01), and following the second week of the simulation (mean score 70.8/100 vs. 62.4/100, p= <0.01	13.5
				Simulation scenario scoring	significantly faster at initiating CPR in a simulated scenario (immediately after the simulation; 29.1sec vs. 70.1sec p= <0.01), but this was not maintained on follow-up	
				MCQ knowledge test	No sig difference in mean scores	
				End of year exam results	No sig difference in results	
Watmough et al UK (203)	Unexpected medical undergraduate simulation training (UMUST); Students are given a bleep for a week and bleeped at several points for a simulation**	N/A	33	OSAT marking of simulation	Most groups scores improved, but some did not! May be due to a reduction in number of participants over time and differing complexity scenarios	7

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training with other educational methods						
Blencowe et al UK (158)	'From scared to prepared' course; 5-day structured induction training, including group exercises, simulation and shadowing.	Compared in 1st year (2008) with FY1s who did not attend. Second-year became compulsory so no comparison group78	78	Analysis of incidents	Relative risk of self-reported clinical incidents that resulted in patient harm was 0.44 for those who did not attend course compared with 0.03 for those that did attend. Relative risk of self-reported clinical incidents that did not result in patient harm for those who did not attend was 2.11 compared with 2.3 in those who did attend. No STATS 45% reduction in clinical incidents following the course becoming mandatory	11.5
Wayne et al USA (218)	2-day 'boot camp' with technical skills and medical emergency simulation.	Non-participants (historical controls)	46	Skills assessment	Intervention group mean scores were sig higher than control groups; scores of >90% compared with 33-76%, p= <0.01	12.5
Computer-based simulation						
Szyld et al USA (237)	WISEoncall – modules that provide video simulation with the assessment of a clinical situation and practice cases. This study analysed the oliguria module (45min).	N/A	95	Simulation scenario scoring	Sig increase in overall competence scores 2.16/4 vs. 2.78/4 p= 0.000. Simulated patients rated the student's professionalism significantly worse following the intervention (2.57/4 vs. 2/4, p= 0.000)	11
				Subjective, Objective, Assessment, Plan (SOAP) note analysed for clinical reasoning	Sig improvements in overall scores; mean pre-test score 0.94/3, post-test score 1.35/3, p= 0.002)	

2.2.2.2 *The role of simulation for improving medical students' perceived knowledge and skills around preparedness for practice*

<u>Small-group simulation training</u>

Five studies investigated small-group simulation training for preparedness for practice (137, 196, 199, 203, 238).

The use of simulated consultations in a qualitative study were associated with students feeling more prepared for professional practice (KP2) (238). In this setting, simulated tasks were based upon those that an FY1 would be expected to deal with, and in between participants were asked to perform prescribing tasks to add authenticity to the simulated ward. In addition to feeling more prepared, students identified learning in non-technical skills, decision-making, and communication (KP2). Simulation teaching was incorporated in a mentorship programme to help students feel more prepared for clinical practice (137). Following the programme, students reported through focus group data that they felt more prepared for professional practice (KP2) (137). Themes from the focus group analysis also found that the mentorship programme provided support for the transition into professional practice (137).

Bleep simulation has been discussed previously in this review; a simulation involving 14 'mock pages' was associated with a significant improvement in student confidence (mean scores pre-test 4.2/10 vs. post-test 7.4/10, p= <0.000, effect size 2.3) (196). Furthermore, the 'mock pages' simulation led to a significant reduction in self-reported anxiety (mean score pre-test 6.1/10 vs. post-test 4.2/10, p= <0.000, effect size 1.1). Following the UMUST course (described in 2.2.2.1) students expressed (through focus groups) that they felt more confident in using cognitive pathways like ABCDE and more confident to start FY1 (203). Furthermore, 100% of students in this small study (n=33) felt that simulation had helped their approach to real emergencies and 89% could give examples of where simulation had helped them in real life (203). Following a 'resident readiness elective' with simulated 'pages' there was a significant improvement in confidence (pre-test 1.87/6 vs. post-test 3.53/6 p= <0.0001) and improved feelings of preparedness (KP2) (199). This simulation was similar to UMUST(203); participants went about their normal days and were paged at various times with simulated scenarios over a four consecutive week period rather than throughout the year.

Small-group simulation training in association with other educational methods

Six studies investigated (with self-report evidence) the use of simulation in conjunction with other training methods to improve preparedness for practice (139, 158, 164, 198, 202, 212).

A study which examined simulation combined with other educational methods for improving preparedness for clinical practice found that 83% of students felt prepared for clinical practice, compared with 10% of students who did not complete the course (KP2, MERSQI 11.5) (158). When this course became compulsory, 97% of participants agreed they felt prepared (158). A lower quality study (MERSQI 9) examined an 'internship boot camp' comprising longitudinal simulated cases. In contrast to previous findings, the boot camp was not associated with a significant difference in self-reported preparedness compared with non-participants (KP2) (164). However, 89% of participants rated the 'internship boot camp' as the aspect of medical school that best prepared them for practice (164).

Commonly, educators will use standardised courses such as ILS and ALERT in addition to further simulation training in their courses designed to prepare students for practice. When a preparedness course combining ALERT, ILS and other educational methods was analysed using qualitative interviews, students said that although they were anxious, they felt prepared for medical emergencies because of the preparedness course (KP2) (212). These students felt that the acute simulated scenarios forced them to manage the simulated patient independently until help arrived, which enhanced their preparedness for the real thing, and they highly valued the ILS component (212). The ALERT course was highly praised by participants in another medium quality study (MERSQI 10); it gave participants a "toolkit for bridging the gaps between asking for help and help arriving", this was maintained even after commencing professional practice (KP2-3) (139). Participants also reported feeling more prepared following the course (KP2).

A lower quality study (MERSQI 9) evaluated a similar five day 'boot camp', this time for surgical residency. Following the boot camp there was significant improvements in technical confidence scores (mean score pre-test 2.46/5 vs. post-test 3.92/5, p= <0.001) and medical confidence scores (mean score pre-test 2.34 vs. post-test 3.70, p= <0.001)(KP2) (198). At the six-month follow-up, there were no significant differences in technical confidence, but a significant improvement in medical confidence scores (mean score 3.70 vs. 4.15, p= 0.02)(198). This may be due to additional learning from the clinical environment, rather than due to the simulation course. Drawing from the areas that graduates feel unprepared for

(140) a preparation for practice course was piloted for fifth-year medical students, including simulated ward round, handover, prescribing and ‘lessons learnt’ style debrief (202). Although the course was highly valued by students, only confidence in prescribing was measured; this increased following the study (KP2, MERSQI 7), but no further statistical analysis was performed.

Ward-based simulation training

Three studies used ward-based simulation to prepare students for the transition to professional practice (197, 200, 201).

Simulated wards may be a way to enhance students’ preparedness and have been shown in 2.2.4 to be beneficial to develop students’ non-technical skills, which may in turn make them feel more prepared for practice. A simulated ward round and professional skills simulation (SWAPS) enabled students to attend the simulated ward round and then prioritise jobs, ultimately having to deal with a changing ward environment and deteriorating patient (197). SWAPS was associated with significant improvements in mean scores for self-reported confidence (all $p < 0.01$) for a range of domains including prioritisation (mean scores pre-test 5.65/10 vs. 7.16/10), handover (mean scores pre-test 5.00/10 vs. 7.06/10), prescribing (mean scores 4.59/10 vs. 6.01/10), breaking bad news (mean scores 4.33/10 vs. 5.93/10) and working in an MDT (mean scores 5.44/10 vs. 6.77/10) (KP2, MERSQI 7.5) (197). An ‘interns day in surgery’; a simulated surgical ward was associated with improved confidence and reduced levels of stress and anxiety in regards to the transition to professional practice (MERSQI 8, KP2, see Table 2-6) (200). A six hour night shift in a simulated ER was associated with an improvement in mean scores for preparedness (mean score on a scale from -3 to +3 went from -0.34 to 0.95, KP2, MERSQI 8) (201). There was a significant improvement in mean score maintained five days following the simulation (mean score pre-simulation -0.34 to 0.66 five days post sim, $p = 0.001$). Although this simulation intervention was conducted without bleeps, the aim was to provide a similar experience of out of hours working.

*Table 2-6- Studies included demonstrating self-reported evidence for simulation training for preparedness for practice.*denotes RCTs. **indicates length of simulation not specified. 'Survey' and 'questionnaire' were referred to interchangeably throughout the literature, therefore for clarity are referred to by questionnaire. Y1-5 denotes the year of study for students; if missing this was not specified in the study.*

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training (multiple scenario)						
Bartlett et al UK (238)	Safe and effective clinical outcomes sessions (SECO) – simulated primary and secondary care scenarios Primary care 120min, 2-5 cases. Secondary care 90min, 1-4 cases - students are asked to do various tasks of an FY1	N/A	194	Open-ended Questionnaire Focus groups	Most commonly described learning included prescribing, communication, discharge processes and time management. Taking full responsibility for the clinical encounter was key to learning.	6
Dalgaty et al UK (137)	Medical mentorship programme' Junior doctors mentoring medical students; 6-week programme consisting of simulation-based workshops (Improving your clinical practice and becoming an effective practitioner) and in between working on the wards with mentors	N/A	17	Focus groups	Simulation workshops reflected clinical reality and the authenticity combined with mentoring facilitated learning. Simulation facilitated clinical practice and allowed students to determine their performance level	6, medium quality
Frischknecht et al USA (196)	14 'mock pages' – 90min simulations at unannounced times over 4 weeks. Various emergency scenarios, either doctor-patient interaction or doctor-nurse Control received no simulation and were assessed with 3 of the 14 'mock page' scenarios	Standard teaching	178	Questionnaire	Significant improvement in overall confidence (mean scores 4.2/10 vs. 7.4/10, p= <0.000, effect size 2.3). Anxiety ratings decreased significantly ((mean score 6.1/10 vs. 4.2/10, p= <0.000, effect size 1.1p=<0.000, effects size 1.1). Average self-assessment of the 8 topics also improved significantly (P<0.000, effects size 1.4)	13.5
Schwind et al USA (199)	11 pager case scenarios – paged at various stages through their 'resident readiness elective'. All via telephone, each lasting approx. 10min	N/A	16	Questionnaire	Students mean confidence scores increased significantly (1.87/6 vs. 3.53/6 p= <0.0001) Free-text – made them feel more prepared for internship	7
Watmough et al UK (203)	Unexpected medical undergraduate simulation training (UMUST); Students are given a bleep for a week and bleeped at several points for a simulation**	N/A	33	Questionnaire	100% of students felt that the sim had helped their approach to real emergencies and 89% gave examples of where sim had helped them in real life	7
				Focus groups	Realistic, more confident to start FY1, using cognitive pathways like ABCDE, challenging, building on previous skills, learning from mistakes	

Small-group simulation training with other educational methods						
Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Berridge et al UK (139)	Preparation for practice course; Structured 2-week induction including ALS and ALERT simulation course, clinical skills assessment and shadowing	N/A	50	Questionnaire	10 of the 17 items mean scores improved significantly after the simulation. No sig difference in mean scores for anxiety. After commencing clinical practice – further significant improvements on mean scores – particularly for clinical skills, daily demands of their new role and feeling less anxious	10
				Focus group	Increased confidence about their first day in work. Initial frustration regarding repeating ALS/clinical skills but most were grateful for the refresher, very enthusiastic about the ALERT course. Longitudinally ALERT and ALS provided toolkit for bridging the gap between asking for help and help arriving. However – steadily increased clinical responsibility was the only thing that would provide seamless transition	
Blencowe et al UK (158)	'From scared to prepared' course; 5-day structured induction training, including group exercises, simulation and shadowing. Compared in 1st year (2008) with FY1s who did not attend. Second-year became compulsory so no comparison group	N/A	78	Questionnaire	83% students felt prepared compared to 10% of those who had not attended. When became mandatory – 97% felt prepared	11.5
Carling et al UK (212)	'Acute illness teaching programme', consists of ALERT course, ILS, other acute illness simulation and small-group workshops. Integrated with clinical experience over 16 weeks in ITU/HDU	N/A	N/R	Interviews/ Focus groups	Associated with preparedness in acute patient management, provided cognitive pathways especially ABCDE approach, felt more prepared overall following simulation	6, medium quality
Laack et al USA (164)	1 week 'internship boot camp' aimed to develop skills in Dealing with medical emergencies, teaching, communication, coping with stress. Included task trainers and integrated mannequins. Controls were non-participants	N/A	40	Questionnaire	No sig diff in mean scores for self-reported overall preparedness, emotional preparedness, clinical experience or medical knowledge, open-ended questions revealed participants felt the internship boot camp was the single most important aspect in preparedness for internship	9
Okusanya et al USA (198)	5 day boot camp with didactics in the morning and simulation in acute scenarios in the afternoon.	Interns who had not done the course	27	Questionnaire	Significant improvements in technical confidence scores (mean score pre-simulation 2.46/5 vs. 3.92/5 immediately post-simulation, p= <0.001) and medical confidence scores (mean score pre-simulation 2.34 vs. 3.70, p= <0.001)(KP2). At the six-month follow-up, there were no significant differences in technical confidence, but a significant improvement in medical confidence scores (mean score 3.70 vs. 4.15, p= 0.02)	9

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Teagle et al UK (202)	Preparation for practice course; 3-day course with simulated ward rounds, prescribing, handover and 'lessons learnt'/debrief	N/A	95	Questionnaire	Students confidence went from on average 3/5 to on average 4/5 following the session Qualitative feedback mentioned benefits of being able to put theory into practice	7
Ward simulation						
Morgan et al UK (197)	SWAPS- Simulated Ward Round and Professional Skills. Students in groups of 2 had 60min session on ward – initial ward round with consultant and then had to prioritise tasks, culminating in a deteriorating patient/changing ward environment	N/A	133	Questionnaire	Significant improvements in mean scores for self-reported confidence (all p= <0.01) for a range of domains including prioritisation (mean scores from 5.65/10 vs.7.16/10), handover (mean scores from 5.00/10 vs.7.06/10), prescribing (mean scores from 4.59/10 vs. 6.01/10), breaking bad news (mean scores from 4.33/10 vs. 5.93/10) and working in an MDT (mean scores 5.44/10 vs. 6.77/10)	7.5
Sinha et al Australia (200)	'Interns day in surgery' 1-day simulation course with a ward round with 2 scenarios and also 'pre-op' clinic	N/A	155	Questionnaire	Post course evaluations were higher across all domains (only 1 p value documented therefore unclear if significant even though significance testing was done. Also no numbers available – results in graph form)	8
Stroben et al Germany (201)	6hr night shift in simulated ED, teams of 5 work around 7 scenarios including exacerbation of COPD, stroke, STEMI with VF, ruptured spleen, UTI in pregnancy and a head laceration	N/A	30	Questionnaire immediately and after 5 days	Improvement in mean scores for preparedness (mean score on a scale from -3 to +3 went from -0.34 to 0.95). The was a significant improvement in mean score maintained five days following the simulation (mean score pre-simulation -0.34 to 0.66 five days post sim, p= 0.001. Effect size 1.86	8

2.2.2.3 Summary

The research on simulation for preparedness reviewed here indicates that compared with other educational methods, simulation is associated with better preparedness and a reduction in self-reported clinical incidents. In some studies, the differences were not maintained long term, and one study found that simulated patients rated the students' professionalism significantly worse following simulation (237). The self-report data also supports the use of simulation to prepare medical students for professional practice, with studies finding immediate improvements in student confidence both overall and for individual competencies following simulation. Deliberate practice was often used, with students undertaking multiple simulated scenarios, allowing students to develop both objective and self-reported preparedness. Using simulation in this way also allowed experiential learning, with 'concrete experience' of a variety of scenarios commonly encountered following the transition to professional practice followed by reflective observation and forming new concepts during the debrief which they could use in both future simulations and real-life practice.

These studies provide evidence at KP2 that simulation in whatever form is associated with increased preparedness, and compared to other methods, students undertaking simulation felt significantly more prepared. The studies in this section are of lower quality (average MERSQI score 8.9) than in 2.2.3 and 2.2.4 and there is a higher proportion of small studies (7 studies with 50 or fewer participants). Only three papers used simulation alone, the interventions described in the other papers combine simulation with shadowing and didactic learning, so this must be considered when examining the results. It is also the case that part or all of the fifth year at many institutions is focused on preparation for practice, and just by participating in this, students will become more prepared.

2.2.3 Simulation for assessing medical emergencies

Medical emergency training is perhaps the area where simulation is used most across all levels of medical education. Prior exposure to simulated emergencies or deteriorating patients, is vital. Practice builds students' diagnostic and management skills helping them to gain confidence before attempting to resuscitate a real patient. Also, undergraduates can feel unprepared for emergency situations (as discussed in 1.4.1) and may find it difficult to gain adequate experience.

These 28 quantitative studies provide objective (19 studies) and self-reported evidence assessing the benefits of simulation training for the management of acutely unwell medical and surgical patients; 2.2.3.1 covers the objective evidence from 24 studies, 2.2.3.2 covers the self-report data from nine studies.

2.2.3.1 The role of simulation for improving medical students' knowledge and skills around assessing medical emergencies

Small-group simulation training

One scenario

Four studies use small-group simulation with one scenario to train students in assessing medical emergencies (194, 195, 217, 234).

One high-quality RCT (MERSQI 13.5, n=39) showed that small-group simulation training with a focus on sepsis was associated with a bigger improvement from baseline in an MCQ test compared to controls (mean improvement of 6.8/25 for simulation group, 4.5/25 for didactic learning, p= 0.0387)(KP2) (194). Although scores declined over two weeks in both groups, the decline was less in the simulation group (mean reduction of 1.3 compared to 3.6 for didactic/control group, p= 0.167), though this was not statistically significant (KP2).

Simulation for sepsis has been associated with significantly improved mean MCQ scores (mean score 47.6% in pre-test, 66.8% in post-test p= 0.001)(234), in another high-quality (MERSQI 12) study (KP2). A three hour simulation workshop on postoperative shock was found to produce a significant improvement in videoed simulation scores following the intervention (pre-test 40/90 vs. post-test 48/90, p= 0.001) (KP2) (195). However, there was a risk of recall bias as the pre- and post-test MCQs were identical (KP2). Contrary to these positive findings, for participants taking part in simulation covering a chest pain curriculum, mean OSCE scores were not significantly different compared with case-based learning (MERSQI 13.5) (KP2) (217).

Multiple scenarios

Twelve studies used multiple small-group simulation scenarios to train students in assessing medical emergencies (190, 214-216, 222-226, 228, 229, 233).

Students' use of simulation scenarios to train to deal with acute chest pain, stroke and acute dyspnoea was associated with significantly higher OSCE scores when compared with small-group teaching (61.2 +/-3/66 vs. 60.3 +/- 3.5/66, p= 0.017) (KP2) (190). This was a large, high-quality RCT (MERSQI 13.5 n=242); it also found that there was no statistically significant difference between groups' scores on a written knowledge test on the subjects they had learnt about in the simulation (190).

Using simulation to prepare to deal with patients with acute abdominal pain, chest pain and trauma was described in another high-quality RCT (MERSQI 13.5, n=91)(233). The participants taught with simulation missed significantly fewer questions on a MCQ knowledge test compared to control participants who received small-group teaching (mean difference 0.7, 95% CI 0.3-1.0 p= 0.006)(KP2). Following a one-day simulation course on dyspnoea and abdominal pain participants demonstrated significantly higher scores (71% vs. 52% p= 0.0001) in a simulation scenario compared to a control group receiving PBL (KP2) (226). Furthermore, the percentage change in scores from pre-intervention to post-intervention was significantly higher in the simulation group (25% vs. 8%, p= 0.04) (226). Simulation for emergency scenarios in a similar sized, high-quality (MERSQI 13.5, n=83) crossover RCT was associated with quicker insertion of an IV line (28.3secs vs. 86secs), initiating cardiac monitoring (36.2sec vs. 79.1sec), and ordering initial investigations (114.9sec vs. 215.2sec)(p= <0.05). There were no significant differences across the other scored domains (KP2), but both the simulation and group discussion mean time to action for tasks improved significantly (p= <0.05) from their pre-test scores (228).

The benefits of simulation for assessing medical emergencies over didactic teaching in the RCTs included in this review are unclear. When simulation for MI and acute dyspnoea was compared with lectures, one high-quality study (MERSQI 12.5) failed to find a significant difference in mean written knowledge test scores (KP2) (229). A mean improvement (pre/post) was found in test scores across both groups (KP2). Another simulation course on MI and anaphylaxis, examined with an RCT was not associated with a significant difference from video-based training for simulation test scores or knowledge test scores (KP2) (223). Contrary to these findings, simulation for MI and anaphylaxis in another high-quality RCT (MERSQI 13.5) was associated with significantly higher critical actions completed on a simulation assessment (95% in sim group, 71% in didactic group, p= <0.0001) when compared with didactic learning (KP2) (222).

Two case-control studies compared group learning with simulation to see which was most effective. Simulation for septic shock and cardiogenic shock was associated with significantly better mean scores (on an oral examination based on a written case) compared with small-group teaching (septic shock 3.95/5 vs. 3.48/5, p= <0.001, cardiogenic shock 3.88/5 vs. 3.28/5 p= <0.001, KP2, MERSQI 11.5) (214). A smaller study (MERSQI 12, n=44) analysing the differences between an old curriculum (without simulation) and a new curriculum (with simulation) also supported these findings (216). This study found that mean scores across all OSCE stations were significantly higher (average difference across 6 stations 6.63/25 p= <0.0001-0.016) for those trained with simulation (KP2)(216).

A short, high-fidelity simulation with postoperative surgical emergency scenarios, evaluated with a high-quality study (MERSQI 12) found students had significantly improved overall OSCE scores (pre-test 90.8 +/- 2.5 vs. post-test 105.4 +/- 2.2 p= <0.05)(KP2, MERSQI 12) (215). Simulation for neurological emergencies with a focus on general management of emergencies and an ABCDE approach was evaluated with large-scale study (MERSQI 11, n=300). Following the simulation, there was a significant increase in students demonstrating specific and transverse competencies during a test simulation (pre-test 13-33% and post-test 60-87% demonstrated specific competencies, p= <0.05)(KP2) (225). 'Transverse competencies' or non-technical skills demanded "greater integration of knowledge seem to need more time or new sessions" (225). Using simulation for scenarios including transfusion reaction, IV injection of local anaesthetic, hypoxaemia, and anaphylaxis was associated with significant improvement in performance scores on a simulation assessment (mean score 51.84% vs. 68.18% p= <0.0001) and pharmacology test scores (48.52+/-15.71% vs. 56.21+/-16.88% p= <0.0001) during a second simulation (KP2, MERSQI 12) (224).

Small-group simulation training in association with other educational methods

Five studies use small-group simulation training in association with other educational methods such as small-group teaching, didactics and workshops (181, 193, 206, 210, 232, 239).

Simulation in combination with didactic learning (lectures) to provide more focus on acute care skills was associated with significantly better mean scores overall on a clinical performance examination compared with didactic learning alone (53.5% +/- 8.9 vs. 47.7% +/- 9 p= <0.02) (KP2, MERSQI 11.5, n=291)(206). A 'how to save a life' course was evaluated with another study (MERSQI 10); 100% of participants were competent at basic life-saving techniques, judged by trained observers on a simulated scenario (KP2) (181). The course consisted of a lecture and small-group simulation session and was evaluated longitudinally; after 18 months, cardiopulmonary resuscitation (CPR), airway and defibrillator skills had not declined greatly (100%, 88% and 91% respectively) although, the ability to recognise arrhythmias and management of choking has declined substantially (KP2) (181). However, these findings are confounded by the fact that students took a mandatory advanced life support course in between the initial assessment and the follow-up, meaning that any effects may not be due to the simulation alone. A smaller, high-quality study (MERSQI 11, n=63) looking at simulation combined with lectures, skills workshops, and group discussion for recognition of sepsis was associated with significantly improved simulation scenario scores (pre-test 57.5% +/- 13, post-test 85.6% +/- 8.8, 2 weeks post-test 80.9% +/- 10.9, p= <0.05) (KP2) (232). Although the two-week post-test scores had declined slightly, there were still significantly better than pre-test scores (mean score 80.9+/-10.9%, p= <0.05)(232).

Following a national course in the UK on surgical emergencies which combined simulation with lectures and skills stations, participants had significantly improved knowledge MCQ scores when compared to pre-test scores (mean score pre-intervention 57.9%, post-intervention 70.9% p= <0.0001). This improvement was maintained after eight weeks (mean score 69% p= 0.0039)(KP2, MERSQI 12.5) (193).

In Greece, a two-day simulation course was devised which incorporated simulation into the undergraduate curriculum (210). Sixty students attended all modules of the course, with 170 as observers, who attended the lecture and workshop sessions, but observed the simulation sessions; students completing the simulation sessions scored higher mean scores than the observers on the educational environment measure (pre-test 70.08% +/- 16.23, post-test 85.53% +/- 13.40, p= <0.0001) (KP2) (MERSQI 12).

Computer-based simulation training

Three studies used computer-based simulation to train students to assess medical emergencies (227, 230, 231).

A small study (MERSQI 12.5 n=64) compared computer simulation with lecture-based teaching for assessing medical emergencies; students that were trained with a computer simulation had significantly better mean scores on a simulated scenario (17 +/- 7/26 vs. 10 +/- 8/26, p= 0.002)(227). However, the difference was only significant in one domain on the checklist (‘use of a specific treatment’) (227). A similar sized, high-quality study (MERSQI 12.5 n=57) showed that simulation to learn ALS was not associated with a significant difference in mean knowledge test scores when compared with textbook study (KP2). In fact, there was a significantly greater improvement (12.2 +/-3/20 vs. 10.3 +/-2.9/20 p= <0.04) in the score for those in the textbook study group (KP2) (231).

When a computer-based simulation for ten emergency cases was introduced, students had a significant increase in the number of correct medical approaches following the simulation (mean 3.9 before the intervention, mean 9.6 post-intervention), as scored with a written knowledge test (p= 0.006)(KP2, MERSQI 12) (230). This computer simulation presented emergency cases, including bowel perforation, emphysema, hypovolaemic shock, and pulmonary embolus.

*Table 2-7 – Studies included demonstrating objective evidence for simulation training for assessing medical emergencies.*denotes RCTs. **indicates length of simulation not specified. 'Survey' and 'questionnaire' were referred to interchangeably throughout the literature, therefore for clarity are referred to by questionnaire. Y1-5 denotes the year of study for students; if missing this was not specified in the study.*

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI
Small-group simulation training (with one scenario)						
Schwartz et al. USA (217) RCT*	Simulation scenarios on chest pain – 1hr long	CBL	102	OSCE	No significant difference between the groups for the difference in the mean number of observed actions performed on any of the three subscales, nor a difference in overall scores	13.5
Solymos et al. Ireland (194) RCT*	Simulation scenarios on critical care topics with a focus on sepsis**	Lecture	39	MCQ knowledge test with 2-week follow-up	There was a significant difference in the improvement from baseline and post teaching MCQ in the simulation group compared to lecture 6.8/25 (21.1 - 14.3) vs. 4.5/25 (21.5 - 17), p = 0.0387. The results of 2-week follow-up MCQ were lower in both groups than post teaching results. Although this margin was smaller in the simulation group 1.3/25 (19.8-21.1) vs. 3.6/25 (17.9 - 21.5), this was not statistically significant (p =0.167).	13.5
Vattanavanit et al. Thailand (234)	Simulated septic shock scenario, 2hr session plus debrief	N/A	79	MCQ knowledge test	The mean percentage score ± standard deviation (SD) of the post-test examination was statistically significantly higher than the pre-test (66.83%±19.7% vs 47.59%±19.7%, p<0.001). In addition, the student mean percentage confidence level ± SD in management of septic shock was significantly better after the simulation class (68.10%±12.2% vs 51.64%±13.1%, p<0.001	10
Weller et al. New Zealand (195)	3hr simulation workshop on postoperative shock	N/A	71	Simulation scenario scoring	Combining all pre-test and all post-test scores, overall there was a significant improvement from baseline to repeat simulation scores(40/90 vs. 48/90, p= 0.001. The median scores for 6th-year students were significantly higher than for 4th-year students for both baseline (p<0.01) and repeat scenarios (p<0.001).	12
Small-group simulation training (with multiple scenarios)						
Gordon et al. USA (229) RCT*	Simulation on either MI or reactive airways disease management; 30min pre-test, 90min simulation, 90min lecture then 30min post-test	Crossover - lecture	38	Knowledge test	Mean pre/post-test score improvement across modalities (overall change score in simulation 8.8/100 CI 5.7-16.9, change score lecture 11.3/100 CI 5.7-16.9), but no sig diff between sim and lecture	12.5

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI
Herbstreit et al. Germany (190) RCT*	Simulation on 3 emergencies (acute chest pain, stroke, acute dyspnoea), each 90min.	small-group teaching	242	MCQ knowledge test	No sig diff in mean scores	13.5
				OSCE	Better mean scores in simulation group 61.2 +/-3/66 vs. 60.3 +/- 3.5/66; P=0.017, Cohen d: 0.279	
Littlewood et al. USA (214)	Case-based discussion (CBD) vs. simulation for cardiogenic and septic shock; each simulation/CBD lasted 1hr	CBD	85	Oral examination based on written case, scored by examiners	Better mean scores across all parameters in sim group compared with CBD group, sig better mean scores in simulation group for septic shock (3.95/5 vs, 3.48/5 effect size 0.68, p= <0.001) and cardiogenic shock (3.88/5 vs. 3.28/5, effect size 0.89 p=<0.0001)	11.5
McCoy et al. USA (222) RCT*	Simulation sessions on anaphylaxis and MI; 1hr each.	Crossover - lecture	28	Simulation scenario scoring	Mean scores were 93% (95% confidence interval [CI] 91–95%) of critical actions completed for simulation and 71% (95% CI 66–76%) for didactic. Absolute increase for simulation was 22% (95% CI 18–26%). For three domains common to MI and anaphylaxis, simulation scores were higher for history (27%, 95% CI 21–38%), physical examination (26%, 95% CI 20–33%), and management (16%, 95% CI 11–21%) (p < 0.0001).	13.5
Morgan et al. (2002) Canada (223) RCT*	90min simulation sessions on MI, anaphylaxis, hypoxaemia	Video-based learning	144	Simulation scenarios scoring	Students demonstrated an improvement from pre-test to post-test scores, regardless of the scenario on which they were tested. No sig diff between sim and video-based training 30.81/36 vs. 30.65/36)	13.5
				Knowledge test	No sig difference in mean scores	
Morgan et al. (2006) Canada (224)	Four simulation scenarios; transfusion reaction, IV administration of local anaesthetic, Hypoxaemia, Anaphylaxis; 1 day	N/A	226	Simulation scenarios scoring	Significant improvement between pre- and post-test simulator team performance scores when all scenarios were considered together (mean score 51.84% vs. 68.18% p<0.0001). There was also significant improvement in checklist and global rating scores between pre- and post-test performance when analysed by scenario	12
				Pharmacology knowledge test	There was a significant improvement between individuals' mean pre- and post-test pharmacology test scores (48.52+/-15.71% vs. 56.21+/-16.88% p<0.0001).	
Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI

Nackman et al. USA (215)	60-75min high-fidelity simulation of haemorrhagic shock, ARDS, sepsis and cardiogenic shock	N/A	54	OSCE (2 weeks after simulation)	Student performance on the shock stations of the OSCE was significantly improved following simulation. Total mean scores following the sim were 105.4 +/- 2.2 vs 90.8 +/- 2.5, P= 0.05.	12
Ruessler et al. Germany (216)	3 days of simulation training in BLS and ACLS and common emergencies.	3 shifts in the emergency dept	44	OSCE; 1 station within 4 months of completion of the intervention	the mean scores of all OSCE stations were significantly higher in the intervention group as compared to the control group (average difference across 6 stations 6.63/25 p<0.0001 to p<0.016)	12
Sanchez-Ledesma et al. Spain (225)	2 x 30min simulation scenarios; acute subdural haemorrhage, cerebral contusion	N/A	300	Simulation scenarios scoring	Participants demonstrated significantly more specific and transverse competencies following simulation (pre-test scores 13-33% demonstrated the competencies and post- test 60-87% demonstrated the competencies p<0.05). 10 specific competencies and 5 transverse competencies (transverse – NTS	11
Steadman et al. USA (226) RCT*	1-day Simulation scenarios on dyspnoea, abdominal pain.	Crossover - PBL	31	Simulation scenarios scoring 5 days after simulation	The SIM group performed sig better than the PBL group on the final assessment (PBL 52%, SIM 71%, p <.0001). When each student's change in score (percent correct on final assessment minus percent correct on the initial assessment) was compared, SIM group students performed better (mean improvement, SIM 25 percentage points vs. PBL 8 percentage points, p < 0.04)	13.5
Ten Eyck et al. (2009) USA (233) RCT*	Simulation of emergency scenarios (chest pain, altered mental state, dyspnoea, trauma). Each 3hr sessions over a 4-week period.	small-group discussion	91	MCQ knowledge test	Significantly fewer questions were missed by participants in simulation group, with a mean difference per student of 0.7 (95% confidence interval [CI] 0.3 to 1.0; P=.006). Students rated simulation as more stressful (mean 4.1; 95% CI 3.9 to 4.3), but also more enjoyable (mean 4.5; 95% CI 4.3 to 4.6), more stimulating (mean 4.7; 95% CI 4.5 to 4.8), and closer to the actual clinical setting (mean 4.6; 95% CI 4.4 to 4.7) compared with group discussion	13.5
Ten Eyck et al. (2010) USA (228) RCT*	Simulation of 8 cases of deteriorating patients, each 3hr	CBL	83	Simulation scenario scoring	significantly better performance after simulation instruction compared with case-based discussion instruction in four of the defined outcomes including the mean time (seconds) to (1) order an intravenous line—simulation: 28.3[95% (CI): 9.7–46.8] CBL: 86.0 (95% CI: 67.7–104.4); (2) initiate cardiac monitoring—simulation: 36.2 (95% CI: 20.6–51.9) and CBL: 79.1 (95% CI: 63.4–94.8); (3) order initial laboratory tests—simulation: 114.9(95%CI: 75.0–154.8) and CBL: 215.2 (95% CI: 175.5–254.8); and (4) initiate blood pressure monitoring—simulation: 43.4 (95% CI: 21.5–65.2) and CBL: 87.8 (66.2–109.4). There were no significant differences between the means of the remaining four components	13.5

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI
Small-group simulation training combined with other educational methods						
Ander et al. USA (181)	'How to save a life course' small-group teaching and simulation stations, half-day course	N/A	104	Simulation scenario scoring	Competency immediately after intervention was 100% for all competencies (using standardised checklist. Small decline on follow-up 100%, 88% and 91% (no stats available)	10
Dewaay et al. USA (206)	Simulation group received small-group sim training AND the didactic curriculum each lasting 2hr	Lecture alone	291	Clinical Performance Exam (CPX) (additional station included for study not used in official grading)	Mean performance scores by checklist component – history/physical exam/tests/diagnosis/treatment. Overall mean scores sig better (53.5 +/- 8.9%) compared with didactics (47.7 +/-9% p=<0.02) and control (47.9 +/- 9.8% p=<0.01 also sig difference between individual components of the checklist	11.5
Nguyen et al. USA (232)	5hr course on severe sepsis including didactic lectures, skills workshop and simulated scenarios	N/A	63	Simulation scenario scoring	Significant improvement in pre to post-test scores overall – mean 57.5%+/- 13 vs. 85.6%+/-8.8 p= <0.05 and this was maintained after 2 weeks – mean score 80.9%+/-10.9 p= <0.05	11
				Knowledge test immediately afterwards and two weeks afterward	The pre-test, post-test, and 2- Week mean post-test scores were 75±13.0, 85.6±8.8, and 80.9±10.9%, respectively. There was statistically significant improvement in each of the post-test scores compared to the pre-test scores at every level of medical school	
Mughal et al. UK (193)	National surgical workshop consisting of 4 lecture and 6 interactive stations, 4 of which are simulations, each lasting 60min on post op SOB, sepsis, acute abdomen, trauma	N/A	66	MCQ knowledge test	statistically significant improvement on the preworkshop MCQ scores (57.9 vs. 70.9% p= < 0.0001, d = 2.37), improvement was sustained 8 weeks following the workshop (mean score 69%, p= 0.0039, d =1.62)	12.5
Pantelidis et al. Greece (210)	2-day simulation course on emergency scenarios; 15 case-based lectures, ABCDE hands-on station, 10 simulation scenarios each 10min		230 (170 observing, 60 full course)	MCQ knowledge test	Pre-test score was 70.08 (±16.23), while the post-test score was 85.53 (±13.40). Wilcoxon signed rank test showed that significant improvement took place p= <0.001	12
				DREEM; Dundee ready educational environment measure- full participants only, to assess educational environment	Cronbach's alpha was ≥0.8 for the overall DREEM score. The overall DREEM score was 144.61 (±28.05), which may be interpreted as more positive than negative. Full participants scoring higher than OB participants on the overall DREEM score.	

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI
Computer-based simulation						
Karakus et al. Turkey (230)	Computer-based virtual simulator (Lsim) presenting emergency cases; gastric perforation, poisoning, emphysema, DVT/PE, aortic dissection and haemothorax**	N/A	29	Knowledge test	In the 10 computer sim medical cases, an average of 3.9 correct medical approaches were carried out in the pre-test and an average of 9.6 correct approaches in the post-test (t=17.18, p=0.006)	
Kim et al. Korea (231) RCT*	Computer-based simulation on ACLS; 150min.	Textbook study on ACLS	57	MCQ knowledge test, with follow-up test 1 week later	Pre-test scores similar in both groups, test scores improved immediately after the study period in both groups – greater improvement seen in textbook group - 10.3+/-2.9 vs 12.2 +/- 3 p=<0.04. By one week – no sig diff	12.5
Tan et al. Singapore (227) RCT*	1hr screen-based simulation for heart failure and anaphylaxis.	Lecture	64	Simulation scenario scoring	No sig difference in mean overall score, resuscitation score, diagnosis score or calling for help, but sig diff in mean score for specific management – 17+/-7 vs. 10 +/- 8, P=0.002	12.5

2.2.3.2 The role of simulation for improving medical students' perceived knowledge and skills around assessing medical emergencies

<u>Small-group simulation training</u>

Four studies used small-group simulation training to train students to assess medical emergencies (189, 190, 192, 194).

Simulation for sepsis was compared with didactic teaching on the same topic. In this study, students rated simulation significantly higher for being more relevant (9.7/10 vs. 9/10 p= 0.0313) and easier to understand (9.6/10 vs. 9.2/10 p=0.0476) (KP2) (194). This simulation was also associated with objective improvements in MCQ scores as discussed in 2.2.3.1. Students undertaking simulation on three emergency scenarios rated their confidence level higher (on a five-point scale) than controls in a large, high-quality study (n=242, MERSQI 13.5) providing mostly objective data. However, this was only the case for one out of the three scenarios (190).

Attendance on a short simulation course on hypotension and breathlessness was associated with significantly improved mean scores for confidence dealing with and treating medical emergencies (2.17/5 vs. 4.17/5 p= 0.0001, KP2, MERSQI 7.5) (192). Furthermore, students also felt more confident in their knowledge and skills required to by an FY1 (2.57/5 vs. 3.83/5 p= 0.0001). Another similar quality study (MERSQI 9.5) looked at 'near-peer' simulation teaching on emergency scenarios; this was associated with significant improvements in confidence across six competencies (mean scores improved by 12-32%, p= <0.001, KP2) (189). The 'near-peer' simulation was based on problems encountered by junior doctors on the wards.

<u>Small-group simulation training in association with other educational methods</u>

Three studies used small-group simulation training with other educational methods (181, 193, 232).

A 'how to save a life' course was evaluated with a 'level of comfort' questionnaire in addition to the objective data provided (181). Immediately following the intervention, 80-100% of participants agreed that they felt prepared for life-saving clinical skills (KP2). A national course combining simulation with lectures and skills stations was also associated with a significantly improved confidence in assessing the acute surgical patient (2.5/5 vs. 4.2/5 p=

<0.0001), and initiating management (2.7/5 vs. 4.1/5, p= <0.0001)(KP2)(193). Finally, a five-hour course on severe sepsis including simulation, didactics and skills workshops resulted in significant improvements in self-reported confidence (mean scores 1.2+/- 0.6/5 vs. 3.4+/- 0.7/5, p= <0.05) (232).

Ward-based simulation training

Two studies used ward-based simulation training; specifically they used scenarios set in a simulated emergency department to develop a student's ability to deal with deteriorating patients (182, 191). When students were allocated a 'shift' in a simulated ED with a variety of emergency scenarios, students felt better prepared for being a doctor and understood the importance of teamwork (MERSQI 8, KP2) (191). A score of >4/5 on the Likert scale was classified as being prepared; participants mean scores were >4 for taking responsibility, working as a team and communicating effectively. In a smaller, similar quality study (MERSQI 7, n=50) simulation with three scenarios, free-text questionnaire responses revealed participants felt that their clinical reasoning skills were enhanced and after 18 months they referenced using the skills they learned (KP3) (182).

*Table 2-8 - Studies included demonstrating self-reported evidence for simulation training for assessing medical emergencies.*denotes RCTs. **indicates length of simulation not specified. 'Survey' and 'questionnaire' were referred to interchangeably throughout the literature, therefore for clarity are referred to by questionnaire. Y1-5 denotes the year of study for students; if missing this was not specified in the study.*

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training (one scenario)						
Solymos et al. Ireland (194) RCT*	Simulation scenarios on critical care topics with a focus on sepsis**	Lecture	39	Questionnaire	Mean ranking sig higher for Sim sig being more relevant 9.7/10 vs. 9/10 p= 0.0313) and easier to understand (9.6/10 vs. 9.2/10 (p=0.0476)	13.5
Small-group simulation training (multiple scenarios)						
Cash et al. UK (189)	'Near-peer' teaching with 6 simulation scenarios mapped with curriculum; infective exacerbation of COPD, anaphylaxis, hypoglycaemia, GI bleed, acute asthma, meningitis – total 90min session	N/A	25	Questionnaire	Significant improvement in mean confidence scores across all 6 competencies; taking history (p=<0.005 12% mean improvement), ABCDE assessment (23% improvement p=<0.001), focused examination (20% improvement p=<0.001), differential diagnosis, 27% improvement p=<0.001) selecting investigations (29% improvements p=<0.001) and treatment (32% improvement p=<0.001). free-text – v useful, enjoyed being hands-on	9.5
Herbstreit et al. Germany (190) RCT*	Simulation on 3 emergencies (acute chest pain, stroke, acute dyspnoea), each 90min	Small-group teaching	242	Questionnaire	Those taught with sim felt better prepared (higher mean rating on 5 point scale, no figures provided) but no sig diff for confidence for individual scenarios	13.5
Macdowell et al. UK (192)	Simulation session on 'the hypotensive patient' and 'the breathless patient' and acute GI bleed, each session 2hr	N/A	23	Questionnaire	Improved mean scores for self-reported confidence post-intervention (2.17/5 vs. 4.17/5 p= 0.0001), and students also felt more confident in their knowledge and skills required to by an FY1 (2.57/5 vs. 3.83/5 p= 0.0001) Free-text data also emphasised the improved confidence	7.5

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training combined with other educational methods						
Ander et al. USA (181)	'How to save a life course' small-group teaching and simulation stations, half-day course	N/A	104	Questionnaire	80-100% answered either strongly or somewhat agree immediately after the intervention for life-saving clinical skills – all declined dramatically on follow-up	10
Mughal et al. UK (193)	National surgical workshop consisting of 4 lecture and 6 interactive stations, 4 of which are simulations, each lasting 60min on post op SOB, sepsis, acute abdomen, trauma	N/A	66	Questionnaire	significantly improved confidence in assessing the acute surgical patient (2.5/5 vs. 4.2/5 $p= <0.0001$), and initiating management (2.7/5 vs. 4.1/5, $p= <0.0001$)	12.5
Nguyen et al. USA (232)	5hr course on severe sepsis including didactic lectures, skills workshop and simulated scenarios	N/A	63	Questionnaire	Significant improvement in self-reported confidence (mean score 1.2/5+/-0.6 vs. 3.4/5+/-0.7, $p= <0.05$)	11
Simulated emergency department						
Johnson et al. Australia (191)	SimED- simulated emergency department with 9 patient areas, including cubicles and waiting room. Example cases include SVT, ankle sprain, overdose, confusion, facial injuries and domestic violence. Groups of 15-16 students complete 2hr shift over 2 days	N/A	77	Questionnaire	Mean score >4 classified as prepared for taking responsibility, working as a team and communicating effectively. Areas scoring a mean score of <4 included procedural skill, case presentations and handover. Described as realistic and challenging	8
Murray et al. Canada (182)	Simulated ED designed to enhance student clinical reasoning, cases were chest pain, headache (SAH) and abdominal pain**	N/A	50	Questionnaire immediately and after 18 months	Free-text analysis responses suggest that the sessions were memorable to students and significant in helping them develop an approach to assessing undifferentiated patient complaints	7

2.2.3.3 Summary

Of all the areas discussed in this review, the simulation interventions for assessing medical emergencies were the most similar in the way they were designed and run (compared to those for non-technical skills and preparation). The simulations for medical and surgical emergencies were delivered with simulation over one to three hours and assessed mainly with objective measures (compared to more self-report data for simulation for preparedness and non-technical skills). Additionally, the studies that investigated simulation for assessing medical emergencies were the highest quality studies in this review (average MERSQI score 11.6), with some of the larger sample sizes. Despite the high-quality and homogeneity, the frequency of the use of simulations was varied, with some simulations repeated over several weeks while others consisted of a single scenario.

Although most studies demonstrated students using the concepts of deliberate practice and experiential learning, the studies that only used one simulated scenario (194, 195, 217, 234) would not allow participants to complete the full cycle of Kolb's theory (concrete experience, reflective observation, abstract conceptualisation and active experimentation). Despite this, both pre/post-test studies noted a significant improvement in students' knowledge and skills related to assessing medical emergencies (195, 234). Although one of the RCTs found a significant difference in favour of simulation (194), the other RCT failed to find a difference between simulation and CBL for developing students' knowledge and skills for assessing a medical emergency (217).

The objective evidence presented suggests that simulation is associated with immediate improvements in assessing medical emergencies, as judged by written knowledge tests, simulation tests and OSCE scores. Simulation also appears to be more effective than small-group and PBL-type learning for this skill. However, some studies that compared simulation with didactics found a significant difference in knowledge or skills, while others found no difference. This may have been the result of how the outcomes were measured. For example, participants undertaking simulation would likely perform better in a simulation assessment compared to controls who did not receive simulation training. Furthermore, although computer-based simulation seems to be associated with immediate improvements in assessing medical emergencies, when compared with other educational methods there were mixed results (although this represents only two out of the 28 studies). Only two studies followed students up longitudinally; one found self-reported change in behaviour (KP3 (182)), the other found that simulation scores declined on follow-up (181).

The self-reported data from these studies suggest that simulation is associated with immediate improvements in students' confidence in assessing medical emergencies and is better than other educational methods for improving students' confidence. However, fewer studies described self-report data (eight out of the 28 studies).

2.2.4 Simulation for non-technical skills

There is a growing focus on the importance of non-technical skills in medicine, with increasing evidence that human factors are the cause of most clinical incidents (81). Therefore, multiple simulation courses have been devised to try to improve healthcare workers' non-technical skills (23, 44). One key area targeted is team-working skills, and courses such as PROMPT (see 1.2.4) have shown KP4 level outcomes at the postgraduate level (85, 87, 240, 241).

Educators have begun to introduce non-technical skills training into undergraduate courses, and in 2009, the World Health Organisation produced a patient safety curriculum guide for medical schools (242). This offered guidance to medical schools on patient safety education to prepare students for clinical practice.

Ward simulation may be a useful way to introduce and develop non-technical skills such as situation awareness and prioritisation. In this setting, educators may introduce distraction or interruption to highlight the importance of situation awareness and the effects on medical error. As an additional element to a ward simulation, pagers or 'bleeps' may be introduced to add to the learning experience (in a similar way to one of the simulations under study in this thesis).

Many of the included studies use TeamSTEPPS; an 'evidence-based teamwork system to improve communication and teamwork skills among health care professionals' developed and used by postgraduate healthcare professionals in the US. TeamSTEPPS has been used in many postgraduate and descriptive studies looking at interprofessional teamwork (243-245); as TeamSTEPPS is designed for postgraduates, it has been adapted for the studies discussed here

The 20 included studies are mostly quantitative, self-report studies investigating the use of simulation in undergraduate education for non-technical skills and mainly focus on teamwork and communication skills; 2.2.4.1 covers the objective evidence from eight studies, 2.2.4.2 covers the self-report data from 17 studies. The ability to work in a team is a vital non-technical skill; simulation for non-technical skills often focuses on emergency situations where teamwork skills may be tested the most. The majority (14 studies) provide this in an interprofessional setting, with students of medicine, nursing and pharmacy and other healthcare disciplines come together to develop their teamwork and non-technical skills.

2.2.4.1 The role of simulation for improving medical students' knowledge and skills around non-technical skills

Small-group simulation training

Two studies use small-group simulation training for developing students' non-technical skills (209, 220).

Two simulated emergency scenarios with a focus on non-technical skills were evaluated longitudinally using two objective instruments (focused on communication and teamwork) (209). Mean scores were significantly higher following the intervention for team-working (mean improvement 0.61/6 p= <0.05), situational awareness (mean improvement 0.81/6 p= <0.05) and communication (mean improvement 1.16/6 p=<0.05). There was a significant decline in mean scores after six months (mean drop in subscales 0.15, 0.43 and 0.75/6 respectively, p= <0.05), and there was no significant differences longitudinally in the other communication and teamwork assessment instrument (KP2, MERSQI 12) (209).

A TeamSTEPPS framework was used to guide the design of an immersive interprofessional simulation which was evaluated with mixed methods (MERSQI 11.5, n=30) (220). When analysed with a team performance observation tool, interprofessional participants' mean performance ratings for domains in which they had received negative feedback significantly improved in the subsequent simulation (improvements of 0.39-0.75/5 p= <0.001 – 0.017) (KP2) (220). For domains participants had received positive feedback for, mean performance ratings went down (reductions of 0.22-0.94/5), although this was not always significant.

Small-group simulation training in association with other educational methods

Five studies use small-group simulation training in association with other educational methods such as didactics and group discussions (188, 207, 219, 246, 247).

Simulation in conjunction with a didactic lecture on TeamSTEPPS was compared in a four-group comparison study. This large, high-quality (MERSQI 14, n=438) study compared high-fidelity simulation plus didactic lecture with low-fidelity simulation, audience response didactic, and didactic lectures alone. Between the groups, there was no significant differences between mean scores on a teamwork attitudes instrument (CHIRP), teamwork knowledge test, or the scores from simulated patients (246). There were, however, significant improvements in mean scores on the teamwork knowledge test following all interventions (mean score 9.13/12 vs 10.16/12, p= <0.001)(KP2)(246). A further study (MERSQI 13, n=213) found that TeamSTEPPS simulation in association with workshops, lectures, and group discussions were associated with significant improvement in mean scores on a teamwork knowledge test (mean scores 8.68 vs. 10.08/12, p= <0.001) (207). Furthermore, there were significant improvements in scores on a teamwork attitudes scale (mean score 4.06 vs. 4.14/5, p= 0.006, marked by facilitators) and 97.6% of team skills were correctly identified by participants on video vignettes (KP2) (207). Following a similar TeamSTEPPS intervention with an online learning module, simulation, and case discussion, a similarly sized study (MERSQI 10.5, n=201) showed a significant improvement in mean team performance scores (6.71/11 vs. 9.93/11, p= <0.001), judged by expert facilitators, and significant improvement in a TeamSTEPPS knowledge test (10.88/14 vs. 12.88/14 p= <0.001)(KP2) (219).

Moving away from TeamSTEPPS, a ‘human factors’ day comprising of tutorials, small-group teaching and simulated patients within a surgical undergraduate clerkship was associated with significantly higher mean scores (compared with standard teaching) on a written assessment of team-working (1.72/4 vs. 1.34/4, p= 0.007) (188). Despite this, there was no significant difference in mean scores for work-life balance between the intervention and control groups, nor a significant difference between mean scores on a communication video vignette assessment (MERSQI 12.5) (KP2) (188). Following an interprofessional one-day team training course (BEST; BEtter and Systematic Team training) including simulation and lectures, facilitators reported strong levels of agreement (mean scores >3.6/5) that students performed better following the simulation, particularly for communication and leadership (KP2, MERSQI 7.5) (248).

Ward-based simulation training

A simulated ward intervention was associated with a significant increase in overall simulation assessment scores (mean scores 18.49/34 vs. 19.12/34, p= 0.0285). Participants also had a significant increase in mean scores in individual domains including situational awareness (mean score 2.87/4 vs. 3.03/4, p=<0.001) and task management (mean score 2.91/4 vs. 3.01/4, p= 0.045) following the simulation intervention (KP2) (221). In this large, high-quality study (MERSQI 12, n=217) patients were designed to present problems that would develop the student's non-technical skills, with the simulations videoed and then scored by the researchers using a validated coding framework.

*Table 2-9- Studies included demonstrating objective evidence for simulation training for non-technical skills.*denotes RCTs. **indicates length of simulation not specified. 'Survey' and 'questionnaire' were referred to interchangeably throughout the literature, therefore for clarity are referred to by questionnaire. Y1-5 denotes the year of study for students; if missing this was not specified in the study.*

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training (with multiple scenarios)						
Anderson et al Australia (220)	3 TeamSTEPPS interprofessional simulation scenarios, 2hr	N/A	30	TeamSTEPPS team performance observation tool	Mean performance ratings for positive items went down following sim (between 0.22 to 0.94/5, not always sig), but negative items mean scores went up between 0.39-0.75/5- p=<0.001 *not adjusted for multiple testing*	11.5
Garbee et al USA (209)	Two high-fidelity simulations of unstable AF and tension pneumothorax**	N/A	52	Communication and teamwork skills assessment instrument (CATS)	Mean scores in all four subscales improved following simulation – only situational awareness and cooperation sig diff (numbers not reported)– no sig diff longitudinally	12
				Teamwork assessment scale (TAS)	Sig improvement of mean scores pre/post (mean improvement in the 3 subscales of team-working 0.61, situational awareness 0.81 and communication 1.16/6 p= <0.05), sig drop in mean scores longitudinally (mean decrease in scores in the 3 subscales 0.15, 0.43 and 0.75, p= <0.05)	
Small-group simulation training combined with other educational methods						
Cahan et al USA (188)	'Introduction to human factors day'; small-group tutorials and three simulated patient scenarios**	Standard teaching	148	Written assessment of team-working and work-life balance	Sig higher mean scores for teamwork in intervention group (1.72/4 vs. 1.34/4, p=0.007). Mean post-test scores sig higher than pre-test scores (1.8/4 vs. 1.33/4, p=0.01). No sig diff in mean scores for work-life balance, no sig diff in pre/post-test mean scores	12.5
				Communication challenge videos; participants asked to write a response	Rated by experts – interrater reliability 0.808. No difference in overall mean scores between control and intervention, but sig increase in mean scores pre/post-intervention (2.32/5 vs. 3.45/5 p=<0.001)	
Hobgood et al USA (246) *RCT	90min didactic lecture focusing on TeamSTEPPS curriculum. Then split into 4 groups; 1.High-fidelity simulation 2.Low fidelity simulation 3.Didactic with video scenario 4.Didactic alone	Didactic	438	Simulated patient checklist scoring	Excellent interrater reliability. No sig diff in mean scores across the cohorts	14
				MHTPS	Interrater reliability 0.83-1. No sig diff in mean scores across cohorts	
				Teamwork knowledge test	Sig improvement in mean scores pre/post-test; 9.13/12 vs. 10.16/12 p=<0.001, no sig diff between cohorts	

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Jakobsen et al Norway (248)	Four 60min scenarios, interspersed with lectures	N/A	145	Facilitator questionnaires	Strong levels of agreement (mean scores >3.6) that students performed better after simulation – particularly for communication and leadership. Mean score 4.8 for the course being multiprofessional	7.5
Reed et al USA (219)	Online TeamSTEPPS module followed by 1hour simulation, discussion, and another simulation	N/A	201	Team performance evaluation form	Mean score significantly improved post-intervention; 6.71/11 vs. 9.93/11, p=<0.001	10.5
				TeamSTEPPS fundamentals examination	Mean scores significantly improved following intervention; 10.88/14 vs. 12.88/14 p= <0.001	
Robertson et al USA (207)	4hr team training (modified TeamSTEPPS) programme with lecture and simulation training exercises; resus of trauma patient and STEMI	N/A	213	Teamwork knowledge test	Sig improvement in mean scores both overall and for medical students and nursing students (mean improvement 1.39/12, p=<0.001	13
				Teamwork attitudes scale CHIRP (marked by facilitators)	Sig improvement in overall mean scores for attitudes towards teamwork (4.06 vs. 4.14/5 p=0.006) – when analysed separately no SD in medical students mean scores for attitudes. Participants who took part in simulation first had significantly improved attitudes towards teamwork (4.07 vs. 4.16/5 p= 0.037) whereas participants who saw the videos first did not demonstrate a difference in attitudes	
				Video vignettes marked by facilitators	97.6% of the team skills were recognised	
Ward simulation						
Harvey et al UK (249)	90min ward simulation with 4 scenarios which were videoed. Scenarios were repeated once with students in different roles	N/A	217	Simulations video recorded and coded by 2 trained researchers using coding framework to evaluate non-technical skills	Sig increase in overall mean scores pre/post (mean scores 18.49/34 vs. 19.12/34, p=0.0285) and individual scores for situational awareness (mean score 2.87/4 vs. 3.03/4, p=<0.001) and task management (mean score 2.91/4 vs. 3.01/4, p= 0.045)). Fair interrater reliability – kappa ranged from -0.095 – 1.00	12

2.2.4.2 The role of simulation for improving medical students' perceived knowledge and skills around non-technical skills

Small-group simulation training

Nine studies investigate the effects of small-group simulation training on students self-reported non-technical skills (183-187, 208, 209, 213, 220).

An interprofessional cardiac arrest simulation was associated with improvements in mean scores (48.8 vs 55.6/60) on an attitudes questionnaire following the intervention (187). Medical students in this small, lower quality study (MERSQI 8.5, n=40) also demonstrated (in free-text comment analysis) a desire to change behaviour and improve collaboration with their nursing colleagues (KP2)(187). A cardiac arrest simulation was the basis for a further RCT comparing simulation to roundtable discussion (MERSQI 10) (183). This study used a cardiac arrest simulation as it was felt to be a situation in which all health professionals had 'shared' knowledge. Although overall 98% of participants had a better sense of their role on the clinical team and just over half had changing views on their role in the clinical team, the only significant difference found between the groups was significantly higher stress in the simulation group (mean score 2.34/5 vs. 3.40/5, p= 0.000) (183). Following a resuscitation simulation scenario, students in a small, lower quality study (MERSQI 7, n=34) reported increased team coordination and understanding of each other's roles (184) in the qualitative questionnaire. "The importance of communication became very clear" to the participants, and they had more confidence working with other healthcare workers (184)(KP2).

A 12-week simulation curriculum using emergency scenarios, designed to enhance decision-making and teamwork skills for 3rd-year medical students was evaluated in a further lower quality study (MERSQI 8.5) (186). Participants reported significant improvements in self-reported confidence in assessing a medical emergency (mean change 0.87 +/- 0.17/10 p=<0.001), decision-making (mean change 0.97+/- 0.19/10 p= 0.001), teamwork skills (mean change 0.47+/- 0.13/10 p=0.01), and decreased feelings of stress over the 12 weeks (mean change -1.03+/- 0.29/10, p= 0.001) (KP2) (186).

Participation in two emergency simulation scenarios was associated with a significant improvement in scores on the validated high-performance teamwork scale (MHPTS; 19.98+/-5.01/32 vs. 25.36+/-4.65/32, p= <0.05) (209). This improvement did not change significantly after 6 months. A further interprofessional simulation was associated with high levels (>90%

agreed) of self-reported confidence in debrief and reflection, critical thinking, clinical learning and interprofessional teamwork on a simulation experience survey (220). Semi-structured interviews also suggested participants had a greater appreciation of different roles and confidence in working as a team (220).

A mass casualty disaster simulation was the basis for a lower quality (MERSQI 7, n=117) mixed-methods study. Following the simulation, 2^{nd}-year medical students demonstrated improved collaboration, negotiation and communication skills (185), according to the qualitative data collected (KP2).

The operating room is another area where non-technical skills are key. A simulation course incorporating operating room team training was associated with a significant improvement in mean scores on an interprofessional teamwork scale (mean score 4.13/5 vs. 4.78/5 p=<0.001, effect size 0.83) (KP2) (213). Scenarios included intra-abdominal haemorrhage due to trauma and local anaesthetic toxicity and were also associated with improvements in the mean scores on the readiness for interprofessional learning scale (RIPLS; mean scores 3.6/5 vs. 3.73/5 post-intervention) and high scores (>4.66/5) on a teamwork assessment scale (213).

Following on from these studies showing multiple KP2 evidence, educators in Germany evaluated a one-day interprofessional simulation course longitudinally with the 'commitment to change' tool (208). This tool 'promotes and assesses behavioural change following an educational intervention' and asks participants to make statements of their intent to change knowledge or behaviours within a specific time. In this medium size study (MERSQI 9, n=64), the tool was completed immediately after the simulation and after two months. Participants made commitments to change their communication, behaviours, knowledge or attitudes immediately following the simulation. After two months, 92% of participants reported their commitments to change had been at least partially achieved (KP3) (208). Examples of commitments to change included 'giving a clear and structured handover', 'targeted communication' and 'respect other professions' (208).

<u>Small-group simulation training in association with other educational methods</u>

Six studies looked at small-group simulation with other educational methods such as didactics and tutorials (172, 204, 205, 219, 246, 247).

Following an interprofessional one-day team training course (BEST; BEtter and Systematic Team training including simulation and lectures), participants rated their confidence in various non-technical skills (248). High mean scores (>3.5/5) were found across the domains of communication, leadership and teamwork (KP2, MERSQI 7.5) (248). Educators at a Scottish university devised a ward simulation teaching intervention, combining simulation with a tutorial and a decision-making tool (172). This qualitative study found no differences in educational benefits of the three methods; although, students found simulation the most valuable part of the teaching. Participants expressed that their decision-making and prioritisation improved following the intervention (KP2).

Following interprofessional simulated scenarios about child abuse and domestic violence combined with lectures and debriefs, researchers found that, 64.4% of participants demonstrated an improvement in their RIPLS scores and 60.2% of demonstrated improved mean scores on an attitudes scale (KP2, MERSQI 8.5) (204).

As discussed previously, the TeamSTEPPS framework can be used to develop interprofessional teamwork and has been used in several studies. The use of the teamSTEPPS framework at the base of an interdisciplinary undergraduate simulation resulted in significant improvements in overall scores on a teamwork attitudes questionnaire (TAQ; mean 4.02/5 vs. 4.16/5 p= <0.001, effect size 0.32) and increased scores on a attitudes questionnaire (AMUSE; mean 3.92/5 vs. 4.21/5, p=<0.001, effect size 0.7, KP2, MERSQI 9) (205). A further study using simulation with online learning found that there was a significant improvement in self-efficacy reported by students following the simulation (mean scores 119.6/160 vs. 144.97/160, p= <0.001, KP2)(219). Contrary to these findings, a large RCT utilising the TeamSTEPPS framework to guide a course that included lectures and simulation (246) found no significant differences between high-fidelity simulation and low-fidelity simulation or didactics alone. The study did find that following any of the educational methods there was a significant improvement in mean scores on a teamwork attitudes instrument (CHIRP, 141.6/180 vs. 144.6/180 p=0.001) (246).

<u>Ward-based simulation training</u>

Two studies use ward-based simulation training for developing students' non-technical skills (171, 173).

When ward round simulation was embedded into an interprofessional curriculum, nursing, physiotherapy, and medical students had an improved understanding of common objectives and team-working (KP2) (173). Students in this small qualitative study (n=29) found the simulation unrealistic, highlighting the importance of realism and participants 'suspending the disbelief'. An 'evening on call' simulation took place on four simulated wards, with students holding a bleep for 45 minutes (MERSQI 6 n=36) (171). Following an orientation to the ward and a verbal and written handover, students would be bleeped for different tasks, review simulated patients on the wards and finish with a debrief. After this intervention, students mean questionnaire scores were high (6.86-7.86/8), suggesting that they felt more prepared for professional practice (KP2).

*Table 2-10 - Studies included demonstrating self-report evidence for simulation training for non-technical skills.*denotes RCTs. **indicates length of simulation not specified. 'Survey' and 'questionnaire' were referred to interchangeably throughout the literature, therefore for clarity are referred to by questionnaire. Y1-5 denotes the year of study for students; if missing this was not specified in the study.*

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI/ CASP
Small-group simulation training						
Andersen et al. Australia (220)	3 TeamSTEPPS interprofessional simulation scenarios	N/A	30	SESS – Simulation experience survey	90-100% agreed or strongly agreed with all survey statements – themes – debrief and reflection, critical thinking and reasoning and clinical learning and IP teamwork	11.5
				Semi-structured focus group interview	Content analysis – greater appreciation of differing roles, confidence in working as a team and felt that it was a valuable educational experience	
Dillon et al. USA (187)	Mock 'code' (resus) developed as an interdisciplinary training experience using a high-fidelity mannequin	N/A	82 (only 40 completed post-test)	Attitude questionnaires pre and post-intervention	Improvement in mean post-test scores; 48.8 vs. 55.6/60. Open-ended questions – themes of teamwork and communication	8.5
Eisenmann et al. Germany (208)	1-day simulation with 5 cases; UTI/dehydration, minor head injury hypoglycaemia and leg injury, ACS, variceal bleed	N/A	64	C2C – commitment to change tool that can promote and assess behavioural change induced by educational intervention. Participants write down 'commitments' and are followed up after 2 months	71.1% students made at least 1 commitment to change – across a range of areas including communication, behaviour and knowledge. At follow-up – 50% provided comments on their original commitments – 91.9% commitments at least partially realised	9
Evans et al. USA (186)	12-week mandatory simulation curriculum; weekly 1hr session, 2 scenarios per session	N/A	95	Self-report questionnaire at weeks 4, 8 and 12 (throughout program)	Significant increase in scores across the 12 week period for assessing a medical emergency (mean change 0.87 +/- 0.17/10 p=<0.001), decision-making (mean change 0.97+/- 0.19/10 p= 0.001), teamwork skills (mean change 0.47+/- 0.13/10 p=0.01), and decreased feelings of stress over the 12 weeks (mean change -1.03+/- 0.29/10, p= 0.001)	8.5
Garbee et al. USA (209)	Two high-fidelity simulations of unstable AF and tension pneumothorax	N/A	52	MHPTS; High-Performance Teamwork Scale	Sig improvement in mean scores pre/post (19.98+/- 5.01/32 vs. 25.36+/-4.65/32, p= <0.05), no sig diff in scores longitudinally	12

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI / CASP
Jorm et al. Australia (185)	Mass casualty scenario designed to enhance teamwork and acquire non-technical skills. 4 cases, 50min each	N/A	117	Questionnaire	Quant – 59% found simulation very engaging and 94% agreed it was a worthwhile activity. 95% felt the learning was memorable. Qual data – 3 themes surrounding educational efficacy – the high fidelity of the simulation, ability to reflect in action and on action and the ability to develop collaborative team-working	7
King et al. USA (184)	15-20min simulated scenario involving a newly admitted patient with respiratory distress, 15 min debrief	N/A	34	Questionnaire	Qualitative data themes (from open questions) were improved communication, knowledge of other professionals and better collaboration	7
Leithead et al. USA (213)	High-fidelity operating room simulation; two 2hr sessions with intra-abdominal haemorrhage and local anaesthetic toxicity scenarios	N/A	152	Interprofessional teamwork scale (IPT)	Significant increase in overall mean scores (4.13/5 vs. 4.78/5 p=<0.001), effect size for med students 1.27, nursing students 1.01, overall 0.83	10.5
				Readiness for interprofessional learning scale (RIPLS)	Increase in overall mean scores (3.6/5 vs. 3.73/5, p=<0.001, effect size 0.37)	
				Teamwork assessment scale (TAS)	Mean scores high, all greater than 4.66	
Reising et al. USA (183) RCT*	High-fidelity simulation scenario of a 'mock code'	Round table discussi on	41	Questionnaire	98.3% had a better sense of their role on the clinical team, 55% reported changing views on their role in the clinical team and 100% found the sim helpful. No sig difference in mean scores for managing stress, team communication but simulation associated with higher mean scores for stress (mean score 2.34/5 vs. 3.40/5, p= 0.000)	10
Small-group simulation training combined with other educational methods						
Brock et al. USA (205)	Interprofessional 4hr training that included 1hr training on 'TeamSTEPPS' 3hr simulation and feedback sessions	N/A	149	TeamSTEPPS TAQ; Teamwork attitudes questionnaire pre- and post-intervention	Improvements in mean overall score (4.02/5 vs. 4.16/5, p=<0.001, effect size 0.32) and mean scores for team structure (p=0.062, effect 0.26), situation monitoring (p=<0.001 effect 0.35) and communication (p=0.002, effect 0.26)	9
				AMUSE; Attitude s, Motivation, Utility and Self-Efficacy questionnaire – pre- and post-intervention	Significant positive changes in mean overall score (3.92/5 vs. 4.21/5, p<0.001, effect size 0.70) and mean scores for each of the four subscales (p<0.001- 0.005, effect size 0.23-0.7)	

Author/ Country	Intervention	Control	Sample size	Evaluation tool	Findings	MERSQI / CASP
Hobgood et al. USA (246) RCT*	90min didactic lecture focusing on TeamSTEPPS curriculum. Then split into 4 groups; 1.High-fidelity simulation 2.Low fidelity simulation 3.Didactic with video scenario 4.Didactic alone	Didactic	438	CHIRP teamwork attitudes instrument	Sig improvement in mean scores pre/post-test (141.6/180 vs. 144.6/180, p= <0.001), no sig diff between cohorts (high fid simulation 145.8/180, low-fid simulation 145.7/180, didactic with video 142.9/180, didactic 144/180)	14
Jakobsen et al. Norway (247)	Better and systematic team training (BEST); four 60min scenarios, interspersed with lectures	N/A	145	Questionnaire	Systematic text condensation used for thematic analysis of free text. Themes were self-insight and stress management, understanding leadership role, insight into teamwork and skills n team communication. High mean scores (>3.5 out of 5) for self-reported communication, leadership and teamwork	7.5
McGregor et al. UK (172)	Teaching intervention consisting of a clinical decision-making tool, a tutorial and a simulated ward environment**	Tutorial	23	Interviews (semi-structured)	Evidence of students learning from mistakes made during simulator session across domains of diagnosis, prioritisation and asking for help/escalation. Simulation was reported to be more useful that the tutorial/decision-making tool	8, High-quality
Reed et al. USA (219)	Online TeamSTEPPS module followed by 1hour simulation, discussion, and another simulation	N/A	201	Self-efficacy measure for interprofessional competencies	Mean scores significantly improved; 119.56/160 vs. 144.97/160, p= <0.001	10.5
Wilcox et al. USA (204)	Simulation as part of interprofessional learning experience including lectures debriefs	N/A	110	RIPLS – Readiness for interprofessional learning	64.4% of participants demonstrated an improvement in their RIPLS scores	8.5
				AHCT Scale -Attitudes towards healthcare teams scale	60.2% of demonstrated improved mean scores on an attitudes scale	
Ward simulation						
McGlynn et al. UK (171)	'An evening on call' 15min handover followed by a 45min session on the simulated ward with a bleep and 30min debrief	N/A	36	Questionnaire	Mean scores ranged from 6.86-7.86 – lowest – acquisition of new skills in communication	6
Nikendei et al. Germany (173)	2 simulated ward round sessions (240min; MI and poorly controlled diabetes) embedded into a mini-curriculum of 4 interprofessional learning units including PBL, BLS, communication skills	N/A	29	Focus groups	Simulation was associated with improved understanding of situation, tasks and common objectives, conducting ward round, the importance of interprofessional care but participants found the sim unrealistic and felt ward rounds might not be the best scenarios to allow interprofessional learning	9, medium quality

2.2.4.3 Summary

These studies provide some objective evidence of improvement in medical students' non-technical skills immediately following small-group simulation and ward-based simulation, and also following interventions combining simulation with other educational methods. These objective improvements were not maintained longitudinally in the few studies that followed up participants. Additionally, there were few significant differences when simulation was compared to other methods (188, 246). The studies describing self-report data also show significant improvements in confidence immediately post-simulation, with some evidence of retention longitudinally (186, 209). One study provided self-reported evidence at KP3 level; however, this study was medium quality and a smaller sample size (MERSQI 9, n=64). Echoing the objective data, there were few differences when simulation was compared to other educational methods, and one study found significantly higher levels of stress in the simulation group (183). Although there were significant differences in objective and self-reported data, for the eight studies combining simulation with other methods, it is difficult to say with confidence that the effects are due to simulation alone. Most simulation interventions studied used multiple scenarios, allowing participants to reflect, form new cognitive pathways and use those newly developed pathways and knowledge in subsequent scenarios, reflecting the theory of experiential learning through simulation. In this way, non-technical skills can be developed through deliberate practice. However, two studies did not allow this repetition (171, 184). These two studies were among the lower quality, but did find immediate improvements in self-reported knowledge of non-technical skills.

2.3 Summary

It is clear from the interventions presented in this review that simulation is being used in wide-ranging ways. Theoretically, the benefits are clear: experiential learning in a safe environment to hone skills before having independent responsibility for patient care. The evidence is varied, and there is very little to suggest effects on patient outcomes at present (KP4).

The studies included in this review provide objective and self-report evidence at KP2 level for simulation at the undergraduate level, mainly from pre/post-test data. Fewer studies compared simulation with other teaching methods; data from comparison studies were mixed, perhaps suggesting that simulation is most effective when used in combination with other modalities rather than alone. The small number of studies comparing simulation to CBL/PBL (mainly for dealing with acute patients, one for non-technical skills) suggest that for these topics, simulation is more effective than CBL/PBL. Simulations benefits may be due to the importance of experiential learning and repetitive practice in these scenarios, may reflect that some scenarios are best delivered with simulation and others with CBL, or it may reflect students' different learning styles.

As students often move to different geographical areas following graduation (150), longitudinal preparedness studies often have high attrition. Results from the 11 longitudinal studies in this review are mixed; not all knowledge and skills are retained long term. However, three studies showed a self-reported change in behaviour and reduction of clinical incidents (158, 182, 208).

Overall, there is promising evidence from the quantitative data that simulation for non-technical skills, dealing with acute patients and preparedness for practice is associated with immediate improvements in both self-reported and objective knowledge and confidence. It is unclear if that knowledge and confidence are maintained in the long term and whether it genuinely brings about a change in behaviour or impacts patient care.

What is also evident is that although there is an abundance of quantitative studies in this area, there are very few mixed or qualitative studies (five mixed-methods, four qualitative). The qualitative data suggests that simulation is undoubtedly associated with improved preparedness for practice; participants felt that simulation "bridged the gap" as "some things you do as a junior doctor cannot be taught by lectures" (137), and they felt that the simulation centre was somewhere they could "relax and practice" (203). Simulation made participants feel more confident with critical thinking and non-technical skills, despite in one study participants valuing shadowing over simulation (139). Participants felt that although ward round simulation improved their understanding of common situations, that too much time was focused on it and it was unrealistic. More qualitative studies could shed light on the reasons that simulation is or is not effective, particularly for non-technical skills and preparedness, both of which are complex concepts.

2.4 Strengths and weaknesses of the evidence

There are several weaknesses to the studies included in this review, some inherent in education research and some related to simulation research.

Of the quantitative studies, only a quarter are at the highest level of scientific evidence (RCT), and the data is mixed, with only half finding a significant difference in favour of simulation. Of the rest, two have mixed results; three found no significant difference, one found a significant increase in stress in the simulation group and one favoured textbook study over simulation. Blinding is very difficult to accomplish in education research, and as most study populations are voluntary, this may give rise to participants who have favourable views of simulation, hence affecting the results. This indicates that although there is some evidence of simulations effectiveness (both from objective and self-reported data), more studies are needed to confirm these findings, especially in light of the other mixed results

Many of the studies examined here use simulation in combination with other educational methods, for example, shadowing, lectures, case-based discussion. It is, therefore, very difficult to prove that simulation alone is responsible for the outcomes. Even if simulation is looked at in isolation, other learning is taking place in the clinical environment, and as part of the medical degree, so this will affect the results. Medical curricula vary in the amount of clinical experience and teaching formats, and some may utilise simulation heavily, others use it sparingly. Additionally, students who come from a medical curriculum that uses simulation broadly may be more confident in a simulation environment. These factors may influence the results of the studies in this review

As demonstrated in Table 2-4, the simulation interventions have been tested with many different tools, some self-report, some objective, sometimes in combination in a single study. It may be that participants perform better due to the tool used to assess, for example, when simulation is compared with PBL, and this is assessed with a simulated scenario or measuring non-technical skills with an MCQ test rather than with a simulated scenario. Furthermore, there are several issues with a pre/post-test design which is used in many of the studies discussed, including recall bias. If there is no comparison group, it may be argued that improvement would be expected with any teaching intervention.

The mixed results from the longitudinal studies included may be in part due to the difficulties with this research design, specifically drop-out and, in education studies, the likelihood of other experiential learning confounding the results.

Large samples that are required in quantitative research are not necessarily needed in education research, particularly for qualitative studies, where researchers can gain rich data from a small number of participants. The sample sizes in this review are varied, and many of the quantitative studies have a relatively small number of participants. There are few qualitative studies in this area, and the addition of more qualitative data may lead to a better understanding of the benefits or lack thereof compared with other educational methods. Furthermore, only one-third of studies triangulate several data sources, and less than a quarter triangulate both self and objective data.

There may be a publication bias towards publishing studies that report positive findings in relation to simulation, thereby affecting the findings of this review. In addition, by excluding conference abstracts, and taking into account the fact that a lot of medical education research may not get published, this may also have an impact on the findings of this review, with a more favourable view on simulation due to less favourable papers not being published.

Finally, self-report data makes up approximately 40% of the data in this review. Although insight and accurate self-reflection are essential skills for junior doctors, self-reporting can be inaccurate and subjective (250). Therefore, self-report data needs to be combined with other data such as supervisor, stakeholder or objective measures to provide robust data supporting the use of simulation in this area. The preparedness for practice and non-technical skills sections have mostly self-report data (60%), whereas the data from assessing a medical emergency is largely objective.

Although there are weaknesses, there are also strengths to this body of evidence. The vast majority is prospective, rather than retrospective data, and there are some large studies, which have been able to show statistically significant differences in knowledge, confidence, and skills with simulation. There are several RCTs which are unusual in education research, but these have mixed results. Despite the issues with self-report data, it is important, particularly for preparedness for practice where confidence and competence interact.

2.5 Conclusions

This literature review has presented the evidence for the use of simulation at the undergraduate level for preparedness for practice, assessing medical emergencies and non-technical skills.

Although studies are few, the data presented here suggests that simulation is an effective means to improve the self-reported and objective preparedness in the short-term. Furthermore, there is some evidence that using simulation in training results in long-term improvements in preparedness, a change in behaviours and a reduction in clinical incidents (self-reported KP4). Simulation is also effective for developing students' non-technical skills according to the objective and self-reported data described.

It is unclear if these effects are maintained over time, and when simulation was compared with other educational methods, there were few significant differences found between the two methods. The evidence is less clear for simulation for assessing medical emergencies, as some studies, particularly those comparing simulation to another method, do not favour simulation. Although these studies provide evidence of the efficacy of simulation, they do not explain why or how it is perceived to be effective; this could be answered with more exploratory qualitative studies in this area. Although there is favourable evidence at KP2 level for simulation, we must consider that it is likely that there is a publication bias towards positive findings in simulation literature. There is a pressing need for large-scale, longitudinal studies in this area to add to the minimal evidence that simulation contributes to long-term retention of knowledge and skills. This subject would also benefit from more qualitative studies examining deeper the reasons that simulation is or is not effective, which may provide educators with good quality evidence regarding the use of simulation.

This chapter has described the KP2 (and minimal KP3) evidence that undergraduate simulation is effective for improving students' self-reported and objective preparedness for practice, assessing medical emergencies and non-technical skills. It has also highlighted the need for more longitudinal studies to determine if simulation for undergraduates can bring about change in behaviours and impact patient care. Furthermore, in the category of preparedness, large-scale, multiple informant, high-quality studies would be useful to determine if simulation can improve medical students' preparedness for practice but also bring about change in students' behaviours and impact patient care. The following chapter describes the rationale for the underlying methodology for this study, designed to address the gaps in the literature outlined in this chapter, and gives a detailed description of the methods used for this thesis.

3 Methodology and Research design

3.1 Introduction

Chapter one of this thesis explained the background and rationale for the research questions to be answered by this study. Chapter two gave a further overview of the literature related to undergraduate simulation for preparedness for practice, assessing medical emergencies and non-technical skills, providing further justification for this research.

As described in section 1.4, there are still improvements to be made in preparing students for professional practice. The impression from the literature is that there is some evidence for simulation being a useful tool to prepare students for professional practice. However, the number of studies on which this inference is based is small, and the evidence base lacks longitudinal multiple informant studies. This research has been designed to fill this gap in the literature and answer the research questions laid out in 1.6; how does simulation affects students' perceptions of their preparedness, in particular for assessing medical emergencies and non-technical skills and what are stakeholders' views on preparedness and the role of simulation.

3.2 Overview

This research was a mixed method two-phase study, carried out over two academic years with multiple participant groups.

One group comprised fifth-year medical student participants from two medical schools who completed questionnaires and interviews at two separate time points; immediately after their local simulation course (student phase) and approximately six months later (doctor phase). At the doctor phase, participants were 3-4 months into their first jobs as doctors (FY1s).

Data from the two academic years (fifth-year students from 2016/17 and 2017/2018) was then combined (Figure 3-1). Questionnaire and interviews were also administered to a second group; key stakeholders for fifth-year students. Stakeholders included clinical supervisors (consultants within the speciality that the student is working at the time of recruitment to the study), hospital leads for 5^{th} year, simulation and directors of medical studies. Stakeholder data was collected throughout the two years of the study.

This chapter provides a logical account of the methods used to complete this mixed method comparative study and the rationale for their use.

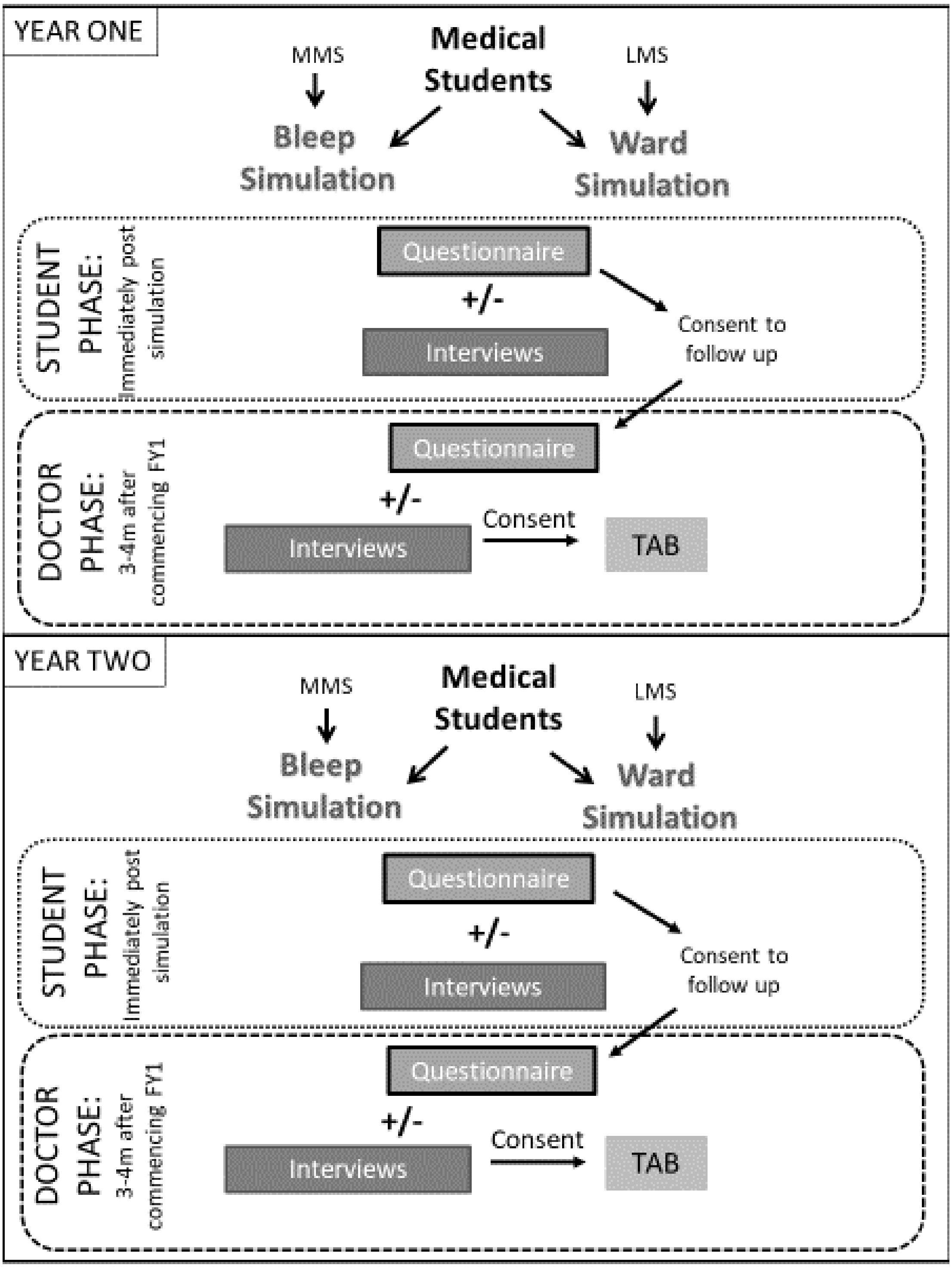


Figure 3-1 - Overview of the study.

3.3 <u>Methodology</u>

This section outlines the broad methodological approaches to this research and the justification for these approaches.

Traditionally, in scientific and educational research, a quantitative design has been used, grounded in the positivist paradigm. This is reflected in this thesis by the high number quantitative studies described in the literature review. Positivism is based on the presumption that “the goal of knowledge is to observe, measure and describe the phenomena experienced” (60 pg4). Therefore, a key component of positivism and hence quantitative research is objectivity. The RCT is considered the highest quality study design in this area; because it is designed in the most objective, unbiased way, and therefore, gives the best evidence for causation. However, observational studies are also objective, and carefully designed so as to minimise bias and confounding.

RCTs can be difficult to design and undertake in medical education research for many reasons. For example, blinding can be extremely difficult to achieve, and participants cannot be denied an educational experience, therefore having a control group in problematic. Therefore, other methods have been employed across medical education research to improve the quality of the evidence base. Other such methods include triangulation of participants, methods, and data. An RCT design would have been unworkable for the research presented in this thesis, as the simulation courses studied were at two institutions, and using an RCT design would have meant denying participants an existing simulation method.

Exam results, questionnaires or standardised performance assessment are examples of quantitative data used across the literature described in 2.2. Quantitative research usually starts from an idea or hypothesis, and studies are designed to prove or disprove the hypothesis (251).

In contrast, qualitative research seeks to observe what happens in practice and develop an idea or theory from these observations. In qualitative research, researchers embrace and explore their preconceived ideas or biases; by exploring these ideas, this may enhance the study. Qualitative research is founded in a constructivist paradigm that believes that “knowledge can be derived from people’s experiences – both those of the researcher and the research participants” (60 pg4). This is particularly relevant in this thesis due to the personal nature of preparedness, and how individuals differing experiences will affect their preparedness. In medical education research, qualitative interviews and focus groups are increasing in use to evaluate educational interventions. Qualitative research is subjective and inductive; this has been a key criticism from those who value objectivity.

More recently, education researchers have begun to see the approaches not as contradictory, but complementary, particularly in the field of medical education (251).

The focus of this research is the concept of preparedness. As discussed in 1.4, there is no ‘one way’ to assess preparedness, and there is no single validated tool with which to objectively measure preparedness. Studies have used a variety of objective measures, such as exam or OSCE results, performance in simulated scenarios, and self-report measures such as questionnaires and interviews to try to explore the concept of preparedness. Although questionnaires are used to evaluate complex hypothetical constructs, it would have been challenging and time-consuming to create a questionnaire that provided both objective and subjective data, and adequately explored the confidence, competence and other factors within preparedness. Creating such a validated tool was beyond the scope of this thesis. The questionnaire data produced by this thesis allowed measurement of differences between participant groups and phases using numbers, but the reasons for any differences would be best elicited by asking the participants involved. In other words, the numerical data can show ‘what’, but not ‘why’.

To obtain an accurate judgement of how prepared graduates are, both quantitative and qualitative methods were utilised. Using quantitative and qualitative methods allowed the topic of preparedness to be approached from different angles; the questionnaire data providing self-reported quantitative data, the interview data providing rich qualitative data, and the TAB form providing more objective data. The addition of qualitative data and triangulating data from stakeholders and longitudinally from participants further strengthened the findings.

Additionally, the qualitative data was able to evaluate the association between simulation and preparedness as well as how simulation interacts with other elements of the curriculum to produce prepared graduates, which would have been difficult to ascertain with quantitative data alone. Exploring the association between simulation and preparedness, when there are so many other educational elements contributing to preparedness, required qualitative data. The interview data in this thesis allowed a more thorough exploration of participants’ prior experiences and narratives.

Medical education research, and indeed this thesis, has to try to account for many factors that can affect the outcome of the research, which makes designing a quantitative study extremely complex. This is another reason for combining the approaches to provide a wider dataset with which to answer the research questions. General confounders and biases that can affect results include the widespread use of volunteer populations, potentially resulting in a study population that is biased towards the subject of the study (252); for example, only students who enjoy simulation participating in a simulation study, or only students who had an interest in surgery undertaking a study about surgical skills. Longitudinal studies in education will be affected by participants' clinical experience in between the phases, as this can never be standardised for all participants (253), but can be further explored using qualitative data. When studies use examination results to compare outcomes, this will be affected by the heterogeneity of the exams, especially important when comparing institutions as examinations are rarely the same between them (254). Educational interventions are often complex and are made up of various teaching modalities, for example, lectures, small-group discussions, and simulation. The evaluation of such interventions is difficult as no two interventions are the same, and it is difficult to distinguish which individual modality brought about the effect (254). This is of particular relevance to this thesis; not only is simulation a complex and heterogeneous intervention, the way in which it interacts with other educational methods to produce preparedness is multifaceted. The use of qualitative interviews alongside questionnaires enabled this to be examined in depth. How to accurately measure outcomes is also difficult; many studies might test the efficacy of simulation with a knowledge test, for example, which might not be the best way of showing learning from simulation. Specific confounders for this study will be discussed in 7.1.

Another motivation for choosing to combine qualitative and quantitative methods is my reflexivity as the lead researcher. The following section will give a more in-depth reflexive account of the thesis to provide further background and explain the development of the work

3.3.1 Reflexivity

Reflexivity is "a researcher's ongoing critique and critical reflection of his or her own biases and assumptions and how these have influenced all stages of the research process" (255 pg788-790). This means having an acute awareness of one's preconceived ideas and how they influence the research design, data analysis, and findings. As a medical doctor who has gone through several transitions during my training, I had shared knowledge and experience with the participants, and I was therefore unable to be completely objective when approaching this topic.

My theoretical standpoint at the beginning came from my personal experiential learning style and my own experiences of transitions within my career. I had limited experience of simulation training in my fifth year but did participate in simulated advanced life support training. I felt incredibly unprepared as an FY1 for on-call working, dealing with night shifts and medical emergencies, and the learning curve when I started work was extremely steep. The step up to registrar from SHO was another difficult transition in my career, confounded by moving to an unfamiliar hospital and losing the established support systems I had in place at my previous hospital. The fundamental difference between the two transitions for me was, for the step up to registrar, the ability to 'act-up' with support. Acting-up is impossible to do fully as a medical student, and some of the data presented in the following chapters is focused on this concept. Given these experiences, I feel strongly that the entire fifth year of medical school should be focused on preparation for practice, and transitions in medicine should be better supported and regulated.

My role in undergraduate medical education across both study sites gave me further insight into students' preparedness. During the course of the study I was involved in the running of both simulation courses and provision of teaching and supervision at LTH. This not only gave me insight into students' preparedness, but it also meant that many of the participants (students and stakeholders) were known to me previously. It may be that participants were more likely to participate because of my prior relationship with them, but also the opposite may be true, and this may have affected the results. The prior relationship with participants was particularly important to be aware of for the qualitative data. Prior knowledge of the interviewer may prevent participants from disclosing specific issues. Conversely, participants and the interviewer may have shared experiences, thus encouraging disclosure. Furthermore, participants may not wish to disclose information to a stranger (256).

Following on from my experiences and my knowledge and involvement in medical education across the two study sites, medical students both anecdotally and through the literature are concerned about assessing medical emergencies. This is particularly the case whilst on call or out of hours with little support. This lack of confidence out of hours, along with my experiential learning stance led to a theory that bleep-style simulation, more aligned with these concerns may be associated with increased student perceptions of preparedness. This may be particularly for the competencies required for the transition to professional practice that were of concern; assessing a medical emergency and non-technical skills. The original study design was therefore devised to test this theory, by using questionnaires based on the competencies from outcomes for graduates and focus groups with medical students triangulated with questionnaires from their supervisors and information from their e-portfolios.

Through the process of this thesis, the focus of the study changed considerably. Due to delays in approval, recruitment issues and student reluctance to have supervisors' direct feedback regarding their performance (see 3.4.2.2), the emphasis switched from a quantitative focused comparison of simulation courses efficacy to an exploration of the process of simulation and its effects on student and stakeholders' perceptions of preparedness. Another factor in this change in focus was the difficulties obtaining TAB forms. Having access to participants TAB forms was limited by how many participants were interviewed in the doctor phase, as consent for the release was performed during the interview (see 3.3.4.2 and 3.4.4.3). The resulting small number of TAB forms received, and the lack of new information gained from the TAB forms also contributed to this shift of focus, as the potential main source of objective data was removed. It is likely that only positive TAB forms were received due to participants being unwilling to share negative feedback, or in fact any direct feedback about their performance. This links with the student participants being unwilling to consent to their individual supervisors providing data about them for the study, and the subsequent amendments to the study design.

My epistemological stance at the start of this research was heavily influenced by my medical background in which quantitative, objectively driven research predominates. This helps, in part, to explain the initial focus of the research towards a quantitative comparison of simulation to establish effectiveness. Through my research journey, as I became more experienced in research methods and examined the wider medical education literature, I realised that using a purely positivist stance would not produce data that would thoroughly explore the full extent of the area of interest, as quantitative data, in this instance, would explain what (if any) the differences were, but not why those differences occurred.

Despite the importance of proving the effectiveness of an educational intervention, it is also important to examine how and why an intervention is effective, especially in education as there are so many confounders that can and will affect learning. Therefore, showing that a specific educational intervention in isolation causes a certain outcome is difficult, as there will always be multiple variables that cannot be controlled for. This is why it was important to not only examine simulation's effects on preparedness, but how other educational modalities interact to contribute to preparedness.

My epistemological stance, along with access to data as detailed above, meant a change in the focus for the thesis. What started as an effectiveness study comparing two diverse simulations became a more explorative study of simulation and perceptions of preparedness from the student and stakeholder perspective.

The following section will give more detail about mixed-methods research and why combining qualitative and quantitative methods is appropriate for this study. Beginning with an overview of mixed methods, the three key aspects that give this study its strength will then be described; triangulation mixed-methods design, triangulation of methods, and triangulation of participants.

3.3.2 <u>Mixed methods</u>

Mixed-methods research has been defined as “research in which the investigator collects and analyses data, integrates findings, and draws inferences using both qualitative and quantitative approaches in a single study” (257 pg7). As medical education research often investigates complex programmes and attempts to measure translation of knowledge, attitudes, and skills, medical education provides the “ideal milieu” in which to carry out mixed-methods research (258). In this thesis, using qualitative interview data helped explore the associations between students’ preparedness for certain competencies (questionnaire data) and their concerns about professional practice, and also the interaction between simulation and other educational methods in the curriculum to develop preparedness.

The dominant theme of mixed-methods research is that the use of the two methodologies combined will “provide strengths that offset the weaknesses of both quantitative and qualitative research” (259 pg5, 12). The weaknesses of self-report data (from the questionnaires) were counteracted in this thesis by using qualitative interview data (and triangulating with multiple participant groups). It is also true that quantitative and qualitative data can act complementarily to create new knowledge and answer research questions (251). Without the qualitative data within this thesis, the findings would have been extremely different; the interaction between feeling prepared and students concerns about the transition, and the relationship between simulation and other elements of the curriculum would not have been explored.

It is not always appropriate to use mixed methods; Creswell and Plano Clark (259 pg8-11) outlined the following areas that are particularly suitable for mixed methods. Those relevant to this thesis are discussed further in 3.4.

1. Research questions in which one source of data alone is inadequate

For example, if quantitative data does not fully answer the research question. Additionally, if there are problems with attrition in a longitudinal study, the addition of qualitative data may strengthen the data.

2. The initial results require explanation with different data

For example, if the quantitative results give different results to what was expected, and it is unclear why interviews or focus groups may give more in-depth data to answer this question

3. Preliminary results need to be generalised

This may be the case where the initial results are in-depth qualitative, and the researchers want to generalise them. For example, an in-depth interview study on burnout in surgical trainees that produced specific themes that may then inform a questionnaire to be administered to a much larger sample.

4. The study needs to be enhanced with a second method

In some studies, a second research method may enhance the findings. For instance, if there was poor recruitment in a quantitative study, the introduction of a qualitative interview with participants to determine the reasons for poor recruitment may improve participation.

5. The theoretical viewpoint requires both quantitative and qualitative data

The theoretical stance of the research may require the collection of both quantitative and qualitative data either at the same time or one building on another, for example, if the quantitative data describes what happens and the qualitative data describes why it happens.

6. Research problems need to be understood with multiple phases

Some studies, particularly longitudinal studies, may benefit from multiple phases with both quantitative and qualitative data. Illing et al (140) used questionnaire and interview data with multiple participant groups longitudinally to assess the preparedness of students in three distinct medical schools.

Mixed methods allowed a pragmatist approach to this thesis and the research questions; pragmatist researchers use “what works” to answer research questions, thereby using diverse approaches giving both objective and subjective data (259 pg16). Tashakkori and Teddlie (257 pg7-8) argue that instead of contrasting the quantitative and qualitative approaches, they should be combined because both methods can and should be used in an individual study. Answering the research question, by whatever method works should be paramount, thus ignoring the opposing theoretical viewpoints of qualitative and quantitative research (257 pg7-8). Using quantitative methods in this thesis provided some ordinal data that could be compared statistically, allowing comparison between the two simulation courses and between students and stakeholders, and also allowing comparison across the transition. The addition of qualitative data allowed further exploration of the effects of the transition and the interaction between simulation and other educational aspects of the fifth-year curriculum.

Mixed methods thereby combine the positivist, quantitative paradigm with the constructivist qualitative paradigm. By combining objective measurement with a more subjective understanding of socially constructed knowledge (251), mixed methods take into account the pre-existing beliefs of the researcher (see 3.3.1) but also allows inductive processes.

This thesis fits into the core principles of mixed-methods research, as described by Creswell and Clark (259 pg5); examining both qualitative and quantitative data, combining the two data sets concurrently. Data was given equal weighting (but could have been given equal or unequal weighting depending on the research question), using multiple phases (259 pg5). Through mixed methods, the self-report data could be strengthened with qualitative interview data (and through triangulation with multiple sites, participants and phases), and the interplay between simulation, the transition and other educational modalities in fifth year could be fully examined. Furthermore, as there is currently no standard quantitative or qualitative method to measure preparedness, combining the two methods provided a richer data set to answer the research questions

3.3.3 <u>Mixed methods – Triangulation design</u>

In the context of this thesis, as discussed in 3.3 and 3.3.2, to answer the research questions adequately covering the concept of preparedness and the heterogeneity of simulation and its relationship with other aspects of the curriculum required a mixed-methods approach. Specifically, Creswell and Plano Clark's "triangulation design" was chosen for its ability to bring together different strengths of quantitative data (large samples, generalisable) with qualitative data (detailed, in-depth), with data being collected concurrently (but analysed separately) and having equal weighting in the analysis (259 pg 55-59, 68-75). This is not to say that either method is inadequate alone, but that together they will provide a complementary, rich data set. Although up to 20 different mixed-methods designs are described across mixed methods texts, four main predominant study designs are used consistently, despite sometimes different nomenclature (258). The triangulation design is the most common approach to mixed methods with the purpose to "obtain different but complementary data on the same topic"; this thesis will follow the traditional triangulation model which collects and analyses qualitative and quantitative separately (this may be concurrent) and then compare and contrast the data (259 pg68-75). Other designs use qualitative data to inform a quantitative instrument (instrument development design) or explore questions arising from quantitative data with qualitative data (explanatory design) (258). As instrument development was not the focus of the thesis, these designs were not suitable for this research. One problem with mixed methods being a newer methodology is that there are no clear guidelines on sampling strategies and appropriate sample sizes. Sampling will be discussed further in section 0. Another potential challenge with the triangulation design specifically is the finding of contradictory data; however, this can lead to further developments in the study to explain the findings (258). By combining diverse data how simulation contributes to preparedness may be better understood.

For the qualitative data, a Grounded Theory informed method was used. Grounded Theory was developed by Glaser and Strauss to provide a systematic method for analysis of qualitative data that would align with the quantitative standards for data analysis (1 pg249, 260 pg4-6). Instead of focusing on testing theories, as per quantitative research, grounded theory concentrates on developing theories that are “grounded” in the data, that is, the experiences of the participants told through interviews, focus groups, and observations (1 pg249)(pg249). In this thesis, this would enable theory to be generated directly from the stories and experiences shared by the participants. It is, according to Bryant and Charmaz, the most commonly used qualitative methodology in medical education research (261 pg1). Key elements of Grounded Theory include an iterative design, with simultaneous data collection and analysis, allowing progression and development of the research, and a constant comparison method of data analysis(1 pg325)(pg325). How Grounded Theory was used in this thesis is discussed in 3.5.2.

3.3.4 Mixed methods – Triangulation of methods

In addition to combining qualitative and quantitative data, multiple methods of data collection were triangulated to enhance the study further. The transition from education to practice can be highly stressful and emotive and so to develop a questionnaire that would adequately cover students’ thoughts, feelings and fears would be challenging. To allow full exploration of students’ experiences, interview data was needed to give a full picture of how simulation contributes to preparedness. Equally, the objective measurement of preparedness alone would not consider the interplay between confidence and competence and individual differences; an interview allows a deeper exploration.

3.3.4.1 Questionnaire

Questionnaires are one of the most commonly used tools to collect data. They may be administered online, paper, postal, face-to-face or a combination of these, each with advantages and disadvantages (Table 3-1).

Table 3-1 – Advantages and disadvantages of various questionnaire collection methods (adapted from (262 pg34-39))

	Advantages	Disadvantages
Mailed Questionnaire	Low cost Wide geographic distribution Suitable for sensitive topics (especially if anonymous)	Long time to collect data May have a poor response rate Must be short
Online Questionnaire	Very low cost	Must be short May have a poor response rate

	Easy to administer and analyse data Short data collection period Wide geographic distribution	
Telephone Questionnaire	Low cost Higher response rates but limited by the personnel available to conduct questionnaire May be longer or more complex Wide geographic distribution Short data collection period	May not capture sensitive topics
Face-to-Face Questionnaire	Higher response rates but limited by personnel available to conduct questionnaire May be longer or more complex Smaller geographic distribution (unless technology used)	Higher cost May not capture sensitive topics Long time to collect data

The type of information that may be gained from questionnaires is varied and includes attitudes, views, confidence, whether that be self-reported or otherwise. Patten states that the benefits of using questionnaires are that they are accessible (particularly if in an online format), economical, quick to complete and the data can be analysed to confirm statistical associations (or lack of) (263 pg1-8). Traditionally, supporters of qualitative research have suggested that interviews are the best way of gaining sensitive information from participants. However, Patten suggests that because participants' responses to questionnaires can be made anonymous (as they are in this study), this encourages participants to be honest in their answers. Interviews are inherently not anonymous, and therefore, questionnaires may be a better way to get these more honest answers (263 pg1-8). The combination of the two methods in this research provides opportunities for participants to disclose their feelings and attitudes.

Questionnaires are a commonly used method of data collection in simulation and other medical education studies. Their popularity in simulation research has led to a useful body of relevant literature that will allow broad comparisons of this study's results with others on simulation for preparedness (127, 133, 137, 164). Specifically, other studies looking at simulation use questionnaires covering overall preparedness and preparedness for some of the same competencies covered in the questionnaires for this thesis (139, 158, 164, 197, 198). Specific numbers cannot be compared due to differing scales (e.g. 7 or 10-point scales, different scale responses). The homogeneity of the questionnaires in this thesis allowed comparisons between the two student participant groups, the two phases, but also between the student and the stakeholder groups. It was important that questionnaires were user-friendly and therefore quick to complete and with several open and closed questions.

As Patten discusses (263 pg1-8), there can be difficulties with response rates for questionnaires, so a variety of methods have been used to try to combat this, including a choice of online or paper-based questionnaires, incentives for completing the questionnaire and focus groups/interviews. The issue of response rates has been noted by multiple authors (262, 263 pg1-8, 264, 265). Generally, mailed questionnaires have the lowest response rates, and Patten suggests that higher response rates may be achieved by speaking to participants directly, either via telephone or in person (263 pg1-8). To maximise response rates, this study used two delivery methods, paper and online, as Ponto suggests that the ideal option is to allow the participant to choose their preferred method (264). By using both paper and online questionnaires, this gave the additional benefits of internet questionnaires which include the ability to use skip logic (which skips questions depending on participants answers) which makes the questionnaire more relevant to the individuals and therefore more attractive to complete (262 pg40-42). Internet questionnaires also enable automatic reminders, and there is some evidence that responders are more likely to give more detailed responses to open questions in an online questionnaire (262 pg40-42). Given the frequency of use of questionnaires, particularly in the medical profession for feedback (266), there is a chance that participants will have experience questionnaire 'fatigue' and be unwilling to fill out another one. The reluctance may be countered by the offer of both paper and online questionnaires.

There are several potential sources of error with the questionnaire method, which include (264, 265 pg3-9, 267 pg340);

1. Coverage error: Sample does not truly represent the population, for example, if only online questionnaires were used and not all the participants have access to the internet
2. Sampling error: Individuals in the sample do not accurately represent the characteristics of the population; for example, if the sample is too small or poorly chosen
3. Non-response error (selection bias): Occurs if characteristics of responders are different from that of non-responders – for example, if questionnaire responses were mostly positive regarding simulation and those with negative attitudes do not respond
4. Measurement error: Questions or instruments do not accurately reflect the topic of interest or obtain truthful answers, for example, if the participant agreed with the interviewer if they expressed an opinion, or length or wording of questionnaire questions (264, 265 pg3-9, 267 pg340)

Several methods have been employed to minimise the risk of these errors, which will be discussed in section 3.4.4.1.

A standard five-point Likert scale was used for the questionnaires in this thesis (118, 268). Likert scaling was developed to measure attitudes (268, 269); therefore they are an appropriate scale to use in this thesis for assessing attitudes of students and stakeholders towards simulation and preparedness for practice. This standardised and widely used scale will allow comparison with other literature in this field and importantly, allows a neutral or undecided option. Using the widest possible scale improves the scale's reliability (270) The five-point scale was used as students and stakeholders have busy professional lives, a seven-point scale may have put them off answering the full questionnaire. Also, if there are too many options, participants may be overwhelmed and have difficulties choosing between comparable responses, causing them to "arbitrarily choose a response option" (271). Likert scales between five- and seven points have been shown to have high levels of reliability and validity (271); therefore in this thesis, the five-point scale was used (in questionnaires, then condensed to three-point scale for analysis; see 3.5.1).

3.3.4.2 Team Assessment Behaviours (TAB) form

As well as direct response, study-specific questionnaires as used in this study, there is data gathered via routinely collected questionnaires, for example, the GMC trainees survey, local hospital feedback surveys, and various forms within doctor's electronic portfolios (E-portfolios). These may also be used to assess preparedness and competence.

E-portfolios are used by doctors of all levels throughout their medical careers, with several different forms designed to provide evidence of training in and competency performing procedures, managing conditions, conducting consultations and finally a 360-degree feedback tool which is disseminated to colleagues, supervisors and allied health professionals. A 360-degree feedback tool, the Team Assessment Behaviours form (TAB) is used by the UKFP for multi-source feedback (93, 272). This form was analysed as part of the doctor phase of the study; chosen as a more objective measure to analyse with the rest of the data (see Appendix 2). The TAB form is usually filled out by the foundation trainee and 15 assessors of their choosing; usually at least three senior doctors, nurse, and allied health professionals or ancillary staff (93). Assessors are asked to fill out several questions about the doctor's attitudes or behaviours based on their observation of working with that doctor. The questions cover a range of attributes including time management, prioritisation, diagnostic skills, working in an MDT and communication skills. Together with their self-assessment TAB, these are amalgamated for the e-portfolio (93). They must have this form filled at least once a year. This particular form within the e-portfolio was chosen for its ability to give an overview of how

FY1s handle foundation training, rather than other forms in the e-portfolio looking at specific procedures or competencies. Analysing data from this form in addition to the other data was intended to give an added and objective general measure of preparedness, based on those working closely with each FY1 and their self-assessment. Other studies have used exam results (218), knowledge tests (211, 273) or OSCEs (190, 206) to try to provide objective evidence of the efficacy of an educational intervention. However, few have looked at this kind of 360-degree assessment.

As discussed in 3.3.1 very few TAB forms were returned, due to a combination of reasons. The reasons for this and implications are discussed in 3.4.4.3.

3.3.4.3 Interviews and focus groups

Brinkmann and Kvale suggest that we may learn about peoples' experiences and attitudes by conversation; "If you want to know how people understand their world and their lives, why not talk to them?" (274 pgxvii). Conversation is, therefore, the basis for qualitative interviewing. Interviews are a suitable methodology when the subject matter concerns aspects of human experience, in this case, preparedness for the transition to professional practice (274 pg2). Edwards argues that we are in an "interview society" where interviews have become an essential part of how individuals understand themselves (275 pg1-2). Interviews, therefore, are an ideal tool to understand preparedness. Interviews may be used as a method when researchers want to understand "meanings that people attach to experiences and practice" (275 pg1-2); in this thesis, the experience of transition and preparedness for this transition. By making the researcher the main instrument, eliciting an asymmetrical exchange of experiences and perceptions in favour of the interviewee is critical (275 pg74-76). The interviewer must try to foster an atmosphere where the participant feels comfortable talking openly about their perceptions and experiences, going beyond a simple conversation (275 pg74-76).

Interviews are the most commonly used qualitative method, with several different forms including unstructured, semi-structured and focus group interviews. All these forms have the following in common;

1. An interactive exchange of conversation between two or more people, in person or via telephone, email or other methods.
2. The interviewer has a key focus or themes to discuss but takes a flexible, fluid approach to gain that knowledge.
3. Situated knowledge may be produced by bringing the relevant topics or themes into focus, involving the "construction or reconstruction of knowledge" (275 pg1-10).

A semi-structured approach was chosen for focus groups and interviews in this thesis as the emphasis was less on personal narratives, but with the flexibility to allow the participants to tell their stories in their own words. Using a semi-structured approach allows an element of standardisation to ensure all participants have the chance to speak about their experiences equally. Interviews may be conducted in person or via telephone or other technology (such as Skype or Facetime), which gives the interviewer and interviewee flexibility.

The use of focus groups and interviews allows participants to share their own experiences, thoughts, and feelings in their own words as well as the more factual questionnaire responses (275 pg1-10). Both focus groups and interviews have been purported to provide “richness and depth” to the data (276). As Liamputtong states, focus groups aim to “Describe and understand meanings […] to gain an understanding of an issue from the participants perspective” (277 pg3). Students’ and supervisor’s thoughts and feelings cannot be adequately assessed with quantitative tools such as questionnaires (although these methods can give preliminary data to inform and develop focus group/interview schedules). Additionally, a focus group dynamic can provide data that individual data collection may not (in some part by replicating regular social interactions) and encourage a range of responses to provide a better comprehension of attitudes, behaviours, and views (278). The group atmosphere should also encourage the disclosure of shared experiences (277 pg4-6). Equally, some participants may feel more comfortable discussing issues on an individual basis and so by offering interviews as well as focus groups; this would capture more data.

Criticisms of qualitative interviews include that they are retrospective and therefore “what people say may not be what they do, have done, or would do in the future” (278). Interviews and focus groups can be difficult to standardise, but they allow reflexivity and allows participants to tell their individual stories without being confined to a rigid structure (275 pg90-93, 279). Although telephone interviews allow flexibility for the interviewee, they have been criticised for not being able to see participants non-verbal behaviours (275 pg48). The language used in interviews may cause a problem due to different meanings, and the ambiguity of questions and responses may mean that participants or the researcher understand certain words or phrases differently (274 pg92-96). A final criticism of interviews is that the results may not be generalisable (275pg 89-98). However, the purpose of interviews is to provide in-depth explanations and meanings, and this in association with the questionnaire data in this thesis will allow some generalisation.

3.3.5 *Mixed methods – Triangulation of participants*

In addition to multiple methods, having multiple participant groups allowed greater triangulation of data and gave a more comprehensive understanding of preparedness, what factors affect it, and how simulation may have a role. Triangulation of participants is valuable particularly in this field as self-reported data from doctors has been shown in the literature sometimes to be contrary to other more objective data (110, 124, 125, 280). Having stakeholders' responses provided different perspectives on how prepared students were and the role of simulation. The different perspectives provided a richer understanding of this area and allowed a more objective assessment of preparedness and potential differences or similarities between the two courses.

Additionally, multiple sites and simulation courses were used, giving a deep insight into simulation as a whole. As described in chapter one, the use of simulation in medicine is vast and, therefore, to examine just one simulation course would not fully answer the research questions set. Furthermore, having medical students from different medical schools (albeit with a similar curriculum) provided different perspectives and validation of findings (281).

3.3.6 Longitudinal design

Longitudinal research, in contrast to cross-sectional research takes multiple measurements from participants over time allowing measurement of change and, in some studies, explanation of change (282, 283). This is important in education research (and this thesis) as a longitudinal design would, therefore, be the only way to prove outcomes at KP levels 3 and 4. Menard describes four different longitudinal designs; total population design, repeated cross-sectional designs, revolving panel designs and longitudinal panel designs (283 pg4-7). While the total population design surveys the entire population, the other three designs take a sample from the population and study them. Repeated cross-sectional design studies different groups at each stage of the research, which was not appropriate for this thesis as the focus is on participants' preparedness over time. Revolving panel designs collect data at various stages while dropping some participants and replacing them with new participants, which again was not suitable as this would not measure change in individuals. The only design that follows the same set of participants over time is the longitudinal panel design. This longitudinal panel design, synonymous with a cohort study, has been used in this thesis to establish changes in attitudes and confidence over time; for some experts, this is the only longitudinal design that truly allows measurement of change (283 pg4-7).

In addition to the designs discussed, longitudinal research may be either prospective or retrospective, and the size of the study will vary greatly depending on the topic of interest. A large population database study may collect data and follow participants over several years, whereas other smaller studies may follow participants over a few weeks (284 pg42-44). Despite numerous challenges (discussed below) there are several advantages to performing longitudinal studies, including establishing a sequence of events, following change over time, excluding recall bias and the possibility of relating incidents to specific experiences (253).This is why the longitudinal design was important in this thesis to enable analysis of perceptions of preparedness at several time points. Cook et al suggest that many education research questions cannot be answered using short follow-up periods, and longitudinal studies are required to provide evidence of educational activities effectiveness (285). By undertaking prospective, multi-institution longitudinal studies, researchers may increase the knowledge of how medical students/doctors competence transforms into "measurable patient health" (286).

Longitudinal qualitative research involves data collection designed to allow researchers to observe changes in the topic under investigation. Balmer et al. believe the power of such research lies in the serial collection of stories which allows the similarities and differences to become more evident (287). The critical element in such studies is that the data collection lasts long enough and investigates thoroughly to detect a meaningful change in the subject being studied (287). As the focus of this thesis is preparedness for the transition, having a longitudinal design spanning that transition was crucial.

Longitudinal design in education allows researchers to investigate whether participants exhibit long-term retention of knowledge and a subsequent change in behaviour (as per Kirkpatrick's Levels, 1.3.1). Linking educational interventions with patient outcomes, even with longitudinal studies, can be challenging (288). There are many studies confirming students' satisfaction with simulation (KP1) (210, 289, 290), but few can demonstrate a change in behaviours or direct benefits to patients (KP3-4), which may only be achieved with a longitudinal design. How outcomes are measured must remain the same throughout a longitudinal study; in this thesis, this was achieved with identically designed questionnaires for the two phases. However, controlling other factors participants are exposed to, for example, the experiential learning that takes place in the clinical environment can be extremely difficult (283 pg7-8, 107-109). This can, to some extent, be clarified in this study with the qualitative data. A key issue in longitudinal research is participant attrition. Several factors may contribute to attrition, including characteristics of the population, frequency, and length of questionnaires/interviews, relevance of topic and mode of data collection (e.g. face-to-face, telephone, internet) (283 pg167-171). Several strategies were employed to reduce attrition, which are discussed in section 3.4.4 (283 pg167-171).

Following participants over time with similar questionnaires and interview schedules may condition responses and lead to the 'Hawthorne effect' where participants change their behaviours due to being involved in the study and not due to the intervention under study (283 pg113). This may in some part be beneficial to this study; by following up the students as doctors, they can look back on their previous answers and having experienced the transition they may feel differently about preparedness or simulation.

3.4 Study design

Having discussed the methodological underpinning of the study, this section will describe the specific details of the setting, planning, population, participants and recruitment for this research. Referring back to Creswell and Plano Clark's suggestions for suitable research problems to be addressed with mixed methods, the following Table 3-2 demonstrates their relevance specific to this study (see 3.1 for an overview of study design).

Table 3-2 – Research problems that may be suitable for mixed methods with relevance to this study

Research questions in which one source of data alone is inadequate	By using both quantitative and qualitative data, this study tried to pre-empt problems with response and attrition rates, which are common with questionnaire and longitudinal studies
The initial results require explanation with different data	While the questionnaire data provided quantitative evidence for simulation, some of the findings were contradictory which required explanation with the qualitative data
The study needs to be enhanced with a second method	As discussed, preparedness is a complex concept that would not be fully understood with quantitative questionnaire data alone. Therefore, the quantitative data is enhanced with the qualitative data
The theoretical viewpoint requires both quantitative and qualitative data	To fully understand preparedness and simulations effects on it required both quantitative and qualitative data
Research problems need to be understood with multiple phases	Students must be followed longitudinally to demonstrate changes in views over time, particularly looking back at their undergraduate training when they have the experience of FY1

To understand the development of the study and the changes made, it is important to describe the original study design here. The original study design was to conduct online questionnaires (across two calendar years; Y1 and Y2) with two participant groups; fifth-year students, their individual supervisors and then the same students when they were FY1s. Focus groups would then be conducted with the students, and interviews with the FY1. The final study design involved paper and online questionnaires, administered to fifth-year students, key stakeholders and FY1 doctors (follow-up of student participants) (Table 3-3). Qualitative interviews were then conducted with student, stakeholder, and FY1 participants. The evolving design of the study is discussed and justified in 3.4.2 and 3.4.3. The time scale and schedule of the study is found in Appendix 3. The study was conducted from October 2016, with data collection commencing in February 2017 and completed in December 2018.

Table 3-3 – Sources of data

PARTICIPANTS	STUDENT PHASE: Immediately post-simulation	DOCTOR PHASE: 3-4 months into FY1
Medical Students	Questionnaire	Questionnaire
	Interview	Interview
		Team Assessment Behaviour form
Stakeholders	Questionnaire	
	Interview	

3.4.1 Population

3.4.1.1 Setting

The study was conducted at two teaching hospitals in the North-West of the UK. Lancashire Teaching Hospitals NHS Trust (LTHTR) at the Royal Preston Hospital site, which is one of four bases where University of Manchester medical students (MMS) are placed, and University Hospitals of Morecambe Bay NHS Trust (UHMBT) at the Royal Lancaster Infirmary site, where Lancaster University medical students (LMS) are placed.

Before designing the study, simulation leads at two hospital sites were approached to gain permission in principle for the study and to discuss what simulation was in place. The sites were chosen based on geographic locality to the lead researcher employment and academic institution, but primarily for their different approaches to simulation for preparation for practice.

The simulation courses being studied are shown in Table 3-5, but both are designed to develop three key areas; non-technical skills, assessing a medical emergency and preparedness for practice. These are key for doctors, lend themselves well to being taught via simulation methodologies and are common areas that students feel ill-prepared for when they start work (110, 128, 139, 140).

Manchester Medical School (MMS)

MMS is one of the UK's largest medical schools. In the academic year 2016/17 there were 422 students in fifth year, and 466 in the academic year 2017/18. Their five-year MBChB course is based in central Manchester, with four allied hospital sites at which students complete their clinical placements. The first two years of the MBChB curriculum is delivered in Manchester or at the University of St Andrew's, while the following three clinically-focused years are based around Manchester. The course uses a Case-Based Learning (CBL) spiral curriculum (Table 3-4).

Lancaster Medical School (LMS)

LMS obtained their primary medical qualification in 2017, and the five-year MBChB degree is taught using Problem-Based Learning (PBL), with clinical placements starting in year two at one base trust during this study (UHMBT). It is one of the smaller medical schools in the UK; the number of students admitted into year one during the study was 54. In the academic year 2016/17 there were 45 students in fifth year, and 58 in the academic year 2017/18 LMS has been awarded additional student numbers, with 69 students starting year one in 2018 and a planned intake of 129 students in 2019. To facilitate this increase in numbers, other trusts have been added for clinical placements (East Lancashire Hospitals Trust; ELHT and Blackpool Victoria Hospital; BVH).

Table 3-4 – Key features of MMS and LMS (291).

	Manchester Medical School (MMS)		Lancaster Medical School (LMS)	
Year established	University 1824	Medical school 1873	University 1964	Medical school 2017
Students overall	2116 (16/17), 2092 (17/18)		286	
Entry requirements	3 A grades at A Level, plus UKCAT Multiple mini-interviews		3 A grades at A Level, plus BMAT Multiple mini-interviews	
Type of course	MBChB Problem-based/ Case-based learning		MBChB Problem-based learning	
Finals timing	Final 'exempting exams' in January of fifth year, resits July fifth year		Finals at the end of 4th year	
Hospital bases	Central Manchester University Hospitals NHS Foundation Trust Lancashire Teaching Hospitals NHS Foundation Trust Salford Royal NHS Foundation Trust University Hospitals of South Manchester NHS Foundation Trust		University Hospitals of Morecambe Bay NHS Foundation Trust East Lancashire Hospitals NHS Trust Blackpool Victoria Hospital	
Components of Fifth year	Medical, surgical, GP and acute placements		Acute placement (7 weeks) GP placement (7 weeks)	
	Finals			
	Quality and excellence personal excellence pathway project			
	Student assistantship (4 weeks)		Student assistantship (7 weeks)	
	PSA		PSA	
	Community Health placement			
	Student selected placement 1 x 4 weeks		Student selected placement (2 x 7 weeks)	

3.4.1.2 Interventions - The simulation courses

Two existing simulation courses, one at each institution, were evaluated (see Table 3-5 for more detail):

1. A 'Ward simulation' course (LMS)
2. A 'Pager/Bleep-style simulation' (MMS)

The '*ward simulation'* is a simulated ward environment during which students rotate around a 'ward' encountering different scenarios with simulated patients or mannequins (249, 292, 293). In the simulation in this study, the focus is on non-technical skills, including communication, time management, and situation awareness. '*Ward simulation'* is described in the literature (see 2.2 (173, 249, 294)).

'*Pager/Bleep simulation'* is where the medical students spend a set amount of time 'on call' with a bleep, and are bleeped with various tasks, ranging from prescriptions to interpreting blood results to assessing a medical emergency. The simulation is designed to introduce the concept of prioritisation, time management, and dealing with uncertainty (203, 211, 295).

This study compared a 'Ward simulation course' (already conducted with LMS students as part of their fifth-year training) with a 'Bleep-style' course (already conducted with MMS students as part of their fifth-year training).

Table 3-5 - Details of the simulation courses

	Bleep Simulation; MMS	Ward Simulation; LMS
Location	Royal Preston Hospital Simulation Suite; Education centre	Lancaster Royal Infirmary Clinical education training and assessment centre (CTAC); Disused clinical ward set up
Simulation technology	METI-man integrated simulator with simulated patients and professionals	A mixture of I-simulate monitors with simulated patients and professionals
Number of students per session	3-5, each carrying a bleep and responding individually to phone calls. Respond individually to mannequin simulation but often called together for simulated cardiac arrest call	12, rotating around the ward in groups of 2; year 2, 24 students per session All students participate on one day at different times
Staff	2-3	12
Staff roles /expertise	Simulation staff	Simulation staff and consultant staff that are involved in medical education
How it works	Students are briefed, given bleeps and a demonstration of how they are used They are then sent back to their clinical areas to await further bleeps. The simulation staff will bleep them about a wide variation of tasks or problems as detailed below. The students are expected to take relevant information, communicate professionally and decide whether they need to come and see the patient or if it can wait or be delegated appropriately. There is a formal debrief following the session with all students.	Students are briefed and allocated a station at which to start. They move around the simulated ward, with 10 minutes per station and 5 mins in between each station to self-debrief (by writing their immediate thoughts on each station on flip charts) At the end of the 90-minute session, they are given a short debrief to ensure there were no immediate problems, but then formal debrief is undertaken the following day. In year two, the debrief was conducted on the same day.
Stations/ Scenarios	• GP referral; exacerbation of COPD/Upper GIB • Hyperkalaemia bloods review	• Patient fall out of bed; acutely confused

	• AKI bloods review • Patient fall • Patient death • Patient wishing to self-discharge • Cannula replacement • Prescription request	• Adult cardiac arrest with advanced life support • Simulated patient with I-Simulate monitor with anaphylaxis • Prescription request with significant distraction techniques • Patient syncope pre-op
Key focus	Non-technical skills; Prioritisation, team-working, time management, decision-making, communication skills (telephone communication) Dealing with medical emergencies	Non-technical skills; Situation awareness, time management, decision-making, communication skills Dealing with medical emergencies
Other simulation courses?	Manchester students at Preston also receive a university standardised simulation session involving mannequins simulating deteriorating patient focused on the management of this; these include 'the shocked patient', 'the breathless patient' and 'recognition of the sick patient'	Lancaster students rotating through ELTH will have access to a bleep-style simulation course at this site. This is run differently than the Manchester course, with no direct contact with mannequins, simulation via bleeps and phone calls and lasting two hours. Students who have participated in this were identified via the questionnaires

The two simulation courses were mapped to the essential components of simulation from the BEME guide (see 1.2.1 and Table 3-6) (32, 33). Although the simulation courses both covered most of these essential components, the way in which the components were delivered differed. For example, the ward simulation debrief was a self-debrief and individual debriefs for each patient scenario, whereas the bleep simulation debrief was combined at the end of the four-hour session. The validity or realism was also achieved by different methods; the ward simulation re-enacted a busy ward situation, which would be similar to the day-to-day role of a new FY1, the bleep simulation more replicated the on call experience.

Table 3-6 – Key components of simulation as per BEME guide(32, 33), mapped to simulation courses

Component	Bleep simulation (MMS)	Ward simulation (LMS)
Feedback (or 'the debrief')	Yes	Yes
Repetitive/deliberate practice	No (but potential for repetitive practice if simulation repeated)	No (but potential for repetitive practice if simulation repeated)
Curriculum integration	Yes	Yes
Range of difficulty level	Yes	Yes
Multiple learning strategies	individual and group learning	self-reflective and instructor-led
Capture clinical variation	Yes	Yes
Controlled environment	Yes	Yes
Individualised learning	No - group session	No - group session
Defined outcomes	No	No
Simulator validity	Yes	Yes

3.4.1.3 Population sampling

Given the lack of written guidance regarding sampling strategies in mixed methods (259), appropriate sample sizes were difficult to approximate. The total student population available was 216 students (the number of fifth-year students on placement at the two base trusts across the two academic years of study, Table 3-7); therefore, sampling was not undertaken, and all students were invited to participate in the study. As a result of this, no formal sample size calculation was performed, as there was no way to increase the samples. In studies where the likely effect size is small, large sample sizes are often necessary to detect significant differences between groups (60 pg43-44). This study was small (due to the available population being small); therefore, it was most able to detect, with any degree of statistical certainly, a large effect size (should one exist). Additionally, it is known that in medical education research, the available sample size is often inadequate to power the study appropriately (220). By using qualitative data and triangulation of methods and participants as well, this strengthened the evidence available to answer the research questions.

The total stakeholder population was also limited by local trust restrictions on the researchers approaching clinicians via email; the Lancaster site operated an 'opt-in' policy, so the stakeholders were emailed by an administrator asking if they were happy to be emailed regarding the study. These restrictions limited the overall stakeholder population to 75 (Table 3-7).

Table 3-7 – Total population available for each participant group by academic/training year and site

<table>
<tr><th>Participants</th><th colspan="5">Total available population</th></tr>
<tr><td rowspan="4">Fifth-year students</td><td rowspan="4">216</td><td rowspan="2">Y1 of study</td><td rowspan="2">92</td><td>MMS</td><td>55</td></tr>
<tr><td>LMS</td><td>37</td></tr>
<tr><td rowspan="2">Y2 of study</td><td rowspan="2">124</td><td>MMS</td><td>74</td></tr>
<tr><td>LMS</td><td>50</td></tr>
<tr><td rowspan="4">FY1</td><td rowspan="4">85</td><td rowspan="2">Y1 of study</td><td rowspan="2">17</td><td>MMS</td><td>4</td></tr>
<tr><td>LMS</td><td>13</td></tr>
<tr><td rowspan="2">Y2 of study</td><td rowspan="2">68</td><td>MMS</td><td>45</td></tr>
<tr><td>LMS</td><td>23</td></tr>
<tr><td rowspan="2">Stakeholders</td><td rowspan="2" colspan="3">75 (across the two years)</td><td>MMS</td><td>54</td></tr>
<tr><td>LMS</td><td>21</td></tr>
</table>

The population sizes were similar to other studies in the literature on simulation (185, 204, 205), and compared with studies on simulation for preparedness for practice this study is in the top quartile according to sample size (196, 197, 200). Given the different sizes of the medical schools and therefore the eligible populations (Table 3-7), it was expected that the two student participant group sizes would be of unequal size (see Figure 3-2 and Figure 3-3).

3.4.2 Participants and recruitment

For all participants, a consent statement was provided at the start of the online questionnaire asking participants to confirm they had read the participant information sheet (PIS) and consent to be involved in the study. At the end of each questionnaire was an expression of interest form for focus groups and/or interviews and for the students, a consent statement for follow-up. A maximum of three reminder emails were sent for non-responders. Students filled out a paper consent form for the qualitative interviews (Appendix 5).

3.4.2.1 Medical students/FY1 Doctors

Fifth-year medical students from MMS and LMS were invited to participate. All MMS and LMS students that had completed the bleep simulation course at LTHTR and ward simulation at UHMBT were invited to participate. The bleep simulation only takes place at LTHTR (not at MMS other base trusts); therefore, only MMS students at LTHTR were invited to participate.

The study was advertised with posters in education centres at the hospitals, and in year two of the study, adverts on Facebook, Twitter and local student information platforms (OneMed – MMS, Moodle - LMS, Appendix 6).

In year one of the study, participants were approached on the day of the simulation by the lead researcher, who gave them verbal information regarding the study, and asked if they were happy to provide their email addresses so the participant information sheet (Appendix 7) and questionnaire link could be sent to them. An email (Appendix 8) was then sent out via the ‘Qualtrics’ platform to the students with the study information and a link to the online questionnaire (Appendix 9). In year two, the process was the same as year one but in addition, the option of filling out a paper questionnaire on the day was given to the participants to try to improve uptake.

All students were invited to take part in focus groups or semi-structured interviews. Students that consented were then contacted with potential dates and times and were asked to bring their consent form with them or sign it on the day. Due to scheduling difficulties and poor recruitment, only two participants were recruited for the focus groups, and so interviews rather than focus groups were conducted, either via telephone or face to face on hospital property.

In student phase, 116 students were recruited (sample population - 216 students; overall response rate 52%) over two calendar years (2016-17 n=23, response rate 25%, and 2017-18 n=90, response rate 73%) and completed the questionnaire. Three participants only completed the personal information and failed to complete the rest of the questionnaire, so these responses were excluded from analysis (see 3.5.1), leaving 113 participant data sets; participants that only missed one or two answers were included in the analysis (this is demonstrated in the tables where n=<113). A total of 67 students were recruited from MMS and 46 from LMS. These samples are proportional to the size of the medical schools as MMS is a much larger medical school and therefore had more potential participants (see also Table 3-4).

For the doctor phase, the students who were now FY1 doctors who consented to follow-up were contacted via email with a link to the doctor phase online questionnaire. In the doctor phase, 30 participants were recruited (sample population who consented to follow-up – 85; overall response rate 34%) over two successive academic years; 2017 (n = 7 out of 17 who consented to follow-up, response rate 41%) and 2018 (n = 23 out of 68 who consented to follow-up, response rate 34%), and completed the questionnaire (see Appendix 10). Two participants consented to participate but failed to complete any part of the questionnaire and were therefore excluded from the analysis, leaving 28 participant data sets (16 foundation doctors who trained at MMS and 12 foundation doctors who trained at LMS). Participants who missed certain questions were included in the analysis.

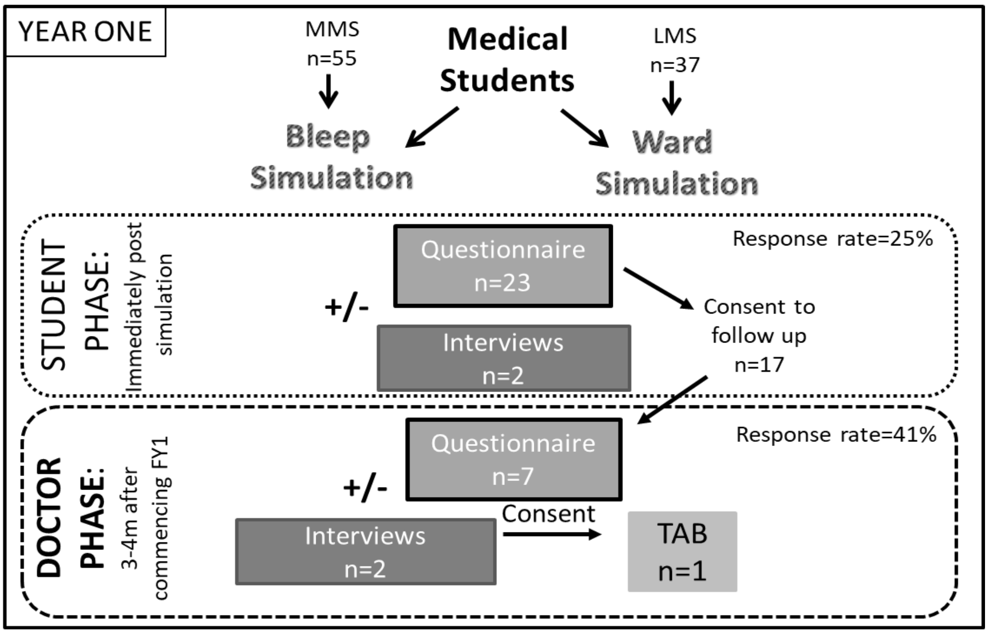


Figure 3-2 – Study diagram with number of participants and response rates for year one

3.4.2.2 Recruitment issues

There were several issues with recruitment in year one of the study, and this resulted in amendments to the study protocol between years one and two to improve recruitment. These issues impacted the design of the study and are therefore detailed here.

Firstly, due to delays in the Health Research Authority (HRA) approval, there was a delay between when the simulation courses took place and when the recruitment emails were sent out. The delay resulted in poor recruitment for year one, possibly due to students being unable to recall the study and the simulation courses. To combat this, in year two direct links to the online questionnaire were included in the initial emails, which were sent out immediately after the simulation course. An expression of interest form was also added onto the end of the questionnaires giving consent for the doctor phase and to be approached for interviews. Additionally, having only one option of the online surveys may have limited recruitment, therefore in year two participants were given the option of completing a paper questionnaire.

Consequently, in year two of the study, a new participant group was added to include key stakeholders for fifth-year medical students. Stakeholders included students' supervisors and heads of year, who would be invited to give general information about the students and not about individual students (3.4.2.4). Due to scheduling difficulties in year one, only two students were recruited for focus groups, and therefore, interviews were undertaken instead, with ten interviews undertaken in year two. Furthermore, to improve recruitment generally, incentives for students to complete both phases and both questionnaires and interviews were introduced. Following these amendments, recruitment substantially improved (demonstrated by Figure 3-3)

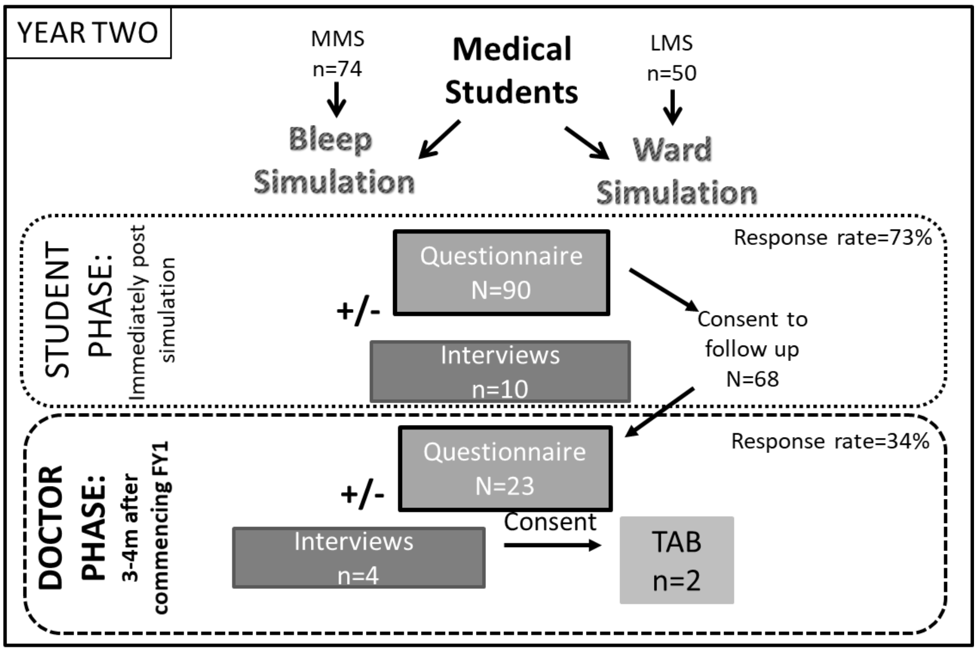


Figure 3-3 - Study diagram with number of participants and response rates for year two

3.4.2.3 Supervisors

The original research design planned to collect data from student and foundation doctor's supervisors if the student consented to this at the focus group stage. Supervisors were consultants within the speciality that the student is working at the time of recruitment to the study. Due to a combination of poor recruitment of students in the student phase of year one, possibly due to students' reluctance for direct feedback about them, despite it being anonymised, no supervisors were recruited for this part of the research (although supervisors were recruited as part of the stakeholder recruitment outlined below). A major amendment (3.4.3) was submitted to collect general, non-individualised data from stakeholders, as detailed below.

3.4.2.4 Stakeholders

Stakeholders such as undergraduate leads/dean, year leads and individual clinical supervisors at the two hospital sites/universities were identified and invited to participate in the study with online questionnaires plus or minus interviews. The data collected from these participants was data regarding the students in general, not specific students individually. This provided overall data regarding simulation and preparation to triangulate with the other data obtained and has been collected throughout the two years of the study following approval of the major amendment. While the student and stakeholder data cannot be directly compared to understand individual student outcomes, they have been compared across the cohorts overall to give a broad indication of how views align or differ regarding preparedness.

Supervisor stakeholders were identified and emailed via the hospital administrators inviting them to participate (Appendix 11), with the PIS (Appendix 12) and individualised link to the online questionnaire (Appendix 13). Key stakeholders within the universities were also approached via email, including director of medical studies, simulation leads and year five leads. Some stakeholders across both LMS and MMS known to the lead researcher were also approached in person and given information regarding the study. This relationship may introduce bias, as participants may be more or less likely to participant depending on their relationship to the lead researcher.

Overall, 24 stakeholders were recruited (sample population 76; overall response rate 32%) over two academic years (July 2017-May 2018) and completed the questionnaire (see Appendix 13); 15 stakeholders from MMS and nine from LMS. These samples are proportional to the size of the medical schools as MMS is a much larger medical school and therefore had more potential participants (see Table 3-4 and Table 3-7). No records were excluded, participants that only missed one or two answers were included in the analysis.

3.4.3 Research Ethics

Ethical approval was received from the Faculty of Health and Medicine Research Ethics Committee (FHMREC) on the 3rd January 2017 (reference FHMREC16037), the Health Research Authority (HRA) on 16th February 2017 (reference 17/HRA/0083) and Research and Development (R&D) departments at LTHTR on 17th February and UHMBT on 18th April (see Appendix 4 for details). Two minor amendments were submitted to change the wording on the research proposal and participant information sheets and to add a direct link to the online questionnaire and expression on interest form for interviews, approved by both FHMREC and the HRA on 6th April 2017. A major amendment was approved following year one of the study to improve recruitment. The amendment included stakeholder participants (instead of supervisors due to poor recruitment of this group) questionnaires and interviews, the addition of paper questionnaires, and the addition of an online voucher incentive for students for completion of both questionnaire and focus groups.

3.4.4 Data collection methods

For the quantitative part of the research, four slightly different tools in the form of questionnaires were designed. Qualitative data was obtained from semi-structured interviews.

3.4.4.1 Questionnaires

The questionnaires were designed after evaluating research in this area, drawing ideas from a range of studies and reports, including OG2015[3] (3). The competencies within OG2015 are considered by the GMC to be essential for new graduates, therefore, they were chosen as the basis for the questionnaire. Versions of these competencies have been used as the basis for questionnaires in other studies (139, 197, 198).

The questions regarding general competencies, overall preparedness and simulation were designed to provide data with which to answer research question one (How does simulation affect students' perceptions of their preparedness for the transition to professional practice; see 1.6).

Questionnaires about the OG2015 competencies were repeated in the student and doctor phases of this study((3) see

Table 3-8). This provided triangulation data with which to contribute to addressing research question one. Questionnaire data generated on preparedness for assessing medical emergencies and non-technical skills competencies would provide information to help answer the supplementary research questions regarding medical emergencies and non-technical skills.

The questionnaire was reviewed and tested by key stakeholders for undergraduates (undergraduate dean, head of medical studies and clinical supervisors for year five students) and amended accordingly.

Both student-phase and doctor phase-participants were asked how much they agreed with the following statements (on a five-point Likert scale; strongly agree- strongly disagree).

1. I feel/felt adequately prepared for my first job as a doctor
2. The skills I have learnt through simulation have set me up well for working as a foundation doctor

This was important to assess overall self-reported preparedness (to answer research question one)(128-130, 139, 158, 164) and to provide quantitative data about simulation and preparedness.

[3] Since the start of this thesis OG2015 has been superseded by Outcomes for Graduates 2018

Table 3-8 – Table demonstrating competencies from OG2015(3) and their corresponding questionnaire item. Students answered on a five-point Likert scale. Full questionnaires are in Appendices 8, 9 and 11.

<table>
<tr><td colspan="2">Outcomes for graduates 2 – The doctor as a practitioner</td></tr>
<tr><td rowspan="6">13. The graduate will be able to carry out a consultation with a patient</td><td>Questionnaire item</td></tr>
<tr><td>Take a thorough medical history</td></tr>
<tr><td>Perform an appropriate physical examination</td></tr>
<tr><td>Answer patient’s questions and concerns</td></tr>
<tr><td>Respect and understand the principles of patient-centred care</td></tr>
<tr><td>Assess patient capacity in line with GMC guidance</td></tr>
<tr><td rowspan="8">14. Diagnose and manage clinical presentations</td><td>Select appropriate investigations</td></tr>
<tr><td>Interpret the results of basic diagnostic tests</td></tr>
<tr><td>Formulate a differential diagnosis</td></tr>
<tr><td>Formulate a diagnosis and management plan</td></tr>
<tr><td>Look after a patient at the end of their life</td></tr>
<tr><td>Fill out a death certificate and cremation form</td></tr>
<tr><td>Plan a patient discharge</td></tr>
<tr><td>Complete a discharge summary</td></tr>
<tr><td rowspan="3">15. Communicate effectively with patients and colleagues in a medical context</td><td>Deal with patients with dependence issues or self-harm</td></tr>
<tr><td>Break bad news to a patient/family</td></tr>
<tr><td>Communicate with difficult/ violent/ angry patients and those with mental illness</td></tr>
<tr><td rowspan="2">17. Prescribe drugs safely, effectively and economically</td><td>Prescribe appropriate medications</td></tr>
<tr><td>Report an ADR</td></tr>
<tr><td colspan="2">Outcomes for Graduates 3 – The doctor as a professional</td></tr>
<tr><td>21. Reflect, learn and teach</td><td>Teach colleagues and students</td></tr>
<tr><td rowspan="2">23. Protect patients and improve care</td><td>Report a clinical error</td></tr>
<tr><td>Understand the principles of infection control</td></tr>
<tr><td colspan="2">SPECIFIC COMPETENCIES</td></tr>
<tr><td rowspan="6">16. Provide immediate care in a medical emergency
21. Reflect, learn and teach others
22. Learn and work effectively within an MDT
23. Protect patients and improve care</td><td>Adapt to changing circumstances and uncertainty</td></tr>
<tr><td>Assess and recognise a medical emergency/deteriorating patient</td></tr>
<tr><td>Lead a team</td></tr>
<tr><td>Manage time appropriately and prioritise tasks</td></tr>
<tr><td>Work in a multidisciplinary team</td></tr>
<tr><td>Work independently and autonomously, taking responsibility for decisions</td></tr>
<tr><td colspan="2">CORE PROCEDURES: Outcomes for graduates 2 – The doctor as a practitioner</td></tr>
<tr><td rowspan="12">18. Carry out practical procedures safely and effectively</td><td>Administer local anaesthetic</td></tr>
<tr><td>Blood Cultures</td></tr>
<tr><td>Blood transfusions</td></tr>
<tr><td>Cannulation</td></tr>
<tr><td>Catheterisation</td></tr>
<tr><td>Electrocardiogram (ECG)</td></tr>
<tr><td>Intramuscular and subcutaneous injections</td></tr>
<tr><td>Skin suturing</td></tr>
<tr><td>Temperature, Pulse, Respiration rate, Blood Pressure</td></tr>
<tr><td>Urine analysis including pregnancy testing</td></tr>
<tr><td>Venepuncture</td></tr>
<tr><td>Wound care</td></tr>
</table>

Students were asked on follow-up (when they were FY1s) regarding involvement in clinical incidents, and behavioural changes to establish whether the simulation brought about changes to behaviour (KP3) or impacted patient care (KP4) (Table 3-9); again providing information to answer the first research question. Finally, FY1 doctors were asked about staying late at work, to provide data on time management and prioritisation, providing data for the sub-research question surrounding non-technical skills.

Table 3-9 – Table demonstrating additional questions for the student and doctor phase

<table>
<tr><td>Student phase additional questions</td><td colspan="3">Doctor phase additional questions</td></tr>
<tr><td rowspan="3">The thought of becoming a doctor makes me feel stressed</td><td colspan="3">The realities of being a doctor make me feel stressed</td></tr>
<tr><td colspan="3">How stressed did/do you feel;</td></tr>
<tr><td>Before you started FY1</td><td>When you commenced FY1</td><td>Now</td></tr>
<tr><td>I am anxious about the transition to becoming a doctor</td><td colspan="3"></td></tr>
<tr><td>What is the one issue that most concerns you about starting work as a doctor? (and is it a minor, moderate or major concern)</td><td colspan="3"></td></tr>
<tr><td rowspan="2"></td><td colspan="3">Have you been involved in or reported any clinical incidents?</td></tr>
<tr><td colspan="3">If yes; what was the severity of the incident?</td></tr>
<tr><td rowspan="2"></td><td colspan="3">How often do you stay late at work?</td></tr>
<tr><td colspan="3">If yes, what are the reasons for staying late?</td></tr>
</table>

The online survey platform Qualtrics was used because it is secure and encrypted. This security reassures participants that their personal information is safe (although this is minimal as no personal information was collected). For the paper questionnaires completed, data was transcribed verbatim onto Qualtrics; therefore, these responses were not completely anonymous. Once analysed, the data set was anonymised.

Questionnaires for the stakeholder participants were also mapped identically to OG2015(3) (

Table 3-8), with additional questions regarding how prepared for practice the stakeholder deems the students to be and various questions regarding simulation and its contribution to preparedness (Figure 3-4). This would provide triangulation data for the research questions surrounding stakeholders' views on students' preparedness.

Many different factors contribute to preparedness. Please rank the following factors by how important you think they are in preparing medical students for practice as a doctor; Curriculum design/student assistantship/shadowing/simulation/clinical skills training/other (please specify)
How important do you think simulation is to prepare medical students for practice?
Are you aware of the simulation courses offered locally? Do you think they are beneficial?
Do you have any opinions on how simulation may be improved?
What (if anything) could your medical school have done to better prepare you for starting work as a doctor?

Figure 3-4 – Additional questions for the stakeholder questionnaire

Several different methods were used to overcome the potential sources of error with questionnaires (section 3.3.4). To avoid coverage error, both online and paper questionnaires were used, and all students across two sites invited to participate. If a participant completed a paper questionnaire, then they were not invited online. For the stakeholder participants, coverage error was more difficult to prevent as the invitation to participate was via email and some check this rarely, and therefore, would be excluded. Sampling error was minimised as a 'sample' is not being used in this study; all students across both sites were invited to participate. However, the stakeholders at one site were self-selected (emailed by an administrator to ask if they would consent to the initial email invitation). The response rate for the student questionnaires over the two study years was 52%, which is considered acceptable by Cohen (267pg340-344); therefore, non-response error was acceptable. The questionnaire was tested by stakeholders across both sites to ensure appropriate wording and length, thereby reducing measurement error. Some of the errors discussed here are unavoidable; they have been reduced as much as possible and been referenced throughout this thesis.

To combat potential drop-out (particularly as students may move to a different area once they graduate), participants were asked to provide personal emails for follow-up, and ethical approval was given for telephone interviews rather than focus groups as not only would it be difficult for participants to return to the North-West for this but also due to the nature of shift work, it may be difficult for the participants to find the time for an interview. There were also incentives (draw for a £50 online shopping voucher) offered for participation in both the questionnaire and interview.

3.4.4.2 Interviews/Focus groups

Initially focus groups had been planned, but due to poor recruitment (in year one - see 3.4.2.2 and scheduling difficulties (students were not available at the same time), qualitative data was collected from semi-structured interviews alone. However, there are strengths to this approach, as the interviews allowed participants to share their own experiences, thoughts, and feelings in their own words as well as the more quantified questionnaire responses (275 pg15-16).

The focus group and interview schedules were identical and designed based on other qualitative studies (202, 212) and concentrated on two main areas; effects of the simulation course and feelings of preparedness. The schedules were designed to be in line with the themes from the questionnaires to provide more broad data with which to answer the research questions, and the questionnaire data was used to develop the schedules throughout the study.

Students were interviewed either on hospital premises in private rooms or via telephone and the interviews audio recorded on an encrypted recording device. They were then transcribed, following which each transcription was given a code, making them anonymous.

Qualitative interviews may be subject to interviewer bias (275 pg15-16, 296 pg30) and therefore, it was essential to be mindful of this and that the interviewer had appropriate training and a well-designed schedule (Appendix 14).

Overall, 12 students were interviewed over the two academic years of the student phase, three from LMS and nine from MMS. The average duration of an interview was 27 minutes, ranging from 18 minutes to 50 minutes; a total of five and a half hours of audio data was collected.

Eleven stakeholders were interviewed over the same two academic years, six from LMS and four from MMS. The average duration of an interview was 33 minutes, range 17-53 minutes; a total of five and a half hours of interviews were completed. Interviews were undertaken between September 2017 and October 2018.

Six foundation doctors were interviewed in the doctor phase, two from LMS and four from MMS. The average duration of an interview was 30 minutes, ranging from 21 minutes to 39 minutes; a total of three hours of audio data were collected from doctor participants.

3.4.4.3 Team Assessment Behaviours

As discussed in 3.3.4.2, a third, objective measure, a form from each graduates' electronic portfolios was analysed (the TAB form) in the doctor phase.

These forms were collected from students who participated in the doctor phase interviews with verbal consent ascertained during the interview. Initial recruitment issues detailed in 3.4.2.2

impacted the number of TAB forms returned, in addition to participants' unwillingness to share the forms. This may be due to self-selection and, therefore, only positive TAB forms were shared, as participants who received unfavourable TAB form comments may be reluctant to share these willingly. This fits in with participants' reluctance to allow supervisors direct feedback about them to be collected as part of the study. Subsequently, the few forms received where overwhelmingly positive, and provided no new data when analysed with the rest of the data collected. They were, therefore, not included in the results.

Although this meant that there was a lack of truly objective data in the thesis, a key component of preparedness is students' perceptions of their own preparedness, which can only be self-reported. Despite the issues with self-report data, how students feel is a critical part of preparedness. This is reflected in the wider preparedness literature in which self-reported confidence is the most widely reported outcome.

3.5 Analysis

3.5.1 Quantitative data analysis

The questionnaire data was analysed using the Statistics Package for the Social Sciences (SPSS) version 14, with a p value of <0.05 considered to be statistically significant meaning that there is 95% certainty that the differences found are not due to chance.

For ease of further statistical analysis, and consistency with the existing literature, all results are presented in a condensed three-point Likert scale. 'Strongly' and 'somewhat agreed' were combined and coded as 'agree', 'somewhat disagree' and 'strongly disagree' were re-coded as 'disagree', with 'neutral' responses remaining the same (Table 3-10).The distinction between strongly or somewhat prepared and strongly or somewhat unprepared was not the focus of this thesis; the focus of this thesis is on whether students were prepared or not. Therefore, for

Table 3-10 – Likert responses grouping

Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Agree		Neutral	Disagree	

Where participants completed only the personal information, for example, to state whether they were students at either LMS or MMS but then failed to complete any of the rest of the questionnaires, they were excluded from the analysis. Where participants answered any of the rest of the questionnaire, this data was included (Table 3-11).

Table 3-11 – Table demonstrating total population, number consented to and completed questionnaire, missing data, and numbers for interview

	Total population	Consented to questionnaire	Completed questionnaire	Missing/ excluded	Completed interview
Student phase	216	116	113	3	12
Doctor phase	85	30	28	2	6
Stakeholders	59	24	24	0	11

Following the initial descriptive analysis of the questionnaire data, three comparative analyses were performed and tested for difference using Chi-squared tests. This provided triangulating data to answer both the overarching research question and the sub-research questions on assessing medical emergencies and non-technical skills.

Within the student data, hospital site (MMS vs LMS) were compared to establish whether there were significant differences between the two sites, and therefore, between the simulation courses. Following this, the student phase was compared with doctor phase, and finally, the student phase was compared with stakeholder data. For the doctor phase and stakeholder comparison, datasets were aligned (to have the same variables) and combined in an SPSS dataset. The results have been presented categorically as per

Table 3-8.

How the comparative analyses helped to answer the research questions is covered in Table 3-12

Table 3-12 – Table demonstrating triangulation data that the individual questionnaire items provide, data from the statistical comparisons and how these answer the research questions

Questionnaire item(s)	What data provides	What comparison data provides
Core competencies + core procedures	Background to preparedness; overall descriptive stats and triangulation data across sites (MMS and LMS), over time (student and FY1) and between different participant groups (student and stakeholder)	MMS/LMS comparison explores the effects of different simulation (bleep and ward) formats on preparedness
		Student and FY1 data comparison provide triangulation and data on preparedness across the transition
		Stakeholder and student data comparison provides triangulation

		and gives stakeholders views of students' preparedness
Overall stress, anxiety, overall preparedness	Background to preparedness; triangulation across sites (MMS and LMS data), over time (student and FY1 data) and between different participant groups (student and stakeholder data)	MMS/LMS comparison explores the effects of different simulation (bleep and ward) formats on preparedness and stress/anxiety
		Student and FY1 data comparison provide triangulation and data on preparedness and stress/anxiety across the transition
		Stakeholder and student data comparison provides triangulation and gives stakeholders views of students' preparedness
'Simulation has set me up well for working as a foundation doctor'	How simulation affects preparedness overall; how this changes over time from student to FY perspective	MMS/LMS comparison explores how different simulation (bleep and ward) formats may affect views on simulation for preparedness
		Student and FY1 comparison provide triangulation data
Free-text data on concerns 'What is the one issue that concerns you most about starting work?'	Background to preparedness and potential focus for interventions including simulation	
Free-text data 'what could your medical school have done to better prepare you for starting work as a doctor?'	How simulation interacts with other educational elements of final year	
FY1 questionnaire extra questions on clinical incidents, time management	Background to preparedness and effects of the transition; whether simulation has impacted behaviours (KP3)	Low FY numbers prevent meaningful comparison between LMS/MMS
Stakeholder additional questions; asked to rank educational elements in final year	How simulation interacts with other educational elements of final year	

Across the whole thesis, 84 p values were generated. This means, with a p value of <0.05 this means that approximately four would have come up statistically significant by chance. Although there are ways to correct for multiple comparisons, including the Bonferroni correction, it was considered inappropriate for to use this or other methods to correct for multiple comparison in this analysis (297). These analyses were not designed to test a hypothesis; the research questions are an exploration of the relationship between simulation and preparedness. The comparative analyses were performed to examine the differences between simulation formats, and different stakeholders across the transition to provide triangulating data to answer the research questions. The goal of the research was not to definitively prove that one simulation was superior to the other, nor that FY1 and student or stakeholder and student opinions were the same or different. Instead, this thesis aimed to explore the impact of simulation on preparedness by looking at different simulation formats, in different universities, at different stages in training, from differing perspectives. Therefore, as described by Bender et al, to adjust for multiple comparisons would be inappropriate (297). Furthermore, the comparisons were not asking one question many times, rather multiple different questions, multiple separate issues (although presented together in tables). This means that the significant results must be regarded with caution as they are exploratory results, and would need to be further tested in confirmatory studies (297).

There is more than one approach to the analysis of Likert scale data (i.e. with parametric or non-parametric tests)(268, 270, 298). In this case the answers to the questionnaire; disagree – neutral – agree, may be considered ordinal. Therefore, the data (MMS vs LMS, student vs doctor phase and stakeholder vs student) were compared and differences tested with Chi-squared tests. In most tests of difference, the actual direction of the difference was clear. However, for one comparison, where it was unclear where the difference lay, a logistic regression was performed to further investigate the difference and to obtain an odds ratio (OR).

For this analysis, the categories were compressed further into two categories; agree, and disagree and neutral. These categories are particularly relevant for this question as students who cannot decide or are ambivalent cannot be considered fully prepared, so the comparison was between 'agree' and everything else. This categorisation also helped to deal with the zero values in the table which made it challenging to work out an odds ratio (OR) for the three categories (no LMS students disagreed that they felt prepared).

Within the doctor phase and stakeholder data, there were some questions that were only asked of that participant group. In the doctor phase, there were additional questions about time management, stress, and involvement in clinical incidents. This data helped to answer the supplementary research question regarding non-technical skills and explore whether simulation had affected behaviours or patient care (KP3-4). In the stakeholder data, stakeholders were asked to rank educational elements within the fifth year regarding how important they are in preparing students for practice as doctors. This helped explore views on the interaction of simulation with other educational elements to impact preparedness and was presented in the results with descriptive statistics.

The free-text questionnaire data was coded and analysed with the qualitative data. In addition, to assess how students graded their concerns (to minor, moderate or major concerns) and what themes there were across the minor, moderate and major concerns, this specific free-text data was analysed. This gave further data regarding preparedness, answering the overarching research question. The free-text comments were uploaded to an Excel document and then a basic thematic analysis was conducted, generating themes iteratively from the data. This gave the eight key themes presented in the following results chapters (*Table 4-13*).

3.5.1.1 The quality of quantitative research

The two key aspects of quality in quantitative research are validity and reliability. Validity is the degree to which the research investigates what it intends to; in this study, whether the questionnaires and interviews truly examine preparedness and simulation. The first consideration when designing a questionnaire; is there already a validated questionnaire available? In the preparedness literature, many questionnaires have been used, but few are validated or specific enough to answer the research questions.

When formulating a new questionnaire instrument, three aspects of validity must be considered; content, construct and criterion validity (299 pg202-204, 300). Content validity or face validity denotes how far the questionnaire covers the whole issue being studied. Content validity was achieved by mapping the questionnaire questions to the OG2015(3), thereby covering preparedness (1 pg313-314)(pg313-314). Construct validity represents whether conclusions can be drawn based on the instrument (questionnaires in this study) about the outcome (1 pg313-314, 300)(313-314). In this thesis, using multiple methods strengthened construct validity. Finally, criterion validity involves determining if the results from the questionnaire correspond with an external criterion (1 pg313-314)(313-314); for example, if the levels of preparedness found corresponded with examination results. This data was not collected as part of this thesis, as there are no appropriate validated external criteria relevant to this research. A key element of validating a questionnaire is testing the questionnaire. This was limited in this research because of time pressures relating to commencing data collection. Due to restrictions on my out of programme research time, it was essential that I begin data collection in year one of the MD. To ensure appropriate HRA and ethics approval, this limited the opportunities for questionnaire testing.

Another aspect of questionnaire quality is internal validity. Internal validity is the extent to which the study's results can be directly attributed to the intervention and the extent to which the findings can be explained by the study's own data (1 pg313-315, 299-204). This can be difficult to achieve in education studies, as there are so many external factors contributing to learning, particularly if a randomised controlled design is not used. In this thesis, many other factors will have contributed to students' preparedness, but by acknowledging differences between the two medical schools, and examining views longitudinally and from different perspectives, a comprehensive data set was built with which to investigate the research questions.

Reliability of quantitative data, the reproducibility of results, relates to the consistency of an instrument or questionnaire (1 pg312). This can be assessed with various methods including retest reliability, parallel test reliability and interrater reliability (1 pg312-314, 267 pg268-270). Retesting participants was done as part of the study; however, the questionnaires used were slightly different, and reliability might also have been impacted by differences between the student and doctor phases. Furthermore, the student and doctor phase data sets were not linked at the level of the individual, so there was no way to perform retest reliability. (Parallel test reliability involves using two different questionnaires or instruments, which participants have to complete (1 pg312-314))

In this questionnaire, no question was deliberately designed to test internal consistency. However, the questions 'I feel stressed at the thought of becoming a doctor' and 'I feel anxious regarding the transition to professional practice' are similar and answers to these were correlated with a correlation coefficient (α= 0.78, p= <0.0001). Although clinically, stress and anxiety are distinct pathologies, the nomenclature is often used interchangeably. Additionally, a Cronbach's alpha was performed correlating between students who feel prepared overall and preparedness for individual competencies. This gave an α= 0.91 which suggests high levels of internal consistency.

3.5.2 Qualitative data analysis

Interviews were recorded on an encrypted digital recording device and transcribed verbatim, the transcriptions anonymised and uploaded on the computer-assisted qualitative data software (CAQDAS) program NVivo 11. To avoid researcher bias and to exercise reflexivity, a grounded theory informed method was utilised for analysis (261 pg12-13, 296 pg4-10, 301 pg118-126). Grounded theory aims to create theories from the data, and therefore involves creating codes and themes directly from examining the data, rather than having predetermined themes. Data was analysed as it was collected, and this allowed the interview schedule to be developed throughout the study. A key element of grounded theory is theoretical sampling; based on initial results from data analysis; theoretical sampling involves selecting participants that will confirm the themes, but also participants who may have conflicting views. Theoretical sampling was not possible in this study due to the small population and reliance on volunteers; the interview schedule was developed based on ongoing data analysis and this allowed clarification of themes.

Had a content analysis been used, with themes created from the literature, there was a concern that themes would have been generated from the author's pre-conceived ideas regarding the topic. Transcripts were read and coded inductively by the lead researcher, with the coding tree being reviewed periodically by the lead researcher's two supervisors. To begin with, transcripts were coded line-by-line in the initial open coding process. An example of this may be found in Figure 3-5.

CC: Do you feel prepared?	
2P1S5: ummm, yes I do, I think I'll be a lot more prepared than what I think I am because I think just naturally I always feel underprepared for things even when I am very prepared for things, because I always think in certain situations, what if that happened…	Preparedness
So you know I feel once I actually get going you know, get my feet under the table and start I think I'll be fine. But it's just the initial role what am I going to be expected to do, because working in a big east end London hospital is gonna be different to Lancaster, so there will be a big sort of difference in the hospitals, there's going to be a big difference in the people that we are seeing, so there is	Transition to professional practice
uncertainty around that… But I'm embracing it and I'm looking forward to it, I see it as a new challenge, and I'm excited and at the same time there's a little bit of uncertainty but I think that that's	Students not prepared for
natural. I don't feel underprepared, I'm not thinking oh my god I need to start reading my books, and learning about XY and Z, I feel like I should be good to go.	Transition to professional practice
CC: So what to you does preparedness mean? What are the essential criteria to be prepared to start work particularly? **2P1S5:** I feel you know being ready for facing situations, the jobs that your expected to do, of which there's a little bit of uncertainty about that, that's why I don't feel… there's a little bit of uncertainty there but preparedness for me is a bit of competency, doing the	
tasks basic tasks, having an understanding of how to deal with maybe not critical situation but more acute situations and recognising them. That's one thing for me, recognising when something needs to be escalated, what you can and you can't handle, what needs senior input.	What does preparedness mean?
	What does preparedness mean?

Figure 3-5 - Example of open coding of an excerpt from a student interview

Following and during this, a constant comparison approach was taken to compare and contrast different codes, to develop them into categories and themes, and form links between the codes. Subsequently, a more focused coding was performed on the more significant codes identified from the initial coding (see Table 3-13).

Category	Focused/selective codes	Open codes
Expanding on 'Learning by doing.'	Educational benefits and desire for this to increase- -Assistantship/shadowing -Simulation -Direct role in patient care for students Practice being an FY1	How to improve preparation Other methods for preparing for practice Reasons for poor preparation
Prepared, but still scared?	'Prepared as I can be' Uncertain nature of medicine Confidence/competence Preparedness/concerns	What does preparedness mean Preparedness Transition to professional practice Areas of stress/anxiety
The link between theoretical and practical medicine; 'Learning by doing.'	Reference to the benefits of experiential learning gained from -Assistantship/shadowing -Simulation -Direct role in patient care for students	Benefits of simulation Learning theories: -Experiential learning -Deliberate practice How is simulation effective

Table 3-13 – Coding process

All transcriptions were reanalysed using those codes and themes to ensure data saturation (261 pg265-266). The coding framework was reviewed at each stage by the lead researcher and her supervisors and can be found in Appendix 15.

Student participants' data drove the initial coding and identification of themes, and these were then applied to the doctor and stakeholder data with an acknowledgement that other, doctor-specific themes may emerge. Having one coding framework across the two data sets made the comparison more straightforward. Upon review of the stakeholder data, no new themes emerged. The student and stakeholder data were very much aligned in many of the themes, and so the student and stakeholder data has been analysed and presented in combination, the doctor data has been presented separately.

3.5.2.1 The quality of qualitative data

An important consideration when designing a qualitative or mixed methods study is ensuring quality. In qualitative research, unlike quantitative, quality is focused on the authenticity and trustworthiness of the research as a whole (302 pg283-284). Ways in which validity may be confirmed in a qualitative study are triangulation, member checking, external audit and reflexivity. Triangulation involves using different data sources (distinct participants, in this thesis; stakeholders and students) or different types of data (in this thesis, questionnaire and interview data). Usually, this is achieved as it has been in this thesis, using several methodological approaches (299 pg199-

202). In this thesis, triangulation was achieved with methodological triangulation, both within methods, but using open-ended and Likert scale response questions, and between methods by using interviews and questionnaires (303 pg199-202). Additionally, data triangulation was utilised, using data collected at different times, with data collected at different times, from different locations and participants (303 pg199-202). Combining and analysing these different sources enhances accuracy, ensures internal validity, and allows the research questions to be examined from various angles (279, 302 pg283-286, 304).

Member checking (or respondent validation) requires one or more participants to check the accuracy of the account, this may involve the researcher returning a transcript to the participant to check correctness (302 pg283-286). Although in this thesis the transcripts were not checked in this way, the follow-up process allowed an element of fact checking. For example, if a participant had said they felt most unprepared or prepared for certain areas or expressed any strong views these were revisited in the follow-up interview. Furthermore, all participants will receive a summary report of the study and findings, which will constitute the 'strong' form of member checking (305 pg61-64)

The process of external audit means that an individual outside the study performs a review of the study for strengths, weaknesses and methodological rigour (302 pg283-284). External audit has been accomplished in this thesis by regular supervisor review of the report and supplementary materials. Additionally, the examiners' review of this work prior to the viva would constitute an external audit.

The practice of reflexivity discussed in 3.3 is an essential element of ensuring quality. Self-reflection on one's own role in the research, and how any preconceived thoughts may affect the findings ensures transparency. One way to combat the influence of preconceived ideas is having multiple coders analysing the data. Although it was not possible to do in this study, coding strategies and coding trees were reviewed intermittently by the lead researcher's supervisors.

3.6 Summary

This research used a pragmatic, mixed-methods, longitudinal approach to investigate the efficacy of simulation for preparedness for practice. The triangulation of qualitative and quantitative data allowed objective and deductive but also subjective and inductive approaches to the research questions. Triangulating methods (questionnaires, interviews and TAB forms) gave information not only on how simulation is effective but also why, and multiple participant groups provided different perspectives on simulation and preparedness. By using mixed methods, with triangulation of qualitative and quantitative data, questionnaires and interviews and multiple participants, this thesis provides a comprehensive data set with which to answer the research questions. Section 3.3 set out these different methodologies and justified their use in this thesis.

The remaining part of this chapter set out the recruitment and sampling strategies for the medical student and stakeholder participants, including the consent process and details of the medical schools from which the participants came. It also included details regarding initial issues with recruitment and strategies employed to improve uptake. Details of the methods used; questionnaire and interview schedule development and administration, and methods for data analysis have also been discussed. Having set out the methodological underpinnings and a detailed account of the study design, the following two chapters will describe the results from the thesis. The first lays out how prepared students are for core competencies, procedures, overall, and views on the transition. The second covers how simulation interacts with other elements of final year to impact students' preparedness.

4 Preparedness for practice: the transition

This first results chapter aims to answer the overarching research question; How does simulation affect students' perceptions of their preparedness for the transition to professional practice. Additionally, this chapter presents results with which to answer the supplementary research question; what are stakeholders' (providers of undergraduate education) views on students' preparedness for professional practice?

To understand how simulation affects perceptions of preparedness, it is first necessary to explore the concept of preparedness, for which the data is described in this chapter. In the following chapter, data on how simulation affects preparedness is presented, thereby answering the research questions set.

To describe preparedness, this chapter presents results based on data collected about students preparedness for the competencies set out in OG2015 (3), including data on students' preparedness for assessing medical emergencies and assessing non-technical skills. Following this, data on overall preparedness, stress and anxieties surrounding the transition is described, along with the qualitative data on how students and stakeholder conceptualise preparedness and views on the transition to practice.

Chapter 5 will describe the quantitative and qualitative data describing the importance of simulation and how simulation interacts with other curriculum elements to increase preparedness is described to link the concept of preparedness (covered in this chapter) with the benefits of simulation.

Quantitative and qualitative data were affected by recruitment issues in year one (see 3.4.2.2). This meant that stakeholders were included and asked to provide broad data on students' preparedness but individual supervisors were not surveyed as per the original research design (3.4). The stakeholder data is not about individual students but about the cohort as a whole, so this must be considered when interpreting the results.

4.1 Preparedness for transition to medical practice: knowledge and skills

To structure the analysis, the data has been divided into subsections in line with OG2015 (3);

- **The doctor as a practitioner;**
    - **The graduate will be able to carry out a consultation with a patient**
    - **Diagnose and manage clinical presentations**

    - **Communicate effectively with patients and colleagues in a medical context**
    - **Prescribe drugs safely, effectively and economically**
- **The doctor as a professional;**
    - **Reflect, learn and teach others and protect patients and improve care**
- **Core procedures**

Competencies related to assessing medical emergencies and non-technical skills are described in subsection 4.2 (in order to answer the remaining two research questions). As a key focus for the thesis (and the simulation courses being evaluated) was assessing preparedness for non-technical skills and assessing medical emergencies, for the FY1 and stakeholder data only the specific competencies related to these research questions (in addition to core procedures) were compared (see 3.5.1 for details). Streamlining the comparison in this way also reduced the possibility of multiple testing throwing up positive results by chance (causing type 1 error (306 pg67-68)).

Although stakeholder and student opinions have been compared, it is important to note that while students are commenting on their perceptions of their own preparedness, stakeholders are commenting on the group as a whole, not individual students. This will affect what conclusions may be drawn from the data. However, it does give an overall view from the stakeholder group with which to triangulate the student data. This is discussed further in the discussion and conclusion (6.3.2, 7.1).

Results

The doctor as a practitioner; The graduate will be able to carry out a consultation with a patient

Overall, students felt prepared for performing a physical examination, respecting patient-centred care and taking a medical history (Table 4-1); 100% agreed that they felt prepared. Students felt less sure about their preparedness for assessing patient capacity, with nearly a quarter of students either neutral or disagreeing they felt prepared.

There were no statistically significant differences found between MMS and LMS for any of the competencies assessed in this section.

Diagnose and manage clinical presentations

The highest levels of perceived preparedness in this category (Table 4-2) were seen for formulating a differential diagnosis (99% agreed that they felt prepared to do this), selecting appropriate investigations (96% agreed), and formulating a diagnosis and management plan (94% agreed); no participants disagreed with these statements. Students felt less prepared for looking after a patient at the end of their life (16% strongly or somewhat disagreed) filling out a death certificate (16% disagreed) and completing a discharge summary (15% disagreed). For death certification and end of life care, around a quarter of participants selected the neither agree nor disagree category.

LMS students felt (statistically significantly) more prepared than MMS students for completing a discharge summary (MMS 68% agreed, LMS 96% agreed, p= 0.001), death certification (MMS 46% agreed, LMS 83% agreed, p= <0.001), looking after patients at the end of their lives (MMS 53% agreed, LMS 74% agreed, p= 0.014) and interpreting results of diagnostic tests (MMS 53% agreed, LMS 74% agreed, p= 0.014).

Communicate effectively with patients and colleagues in a medical context

The highest levels of preparedness in this category (Table 4-3) were for breaking bad news (82% agreed they were prepared for breaking bad news to a family). Participants felt slightly less prepared for dealing with dependence issues (71% agreed) and communication with difficult, violent, or angry patients (66% agreed). For dealing with dependence issues and communicating with difficult, violent or angry patients, around a quarter of participants neither agreed nor disagreed they felt prepared. This finding is similar to preparedness for death certification and end of life care, but the latter has higher levels of disagreement.

LMS students felt statistically significantly more prepared for communicating with difficult patients and those with mental illness than did students at MMS (MMS 58% agreed, LMS 79% agreed, p= 0.030).

Prescribe drugs safely, effectively and economically

Over 90% of participants agreed they felt prepared to prescribe medication (Table 4-4). They felt less prepared to report an adverse drug reaction, with 54% agreeing they felt prepared. Eighteen per cent of participants disagreed with this statement. Again, for this competency over a quarter of participants neither agreed nor disagreed they felt prepared.

When compared (Table 4-4), LMS students felt significantly more prepared for reporting an adverse drug reaction (MMS 39% agreed, LMS 75% agreed, p= 0.001).

The doctor as a professional; reflect, learn and teach others and protect patients and improve care

In this category (Table 4-5), students felt that their training had prepared them for dealing with the concept of infection control; over 90% agreed with this statement. Students felt less prepared for reporting a clinical error, with 56% agreeing that their training had prepared them adequately, and 14% disagreeing and 30% being neutral.

Although overall the proportion of students who felt prepared for reporting a clinical error was just over a half, when medical schools were compared LMS students felt more prepared for this competency than did students at MMS (LMS 79% agreed, MMS 41% agreed p= <0.001).

Table 4-1 The doctor as a practitioner; The graduate will be able to carry out a consultation with a patient; comparison table with total, MMS and LMS numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Answer patient's questions and concerns	113	95.5 (108)	3.5 (4)	0.9 (1)	66	93.9 (62)	4.5 (3)	1.5 (1)	47	97.9 (46)	2.1 (1)	0 (0)	0.546
Assess patient's capacity in line with GMC guidance	113	76.1 (86)	17.7 (20)	6.2 (7)	66	74.2 (49)	19.7 (13)	6.1 (4)	47	78.7 (37)	14.9 (7)	6.4 (3)	0.805
Perform an appropriate physical examination	113	100 (113)	0 (0)	0 (0)	66	100 (66)	0 (0)	0 (0)	47	100 (47)	0 (0)	0 (0)	n/a
Respect and understand principles of patient-centred care	112	100 (112)	0 (0)	0 (0)	66	100 (66)	0 (0)	0 (0)	46	100 (47)	0 (0)	0 (0)	n/a
Take a thorough medical history	113	100 (113)	0 (0)	0 (0)	66	100 (66)	0 (0)	0 (0)	47	100 (47)	0 (0)	0 (0)	n/a

Table 4-2 Diagnose and manage clinical presentations; comparison table with total, MMS and LMS numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Complete a discharge summary*	113	79.7 (90)	5.3 (6)	15.0 (17)	66	68.2 (45)	6.0 (4)	25.8 (17)	47	95.7 (45)	4.3 (2)	0.0 (0)	0.001
Fill out a Death certificate and Cremation form*	113	61.0 (69)	23.0 (26)	16.0 (18)	66	45.5 (30)	27.3 (18)	27.3 (18)	47	83.0 (39)	17.0 (8)	0.0 (0)	<0.001
Formulate a diagnosis and management plan	113	93.8 (106)	6.2 (7)	0 (0)	66	92.4 (61)	7.6 (5)	0 (0)	47	95.7 (45)	4.3 (2)	0 (0)	0.470
Formulate a differential diagnosis	113	99.1 (112)	0.9 (1)	0 (0)	66	97.0 (64)	3.0 (2)	0 (0)	47	93.9 (44)	2.1 (1)	4.3 (2)	0.397
Interpret results of basic diagnostic tests (e.g. Bloods, ECG, X-Rays* p=0.014	113	95.6 (108)	2.7 (3)	1.8 (2)	66	53.0 (35)	22.7 (15)	24.2 (16)	46	73.9 (34)	21.7 (10)	4.3 (2)	0.232
Look after a patient at the end of their life*	112	61.6 (69)	22.3 (25)	16.1 (18)	66	53.0 (35)	22.7 (15)	24.2 (16)	46	73.9 (34)	21.7 (10)	4.3 (2)	0.014
Plan a patients' discharge	110	61.9 (68)	25.5 (28)	12.7 (14)	64	59.4 (38)	23.4 (15)	17.2 (11)	46	65.2 (30)	28.3 (13)	6.5 (3)	0.249
Select appropriate investigations	113	95.6 (108)	3.5 (4)	0.9 (1)	66	93.9 (62)	4.5 (3)	1.5 (1)	47	97.9 (46)	2.1 (1)	0 (0)	0.546

Table 4-3 Communicate effectively with patients and colleagues in a medical context; comparison table with total, MMS and LMS numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Break bad news to patient/family	113	81.5 (92)	11.5 (13)	7.0 (8)	66	81.8 (54)	9.1 (6)	9.1 (6)	47	80.9 (38)	14.9 (7)	4.3 (2)	0.425
Communicate with difficult/violent/angry patients and those with mental illness*	113	66.4 (75)	24.8 (28)	8.9 (10)	66	57.6 (38)	28.8 (19)	13.6 (9)	47	78.7 (37)	19.1 (9)	2.1 (1)	0.030
Deal with patients with dependence issues or self-harm	113	71.7 (81)	23.0 (26)	5.3 (6)	66	66.7 (44)	25.8 (17)	7.6 (5)	47	78.7 (37)	19.1 (9)	2.1 (1)	0.271

Table 4-4 Prescribe drugs safely, effectively and economically; comparison table with total, MMS and LMS numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Prescribe appropriate medications	113	91.2 (103)	7.1 (8)	1.8 (2)	66	97.9 (58)	9.1 (6)	3.0 (2)	47	95.7 (45)	4.3 (2)	0 (0)	0.284
Report an Adverse Drug Reaction (ADR)*	113	53.9 (61)	28.3 (32)	17.7 (20)	66	39.4 (26)	36.4 (24)	24.2 (16)	47	74.5 (35)	17.0 (8)	8.5 (4)	0.001

Table 4-5 The doctor as a professional; reflect, learn and teach others and protect patients and improve care; comparison table with total, MMS and LMS numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Report a clinical error*	113	56.7 (64)	29.2 (33)	14.2 (16)	66	40.9 (27)	39.4 (26)	19.7 (13)	47	78.7 (37)	14.9 (7)	6.4 (3)	<0.001
Teach colleagues and students	113	82.3 (93)	14.2 (16)	3.5 (4)	66	86.4 (57)	9.1 (6)	4.5 (3)	47	76.6 (36)	21.3 (10)	2.1 (1)	0.161
Understand and practice concepts of infection control	113	93.8 (106)	3.5 (4)	2.7 (3)	66	90.9 (60)	4.5 (3)	4.5 (3)	47	97.9 (46)	2.1 (1)	0 (0)	0.255

Core procedures

All students (100%) agreed (Table 4-6) that they felt prepared for performing basic observations and urine analysis and 99% agreed that they were prepared for performing ECGs and venepuncture. Areas that participants felt less confident about included administering local anaesthetic (85% agreed) and skin suturing (83% agreed). Two areas of concern were blood transfusion and wound care, which had the lowest proportion of answers falling in the agree category (blood transfusion 64% agreed, wound care 72% agreed).

When these core procedures were compared between MMS and LMS (Table 4-6) a statistically significant difference was found for rates of agreement for two competencies; administering local anaesthetic (97% MMS agreed, 70% LMS agreed, p= 0.001) and wound care (58% MMS agreed, 92% LMS agreed, p= <0.001). For the other core skills, the proportions of respondents who agreed were similar with high levels of agreement that their training had prepared them adequately.

There were no statistically significant differences in preparedness for core procedures between the student and doctor phase, except for urine analysis (Table 4-7). For many of the core procedures, how prepared participants felt as a student and following the transition from student to doctor were almost identical. This was the case for measuring basic observations, venepuncture, blood cultures, and catheterisation.

Contrary to these findings, for eight of the 12 procedures, there was a significant difference in how prepared students themselves felt when compared to how prepared stakeholders felt the students were as a cohort, suggesting the students felt more prepared than the stakeholders thought they were (Table 4-8). Both students and stakeholders agreed that students were adequately prepared to perform basic observations (100% both groups agreed), cannulation (96% students and 92% stakeholders agreed, p= 0.183) and blood cultures (93% students and 92% stakeholders agreed, p= 0.540). The two groups also agreed that students were moderately prepared to administer a blood transfusion (64% of students and 63% stakeholders agreed, similar levels of neutral and disagrees, p= 0.675).

For all the other procedures, although there were statistically significant differences in perception of preparedness between the students and stakeholders, some are more notable than others. Even though the p values suggest a statistically significant difference in students and stakeholders' views on preparedness for venepuncture, performing an ECG and urine analysis, in both groups >90% still felt that students were well-prepared for these procedures. Procedures that divided opinion more included IM and SC injections, administering local anaesthetic, catheterisation, skin suturing and wound care. For these procedures, students felt significantly more prepared than the stakeholders felt they were as a whole cohort.

Table 4-6 comparison table for procedural competencies, with total, MMS and LMS numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Administer local anaesthetic*	105	84.7 (89)	4.8 (5)	10.5 (11)	58	96.6 (56)	1.7 (1)	1.7 (1)	47	70.2 (33)	8.5 (4)	21.3 (10)	0.001
Basic observations	113	100 (113)	0 (0)	0 (0)	66	100 (66)	0 (0)	0 (0)	47	100 (47)	0 (0)	0 (0)	n/a
Blood cultures	113	92.9 (105)	4.4 (5)	2.7 (3)	66	90.9 (60)	4.5 (3)	4.5 (3)	47	95.7 (45)	4.3 (2)	0 (0)	0.331
Blood transfusions	113	63.7 (72)	27.4 (31)	8.9 (10)	66	66.7 (44)	24.2 (16)	9.1 (6)	47	59.6 (28)	31.9 (15)	8.5 (4)	0.665
Cannulation	113	96.4 (109)	1.8 (2)	1.8 (2)	66	97.0 (64)	1.5 (1)	1.5 (1)	47	95.7 (45)	2.1 (1)	2.1 (1)	0.941
Catheterisation	113	92.9 (105)	6.2 (7)	0.9 (1)	66	92.4 (61)	6.1 (4)	1.5 (1)	47	93.6 (44)	6.4 (3)	0 (0)	0.697
ECG	113	99.1 (112)	0 (0)	0.9 (1)	66	98.5 (66)	1.5 (1)	0 (0)	47	100 (47)	0 (0)	0 (0)	0.397
Intramuscular and subcutaneous injections	113	97.4 (110)	2.6 (3)	0 (0)	66	97.0 (64)	3.0 (2)	0 (0)	47	97.9 (46)	2.1 (1)	0 (0)	0.769
Skin suturing	113	83.2 (94)	11.5 (13)	5.3 (6)	66	81.8 (54)	15.2 (10)	3.0 (2)	47	85.1 (40)	6.4 (3)	8.5 (4)	0.181
Urine analysis including pregnancy testing	113	100 (113)	0 (0)	0 (0)	66	100 (66)	0 (0)	0 (0)	47	100 (47)	0 (0)	0 (0)	n/a
Venepuncture	113	99.1 (112)	0 (0)	0.9 (1)	66	98.5 (65)	1.5 (1)	0 (0)	47	100 (47)	0 (0)	0 (0)	0.397
Wound care*	111	72.0 (80)	18.0 (20)	10.0 (11)	64	57.8 (37)	28.1 (18)	14.1 (9)	47	91.5 (43)	4.3 (2)	4.3 (2)	<0.001

Table 4-7 comparison table for procedural competencies, with total and FY1 numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Student				FY1				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Administer local anaesthetic	105	84.7 (89)	4.8 (5)	10.5 (11)	27	70.4 (19)	7.4 (2)	22.2 (6)	0.209
Basic observations	113	100 (113)	0 (0)	0 (0)	27	100 (27)	0 (0)	0 (0)	n/a
Blood cultures	113	92.9 (105)	4.4 (5)	2.7 (3)	27	92.6 (25)	3.7 (1)	3.7 (1)	0.946
Blood transfusions	113	63.7 (72)	27.4 (31)	8.9 (10)	27	74.1 (20)	14.8 (4)	11.1 (3)	0.394
Cannulation	113	96.4 (109)	1.8 (2)	1.8 (2)	27	100 (27)	0 (0)	0 (0)	0.611
Catheterisation	113	92.9 (105)	6.2 (7)	0.9 (1)	27	92.6 (25)	3.7 (1)	3.7 (1)	0.485
ECG	113	99.1 (112)	0 (0)	0.9 (1)	27	92.6 (25)	3.7 (1)	3.7 (1)	0.064
Intramuscular and subcutaneous injections	113	97.4 (110)	2.6 (3)	0 (0)	27	92.6 (25)	3.7 (1)	3.7 (1)	0.115
Skin suturing	113	83.2 (94)	11.5 (13)	5.3 (6)	27	85.2 (23)	11.1 (3)	3.7 (1)	0.939
Urine analysis including pregnancy testing*	113	100 (113)	0 (0)	0 (0)	27	96.3 (26)	3.7 (1)	0 (0)	0.040
Venepuncture	113	99.1 (112)	0 (0)	0.9 (1)	27	100 (27)	0 (0)	0 (0)	0.624
Wound care	111	72.0 (80)	18.0 (20)	10.0 (11)	27	59.3 (16)	14.8 (4)	25.9 (7)	0.086

Table 4-8 comparison table for procedural competencies, with total and stakeholder numbers and p value for Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Student				Stakeholder				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Administer local anaesthetic*	105	84.7 (89)	4.8 (5)	10.5 (11)	23	47.8 (11)	52.2 (12)	0.0 (0)	<0.001
Basic observations	113	100 (113)	0 (0)	0 (0)	24	100.0 (24)	0.0 (0)	0.0 (0)	n/a
Blood cultures	113	92.9 (105)	4.4 (5)	2.7 (3)	24	91.7 (22)	8.3 (2)	0.0 (0)	0.540
Blood transfusions	113	63.7 (72)	27.4 (31)	8.9 (10)	24	62.5 (15)	33.3 (8)	4.2 (1)	0.675
Cannulation	113	96.4 (109)	1.8 (2)	1.8 (2)	24	91.7 (22)	8.3 (2)	0.0 (0)	0.183
Catheterisation*	113	92.9 (105)	6.2 (7)	0.9 (1)	24	66.7 (16)	33.3 (8)	0.0 (0)	0.001
ECG*	113	99.1 (112)	0 (0)	0.9 (1)	24	91.7 (22)	8.3 (2)	0.0 (0)	0.008
Intramuscular and subcutaneous injections*	113	97.4 (110)	2.6 (3)	0 (0)	24	66.7 (16)	25.0 (6)	8.3 (2)	<0.001
Skin suturing*	113	83.2 (94)	11.5 (13)	5.3 (6)	23	39.1 (9)	56.5 (13)	4.3 (1)	<0.001
Urine analysis including pregnancy testing*	113	100 (113)	0 (0)	0 (0)	24	91.7 (22)	4.2 (1)	4.2 (1)	0.008
Venepuncture*	113	99.1 (112)	0 (0)	0.9 (1)	24	91.7 (22)	8.3 (2)	0.0 (0)	0.008
Wound care*	111	72.0 (80)	18.0 (20)	10.0 (11)	23	39.1 (9)	43.5 (10)	17.4 (4)	0.008

Key findings

These results suggest that medical students feel prepared for the basic tasks of being a foundation year doctor (FY1), and the accompanying skills such as performing an examination, taking a history, formulating a differential diagnosis, and selecting appropriate investigations. Students felt less prepared for dealing with end of life care, death certification, reporting a clinical error and managing adverse drug reactions. For most competencies there was no statistically significant difference between medical schools, but for two (administering local anaesthetic and wound care there was a difference: MMS students felt significantly more prepared for administering local anaesthetic when compared to LMS students while for wound care it was LMS who felt more prepared.

Despite feeling prepared overall for basic procedures such as observations, urine analysis, ECG, IM, and SC injections, students' perception of their levels of preparedness for undertaking a blood transfusion (64%), administering local anaesthetic (85%) and wound care (72%) were lower.

There were no statistically significant differences found between student and FY1 views on their preparedness for core procedures. This means that despite their experiences of the transition (4.3.4, 4.3.5), looking back, they agreed with their judgements on their own preparedness.

The most noticeable differences in results were seen when comparing the stakeholder and student data. In this analysis, it was clear that students felt more prepared for practice than the stakeholders judged them to be. This difference was statistically significant for eight out of the 12 core procedures. Even where the difference was not statistically significant, for all the competencies, the trend was towards students feeling more prepared than the stakeholder's judged them to be. Although the stakeholders were not commenting on individual students, rather, the cohort as a whole, this data still gives a feel of stakeholders' opinions and suggests a significant divide with the perceptions of students themselves. The following section covers the specific data answering the supplementary research questions on assessing medical emergencies and non-technical skills.

4.2 Preparedness for practice: Assessing medical emergencies and non-technical skills

Students felt most prepared (Table 4-9) for working in an MDT (98% of students agreed), and for assessing a medical emergency (94% agreed). No students disagreed with either statement. Students felt less prepared for working independently (74% agreed), adapting to changing circumstances and uncertainty (68% strongly or somewhat agreed), and leading a team (66% strongly or somewhat agreed). These three competencies had around or over a quarter of participants neither agreeing nor disagreeing that they felt prepared.

The fact that a quarter of participants neither agreed nor disagreed that they felt prepared for some non-technical skills may, in part, be due to students not experiencing these skills as an undergraduate, making them unsure about the competence; however, the neither agree nor disagree selection may also be used to avoid giving a response. It also may mean that they are undecided or indifferent towards that particular competence

There were no statistically significant differences between the two sites in the reporting of preparedness for assessing medical emergencies or non-technical skills. Students across both sites felt prepared assessing a medical emergency/deteriorating patient (96% MMS, 92% LMS p = 0.389) and working in a multidisciplinary team (97% MMS, 100% LMS p = 0.229). There were varying levels of preparedness for the other competencies. Compared with LMS, there appeared to be more MMS students neither agreeing or disagreeing that they felt prepared for these competencies.

Following the transition from student to FY1 (when looking at the follow-up data), there were no statistically significant differences in views on preparedness for assessing medical emergencies or non-technical skills (Table 4-10). The trend on follow-up was towards FY1 doctors feeling less prepared than they thought they were as students. This was particularly true for assessing and recognising medical emergencies (89.3% agreed as FY1, 93.8% as students p = 0.404) and working in a multidisciplinary team (92.9% agreed as FY1, 98.2% as students p = 0.125). These two competencies remained the areas the FY1s felt they had been most prepared for.

Although these differences are not statistically significant, they may indicate a trend towards overconfidence among students and this could have clinical implications upon transition to professional practice. Equally, the competencies where FY1s felt they were more prepared than they thought they would be when students may have been the result of underconfidence as a student (which may have consequences) or may reflect the FY1s experiences as qualified doctors.

In contrast, significant differences between opinions of students and stakeholders were found in three of the five non-technical skills competencies, and for assessing a medical emergency (Table 4-11). The differences suggest that students feel significantly more prepared than stakeholders judge them to be as a cohort. The possible reasons for these differences are detailed in the discussion.

Students felt more prepared than stakeholders judged them to be for assessing medical emergencies (94% students agreed, 67% stakeholders agreed, p = <0.001), leading a team (66% students agreed, 21% stakeholders agreed, p = <0.001) managing time and prioritisation (80% students agreed, 58%

stakeholders agreed $p = 0.003$), and working independently (74% students agreed, 42% stakeholders agreed $p = <0.001$).

These results suggest that there is a large difference in how prepared students feel compared to how stakeholders think of the cohort as a whole. This trend was also seen in results for core procedures, discussed in 4.1.

Table 4-9 Comparison table for assessing medical emergencies and non-technical skills, demonstrating total numbers, numbers from MMS and LMS and p values for the Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				MMS % (n)				LMS % (n)				P value
	N=	Agree	Neutral	Disagree	N =	Agree	Neutral	Disagree	N =	Agree	Neutral	Disagree	
Adapt to changing circumstances and uncertainty	111	67.6(75)	28.8 (32)	3.6 (4)	64	59.4(38)	35.9(23)	4.7 (3)	47	78.7(37)	19.1 (9)	2.1 (1)	0.098
Assess and recognise a medical emergency/ deteriorating patient	113	93.8(106)	6.2 (7)	0 (0)	66	95.5(63)	4.5 (3)	0.0 (0)	47	91.5(43)	8.5 (4)	0.0 (0)	0.389
Lead a team	113	66.3(75)	27.4 (31)	6.2 (7)	66	63.6(42)	30.3(20)	6. (4)	47	70.2(33)	23.4(11)	6.4 (3)	0.719
Manage time appropriately and prioritise tasks	113	79.6(90)	18.6 (21)	1.8 (2)	66	75.8(50)	21.2(14)	3.0 (2)	47	85.1(40)	14.9 (7)	0.0 (0)	0.314
Work in a multidisciplinary team	113	98.2(111)	1.8 (2)	0 (0)	66	97.0(64)	3.0 (2)	0.0 (0)	47	100(47)	0.0 (0)	0.0 (0)	0.229
Work independently and autonomously, taking responsibility for decisions	113	74.3 (84)	23.0 (26)	2.7 (3)	66	68.2(45)	27.3(18)	4.5 (3)	47	83.0 (39)	17.0 (8)	0.0 (0)	0.123

Table 4-10 Comparison table for assessing medical emergencies and non-technical skills, demonstrating total numbers, and numbers from the FY1 follow-up (doctor phase) and p values for the Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				FY1 % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Adapt to changing circumstances and uncertainty	111	67.6 (75)	28.8 (32)	3.6 (4)	28	64.3 (18)	21.4 (6)	14.3 (4)	0.086
Assess and recognise a medical emergency/ deteriorating patient.	113	93.8 (106)	6.2 (7)	0 (0)	28	89.3 (25)	10.7 (3)	0 (0)	0.404
Lead a team	113	66.3 (75)	27.4 (31)	6.2 (7)	28	71.4 (20)	25 (7)	3.6 (1)	0.816
Manage time appropriately and prioritise tasks	113	79.6 (90)	18.6 (21)	1.8 (2)	28	82.1 (23)	10.7 (3)	7.1 (2)	0.210
Work in a multidisciplinary team	113	98.2 (111)	1.8 (2)	0 (0)	28	92.9 (26)	7.1 (2)	0 (0)	0.125
Work independently and autonomously, taking responsibility for decisions	113	74.3 (84)	23.0 (26)	2.7 (3)	28	67.9 (19)	28.6 (8)	3.6 (1)	0.785

Table 4-11 Comparison table for assessing medical emergencies and non-technical skills, demonstrating total numbers, numbers from stakeholder data and p values for the Chi-squared statistical test

At this moment in time, I feel my training has prepared me to;	Total % (n)				Stakeholder % (n)				P value
	N=	Agree	Neutral	Disagree	N=	Agree	Neutral	Disagree	
Adapt to changing circumstances and uncertainty	111	67.6 (75)	28.8 (32)	3.6 (4)	24	64.3 (18)	21.4 (6)	14.3 (4)	0.490
Assess and recognise a medical emergency/ deteriorating patient*	113	93.8 (106)	6.2 (7)	0 (0)	24	89.3 (25)	10.7 (3)	0 (0)	<0.001
Lead a team*	113	66.3 (75)	27.4 (31)	6.2 (7)	24	71.4 (20)	25 (7)	3.6 (1)	<0.001
Manage time appropriately and prioritise tasks*	113	79.6 (90)	18.6 (21)	1.8 (2)	24	82.1 (23)	10.7 (3)	7.1 (2)	0.003
Work in a multidisciplinary team	113	98.2 (111)	1.8 (2)	0 (0)	24	92.9 (26)	7.1 (2)	0 (0)	0.466
Work independently and autonomously, taking responsibility for decisions*	113	74.3 (84)	23.0 (26)	2.7 (3)	24	67.9 (19)	28.6 (8)	3.6 (1)	<0.001

4.3 Overall preparedness, conceptualisation of preparedness

Despite mostly feeling confident and prepared for most outcomes detailed in OG2015 (3), when asked about the transition to being an FY1 doctor, students felt stressed and anxious. This is a theme throughout the entire quantitative and qualitative data set. Overall, 73% of students agreed that they felt prepared for their foundation jobs. Despite this level of preparedness, 71% felt stressed about becoming a doctor, and 77% felt anxious about the transition to professional practice.

There were no significant differences between MMS and LMS for stress and anxiety related to the transition, however, the results for how prepared students felt overall ("I feel adequately prepared for my first job as a doctor") were not so clear. Although a higher percentage of MMS than LMS students agreed with this statement (MMS 74% LMS 70%), more MMS students also disagreed with the statement (MMS 9.1% disagreed, LMS 0% disagreed), and the difference in response between medical schools to this question was statistically significant (p= 0.039).

To identify where the difference in preparedness lay, logistic regression was performed. The results of the logistic regression gave an OR of 1.2 (confidence intervals 0.57, 2.56) for MMS students compared to LMS students for feeling prepared (relative to those who were neutral or disagreed). This difference was not statistically significant, and, therefore, suggests that there was no evidence for a difference between MMS and LMS for overall preparedness.

The results also showed that after three to four months of experience of work as a doctor, participants still felt stressed (78% strongly or somewhat agreed). However, 19% were neutral and 4% (one participant) strongly disagreed with this statement.

Overall, 70.4% of participants felt that looking back following the transition from student to doctor, they had been adequately prepared for their first jobs, with 7.4% disagreeing with this statement. When compared with student phase data, no significant differences were found.

Participants were asked about their stress levels across the transition (before FY1, when they started FY1 and at the time of the doctor phase questionnaire; 3-4 months into FY1), participants felt most stressed upon commencement of their foundation posts, when on average they felt 75% stressed (100% being most stressed, 0% being least stressed). They felt least stressed after 3-4 months experience of the job (Table 4-12).

Table 4-12 – Descriptive statistics for how stressed participants felt before, upon commencement and currently in their foundation posts.

How stressed did/do you feel… (0%-100%)		Quartiles		
	n	25^{th} centile %	Median %	75^{th} centile %
Before you started your foundation post	27	49	60	70
When you commenced your Foundation post	27	60	75	85
Now	27	30	40	60

This data was further analysed with linear regression, to characterise the association between stress levels before FY1, upon commencement of FY1 and at the time of the doctor phase questionnaire. The linear regression (Figure 4-1) suggests that there was a significant positive association with how stressed participants were both before and at the start of FY1 (regression coefficient 0.485, p= 0.007). For how stressed participants were at the start of FY1 and now, the regression coefficient was 0.61, p= 0.007. This suggests that students that were more stressed before commencing FY1 were more likely to be stressed at commencement and now.

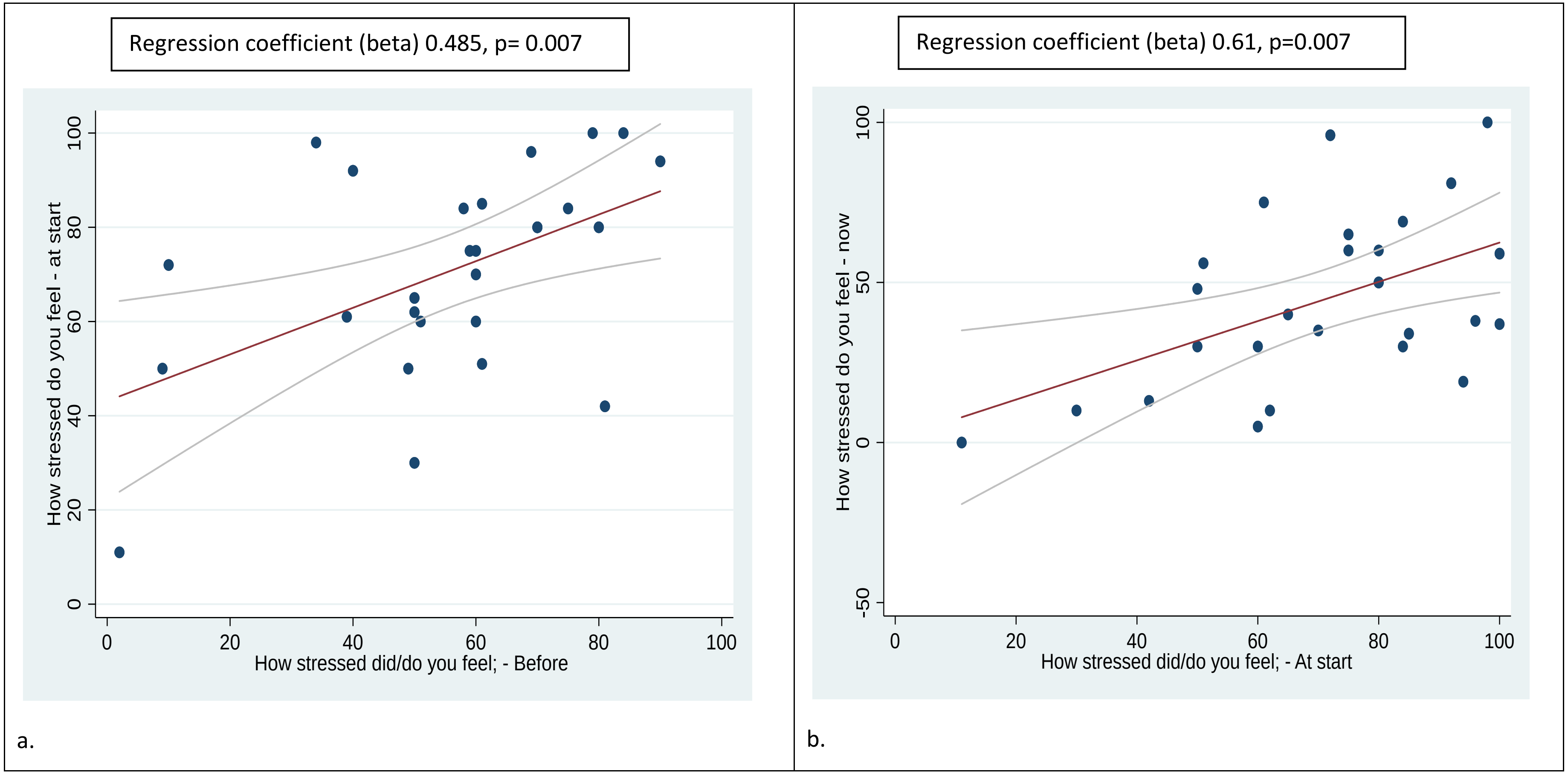


Figure 4-1 – Scatter plots showing correlation between stress levels prior to commencing FY1, upon commencing FY1 and now. a. Correlation between stress levels before and upon commencement of FY1, b. Correlation between stress levels upon commencement of FY1 and now. Best fit line with 95% confidence intervals is shown, p= <0.05 considered statistically significant.

Overall, there was no statistically significant difference between students' perceptions of preparedness across the transition from student to working doctor. Furthermore, despite the difference found in the stakeholder data on individual competencies, there were no significant differences between student and stakeholders' opinions on overall preparedness (75% stakeholders agreed students were prepared, 73% students agreed).

4.3.1 *Conceptualisation of preparedness*

Throughout the data the ideas of how prepared (or not prepared) students were and what they were concerned about facing seemed to be interchangeable. This is despite clarifying what participants meant by preparedness. Students and stakeholders alike talked about confidence, competence or knowledge base, knowing what to expect and what is expected of you (Figure 4-2).

Student	Stakeholder
It's having the knowledge base like the foundation of knowledge you need to do your job, do it safely and then a lot of it is confidence that you're able to handle a situation and you know what to do and you feel like you're capable of it. S12, interview	It's that they understand what is expected of them and then when they step onto the wards as a house officer, they know how to do the tasks that are required of them and they know where they are in terms of their knowledge and professional skills. SH2, interview
It's the ability to carry out the job of a house officer with the degree of competency and knowing the limits of that competency and knowing when to escalate, knowing how to operate within your own limits. S6, interview	It means that within reason, when they actually start as an FY1, they know what is expected of them and they are prepared for the majority of things they have to do. SH4, interview
It's being able to go in and feel confident that I can do the job that's expected of me and have a bit of an idea about what's expected of me. S7, interview	Having the necessary background skills and knowledge and more importantly the attitude, and for the medical student so that they are ready to get involved in clinical practice under supervision. SH6, interview
It's more just being able to do the day-to-day things of an FY1 and know that you're able to be safe and look after people in the first instance. S9, interview	Its two aspects, […] the overt one is the physical ability to do the job, so can you perform the tasks required of an FY1 doctor. The second thing is psychological preparation. SH8, interview

Figure 4-2 – Quotes on the conceptualisation of preparedness, student and stakeholder participants[4].

Both competence and confidence were therefore fundamental to participants understanding of preparedness in this study. Participants expected students to be competent at the skills

[4] S1= Student 1 interview, SH1= Stakeholder 1 interview, SFTQ = Student free-text questionnaire response, STFTQ = Stakeholder free-text questionnaire response, FYD1= Foundation doctor 1 interview

required to be an FY1, but also confident to undertake these skills and confident in knowing when to escalate.

4.3.2 *Preparedness for the transition*

Despite the quantitative data surrounding the transition being generally positive (with the exception of the stakeholder data), students still expressed concerns about becoming an FY1.

Being confident was important and linked with the benefits seen with experiential learning and simulation (discussed in 5.2). Students expressed throughout the data that they felt more confident following the simulation for both individual tasks and procedures and also in general about the transition to professional practice.

> *There needs to be a transition period of going from putting your hand up and saying I'm a student I have no responsibility, to I'm the only person here that does have responsibility now what do I do? I think it's safer to make that transition via simulation… […] I'd say I got more out of that day [simulation] that I would have just being on the ward. S5, interview*

The increase in responsibility from medical student, with no responsibility for patient care, to foundation doctor who oversees decisions that could affect patients' health is considerable. Students felt worried about this substantial increase in responsibility which resulted in underconfidence and worry.

> *Having to make decisions that will affect people's health. SFTQ*

Foundation posts may be the first time the graduates have worked for a number of years. It is also likely to be the first time they have faced the intensity of hospital shift working while having responsibility for patients' health. Stakeholders felt that students were unprepared for the realities of working life, particularly shift working, which is very hard to emulate or prepare for in medical school.

> *Because it's not just the actual nature of the job, it's the working for the first time, they've not worked for 5-6 years and they're not used to shift patterns, they're not used to missing their lunches […] I think you're never going to be able to prepare them for their first job, because it's their first job! SH10, interview*

Concerns over working long hours, managing shift working and having a poor work-life balance were echoed in the free-text comments.

> *Long hours, not enough time for enjoyment. SFTQ*

Taking on responsibility. Dealing with stressors of working life. SFTQ

The finite nature of preparedness was recognised; students often commented that they were 'as prepared as I can be', identifying both that some things cannot be fully prepared for and that there is a limit to what medical schools can offer to aide preparedness as an undergraduate (for example, independent decision-making, out of hours working).

You can only feel so prepared till you go and do it and see how you handle it, so I think I'm about as prepared as I can be! S12, interview

You're never going to be completely prepared, you just have to start and learn some of it on the job, I think, as prepared as I think I will be. S11, interview

The transition to professional practice from undergraduate to postgraduate may be the biggest step up of the student's lives so far. Both stakeholders and students referred to this and this reinforced the concept of being 'as prepared as they can be'.

They are as prepared as medical students can be prepared, in terms of it's a major jump! Nothing can prepare them for that jump apart from doing it. SH11, interview

Ultimately there may be a ceiling of preparedness and, therefore, only so much the medical school can implement to make students feel prepared. The complex nature of medicine means that it is likely no matter how prepared an FY1 is, they will come across something that they don't know. This was mentioned by students across the interview and free-text data.

No, not really. There's decent preparation provided but the concerns are normal fears of the unknown. SFTQ

All the things that go alongside like the human factors practical skills. You can get them nailed and then by the time you get to this point a week before we finish. I certainly feel like there's nothing else I could do that would prepare me anymore. You're never going to be completely prepared. S11, interview

Medicine involves lifelong learning, and in addition to being 'as prepared as they can be', learning on the job is vital. Participants recognised the importance of learning on the job throughout the student and doctor phase. Furthermore, participants felt some things could only be learned or developed once they had started working, in particular, their diagnostic and decision-making skills. This was emphasised by FY1s following the transition (4.3.5).

Making decisions is the bit I'm nervous about. I probably will be for a while until I've made decisions and they've been okay, so I've had a bit of practice. S12, interview

The importance of support for newly graduated doctors is well known. Students and stakeholders emphasised the importance of support particularly in the first few months of professional practice, and for the less confident graduates.

Support is so important, not only within the foundation team but also the actual placements, particularly the first placement or going into the second placement. SH11, interview.

Support was felt to be essential to reduce the stress associated with the transition. Participants emphasised this throughout the data, both acknowledging that new FY1s would be stressed but also that the transition is a very mentally demanding period.

Help and support on a daily basis is essential to give them that support and stop them getting too stressed because it is a very stressful time. So, I think the support is essential. SH5, interview

Transitions happen throughout medicine not only from undergraduate to qualified doctor but also from FY1 to FY2, from SHO to Registrar and Registrar to Consultant and there are many similarities between these transitions. Students and stakeholders expressed throughout the data that these transitions no matter how prepared you are, or you feel, will always be challenging and scary.

There's like a door you go through between being an undergraduate and starting FY1 and one day you're on one side of the door, and the next day you're on the other side of the door. There's no magical learning that takes place by passing through that door[…] Suddenly people are looking at you to fulfil a different role and I'm not sure what preparedness you can have about how it's going to be on that side of the door, rather than on one side of it. SH3, interview

Although students should feel prepared, i.e. confident and competent, there were strong feelings from all participants that any transition of change in life is likely to attract a healthy amount of apprehension. This trepidation was felt to be a natural but important response to a major life change, and most felt they had been prepared well.

People have said before no one should go on their first day as a doctor and think yeah, I can do everything. Everyone should be a bit scared! S7, interview

I think it's normal to have these feelings, which doesn't represent any fault from uni. SFTQ

The data presented so far in this section has highlighted the issues surrounding preparedness and the possibility that students can never *fully* be prepared for working life as a doctor for a variety of reasons, with some areas more complex to prepare for than others. Also, given the nature of medicine, an element of concern and worry is to be expected; hence, students are ‘prepared, but still scared’. On top of this, this data has raised questions about how preparedness is measured. The quantitative data (4.1) suggests that stakeholders feel students are less prepared than the students think they are themselves. However, when asked if 100% preparedness can be achieved (on the GMC survey), many stakeholders said that this was unfeasible.

You’re never going to get 100% prepared, and I think all we can do is put in place everything we can think of and change procedures to try and work out what it is that works well and what doesn’t work, and how can we get even more of them feeling confident about being an FY1. SH4, interview

This supports the idea that students are ‘as prepared as they can be’, but most stakeholders also felt that despite 100% being unachievable, educators should strive for a higher percentage.

From GMC perspective I think I can see the limitation and I would agree 70-75%, but it doesn’t mean that this generation of medical schools shouldn’t look and see if we can improve on this. SH6, interview

A lack of competence or confidence leading to poor preparedness may impact patient care. Educators must, therefore, continuously strive to improve medical students’ preparedness.

4.3.2.1 Preparedness for the transition; Assessing medical emergencies and non-technical skills

Students overall preparedness and reflections on preparedness have been presented in the previous chapter. This section covers participants’ specific concerns about assessing medical emergencies and non-technical skills.

Being in situations that students felt were beyond their capabilities worried students. This was particularly evident when thinking about having to deal with sick patients due to needing to make rapid decisions about a patient’s care, and concerns about making the wrong decision and causing patient harm.

Feeling out of depth re. making independent decisions about unwell patients. SFTQ

The possibility of harming patients or making mistakes troubled student participants. Throughout the free-text data, students expressed feeling worried about taking responsibility, with actions having consequences and their decisions having adverse effects on a patient’s condition.

Making a mistake that will lead to a patient becoming unwell (during nights/on calls). SFTQ

Scared of missing diagnosis/making error. SFTQ

Not knowing what to do in an emergency or when asked by a nursing colleague was also a major concern. This was interlinked with a perceived lack of readily available support, particularly when on call out of hours.

Not knowing what to do when nurses ask you. SFTQ

Not knowing what to do for an unwell patient. SFTQ

Following on from fear of making mistakes and that impacting patients health, some students were concerned about making such a big mistake that they would be struck off.

Getting struck off. SFTQ

Being Bawa Garba[5]*. SFTQ*

Independently facing acutely unwell patients was another source of worry for students. Despite feeling prepared for assessing a medical emergency according to the quantitative data (4.2), students expressed concerns about facing this as a doctor across the free-text and interview data. The thought of facing medical emergencies, alone, on call, in addition to having to prioritise their workload made participants feel overwhelmed and unprepared.

Being first to the scene to assess a patient even though I feel like I know have the skills for it, I'm still nervous about it. S8, interview

Being on call/on a shift and having to prioritise patients and make decisions - feels like a lot of responsibility. SFTQ

Lack of support and lack of seniors available, time and staffing pressures were also sources of concern; all of which would be more likely and more difficult when on call and dealing with acutely ill patients.

Because medical emergencies do not happen to suit student timetables, students can find it hard to gain experience of dealing with them. Students reported finding it difficult to get enough exposure to emergency circumstances (see 5.2 and 5.3), and students and stakeholders felt that this impacted detrimentally on how prepared graduates felt. Even if students are fully prepared and feel confident and feel competent, the uncertain nature of medicine could change that in the first few weeks.

[5] Dr Bawa-Garba, a paediatric trainee who was recently (at the time of the study) charged with gross negligent manslaughter and struck off the medical register by the GMC (307)

Part of it is the random nature of medicine, the things you see that upset you or make you feel unprepared […] don't come along once every month or once every 3 months. They are thrown in randomly; it's possible to have something that shakes the foundations of your beliefs to your core on your first day, but it equally possible just by luck to sail through […]. The heterogeneity of the foundation years is probably going to make people feel unprepared no matter what we do. SH3, interview

It might never be possible to prepare adequately for many aspects of the day-to-day role of a junior doctor. Consequently, some participants expressed a need for simulated experiences to fill this gap. Areas of concern have been discussed earlier in this chapter: having responsibility, making mistakes and dealing with acute situations. Additionally, both student and stakeholders felt that students could never be fully prepared for these areas, particularly that of dealing with acute situations.

Assessing sick patients, again they need a little bit of help and little bit of guidance, we find the FY1s when they first start do need a little bit of help and I think that's just a function of not having much exposure really. SH5, interview

In an emergency, or the middle of the night, even more basic tasks such as administrative tasks and handover may feel difficult. Participants described feeling unprepared for facing even simple tasks that they would usually feel prepared for at night or in an emergency.

Being asked to do stuff in the middle of the night and having to make those decisions and stuff like prescribing, having to quickly prescribe stuff I don't feel that confident with that kind of stuff. S4, interview

Once FY1 doctors, participants reflected on stressors in their day-to-day jobs. Much of the concerns of FY1 doctors reflected issues they had described being concerned about prior to the transition.

The independent nature of the job was a particular concern when it came to management of sick patients. FY1 doctors described regularly being in situations that they felt were beyond their capabilities, especially when the workload was intense, and there were sick patients to manage at the same time, which was commonplace.

The on calls are the time when you feel a bit more out of your depth, but more just that you're trying to figure problems out on your own a bit […]. I had quite a busy on call a couple of weeks ago […], and the bleep just was not stopping it was going off every two minutes with all these smaller things, people needing warfarin doses and stuff. FYD 3, interview

Although the concerns about having the responsibility of independent management of sick patients were widespread, some FY1s also worried about what they described as 'lower level' problems. Participants described worries about patients with more subtle signs and symptoms as well as worries about sicker patients.

If you see someone with niggling symptoms that you think oh this could transform into something, then that can be very stressful. That's the main thing you come home and not worry about but are more concerned about. FYD 4, interview

Although the intense workload caused stress for some, participants also suggested that having this workload was a valuable learning experience. Over time, because they had so much experience of different problems, they were more confident dealing with on-call working. Furthermore, due to the work intensity participants felt this enhanced their time management and prioritisation skills.

Because the day job has been so busy and I've been exposed to so much during the day I think my on calls haven't... I felt more comfortable dealing with on call. FYD5, interview

I've got used to a lot of jobs, being asked to do a lot of jobs and I can do them much quicker now. FYD1, interview

How hospital placements were ordered, from lower intensity to higher intensity later in the year was found to be beneficial. One participant who had started on a lower intensity job, with less sick patients felt this arrangement had been helpful to ease the transition to professional practice. By the time he started on a more intense speciality, he had more confidence in dealing specifically with sick patients.

I've got more experience now, I think they way that my rotations have gone has been quite good, psychiatry has a little bit of medicine, but obviously everyone is physically well […]. Then surgery, people are getting a bit more sick, and then finally at the end of the year I've got gastro, so it wasn't like I was thrown in at the deep end, in terms of sick patients FYD1, interview

This also reflects the importance of learning on the job, with support.

Staying late at work and not having adequate breaks may indicate poor time management and prioritisation skills. This can lead to a poor work-life balance, result in burnout, and impact patient safety. Participants were questioned regarding staying late at work to assess this, with the acknowledgement that other issues may have an impact, including understaffing and the new junior doctor contract (contractually obliging employers to offer remuneration for any extra hours worked).

Most participants reported staying over 30 minutes late on more than one occasion, with some staying late much more than that, but that this had improved over the first few months following the transition.

When we first started I would say I was staying 30-60minutes late most days, now I sometimes leave on time but sometimes maybe half an hour late, so it has improved, and that's just getting a bit better at the job really, so now I'd say I stay half an hour late 3 days a week. FYD3, interview

This participant acknowledged the impact of time and experience; over time, she was staying late less demonstrating better time management, more familiarity with procedures and processes. The intensity of the workload added to the difficulties experienced, and participants felt this had been difficult to appreciate and experience as an undergraduate.

I'd say workload was quite difficult to manage initially and being able to leave on time and not knowing, prioritisation of task, what can wait till tomorrow what needs to be done today, so, it's not difficult, but it's something you've not really learnt before, so that was something that needed getting used to. FYD5, interview

Although initially finding prioritisation difficult, most participants felt comfortable with this after the initial few weeks.

We didn't get much training on prioritisation, but I think it became pretty obvious. I think I was worried, but I think I was more prepared than I thought I was. FYD2, interview

In summary, despite appearing to be prepared for assessing medical emergencies and some non-technical skills (as demonstrated by the quantitative data in 4.2), students still described feeling concerned about facing such scenarios, particularly when on call and at night. These concerns about assessing medical emergencies were also reflected in FY1 accounts of their experiences of work. It was felt to be more of a concern due to difficulties in experiencing appropriate cases as a student. FY1 doctors described staying late at work often, particularly immediately after the transition, which may suggest poor prioritisation and time management skills. It may be, as described in the previous chapter, that new FY1 doctors can never be fully prepared for assessing medical emergencies and non-technical skills, further highlighting the importance of on the job learning and support.

4.3.3 Student concerns about professional practice

Students had concerns about a range of issues, which have been discussed in 4.3.2. They were also asked 'what is the one issue that MOST concerns you about starting work as a doctor?', and then asked to classify their free-text comments as minor, moderate or major. The original free-text comments themselves were analysed with the qualitative data and described in 4.3.2; their classification into minor, moderate and major concerns will be discussed here.

From the free-text responses and interview data it was apparent that although students felt prepared overall and felt prepared for many specific competencies and procedures (section 4.1, 4.2, 4.3) they still felt concerned about making the transition. These concerns were particularly apparent for areas such as dealing with acutely ill patients, where although 93% of students reported feeling prepared in the questionnaire, participants frequently mentioned dealing with acutely ill patients as a concern in the free text. The idea of being prepared but still feeling concerned is discussed further with the qualitative results (4.3.3, 4.3.4, 4.3.5) and is vital to understand if we are to better prepare our medical graduates for professional practice.

A thematic framework drawn from the data was used to group the responses into themes (*Table 4-13*), meaning that some answers fell into multiple themes.

Table 4-13 – Free-text themes and explanations; themes described with example comments in Figure 4-3, Figure 4-4, and Figure 4-5*.*

Theme	**Description**
Responsibility, actions having consequences	Reference to an increase in or worry regarding responsibility, for example, making decisions, and/or their actions (decision-making) having negative consequences on patients
Making mistakes/Harming a patient/Not knowing what to do	Making mistakes including drug and diagnostic errors and harming a patient
NTS	Any reference to non-technical skills; prioritisation, time management, situational awareness, team-working
On call/ assessing a medical emergency /independence	Concerns regarding working on call, often hand in hand with dealing with sick patients independently
Long hours/organising on calls/swaps/workload	Concerns over long hours/shift working, working life
Clinical/practical skills/other	Concerns over practical skills such as venepuncture, cannulation and anything else that does not fit into another category e.g. financial independence
Lack of support/being alone	Concerns regarding a lack of support from senior staff
New environment	Reference to concerns regarding new hospital environment, new team, geography, etc.

Overall, 33% of participants felt their concerns were minor, 57% moderate and 10% of participants had a major concern.

For concerns identified as minor, responses were evenly spread throughout the eight themes detailed already in this chapter (Table 4-13). The spread of comments in this minor category echoed the overall data, with more comments found in the 'responsibility', 'making a mistake' and 'on call, dealing with acute patients' themes (Figure 4-3). Students felt concerned about making a mistake and that leading to patient harm, working independently with increased responsibility and assessing a medical emergency. They also worried about when to escalate to a senior and feeling out of their depth managing patients alone.

The most common moderate concern was making mistakes or harming a patient (Figure 4-4). Just over a quarter of all the concerns reported as moderate were concerns regarding on-call working and assessing a medical emergency. Students felt apprehensive about being the first person to a cardiac arrest call and making independent decisions, particularly when on call. This linked into concerns about making mistakes involving medical emergencies.

Finally, when looking at the major concerns that participants had, the majority were regarding making mistakes and accidentally harming patients (Figure 4-5). It is clear from these free-text comments that efforts to improve preparedness may need to be directed towards preventing clinical errors and giving medical students more responsibility in direct patient care (and therefore increases responsibility).

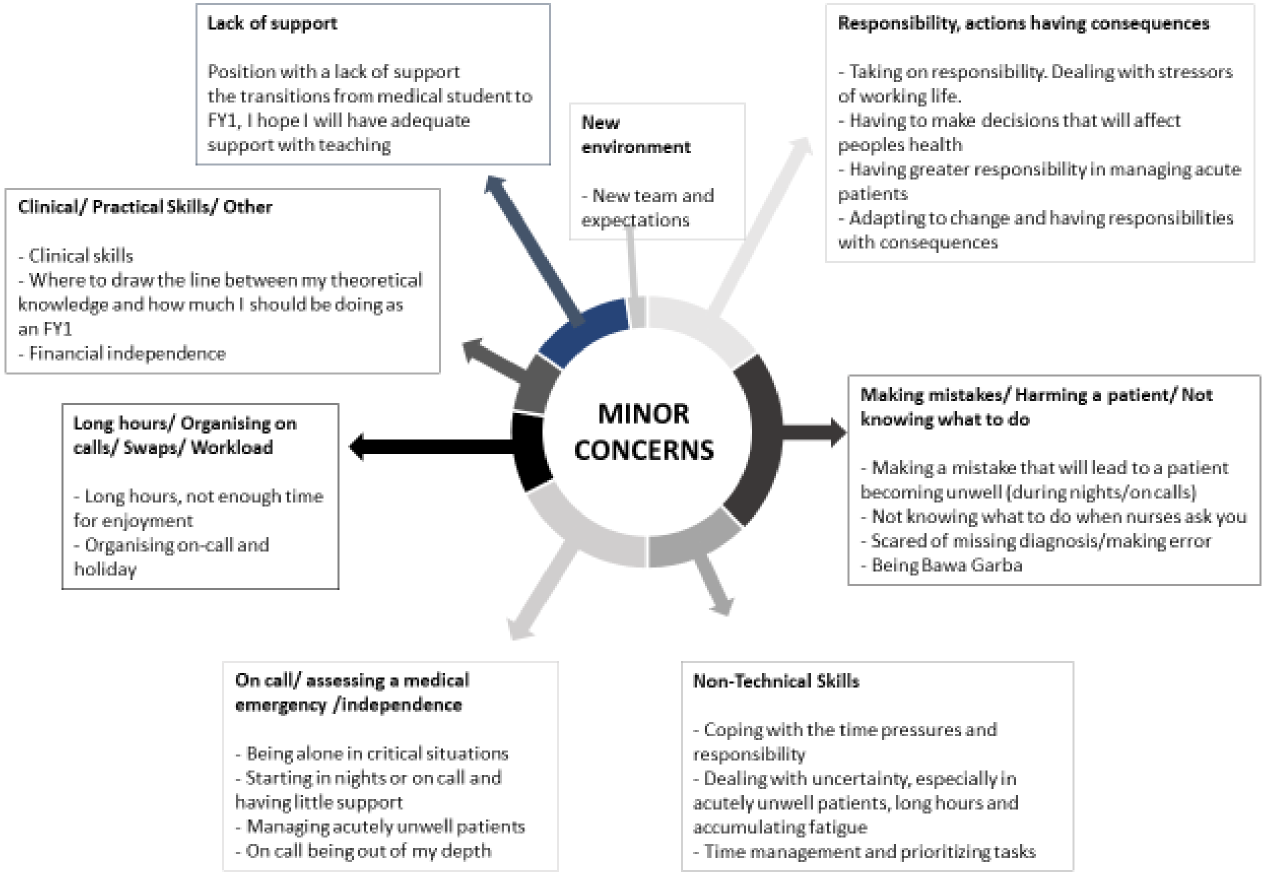


Figure 4-3 – Participants who answered that their concerns were mild with the associated example quotes, split into themes as per Table 4-13.

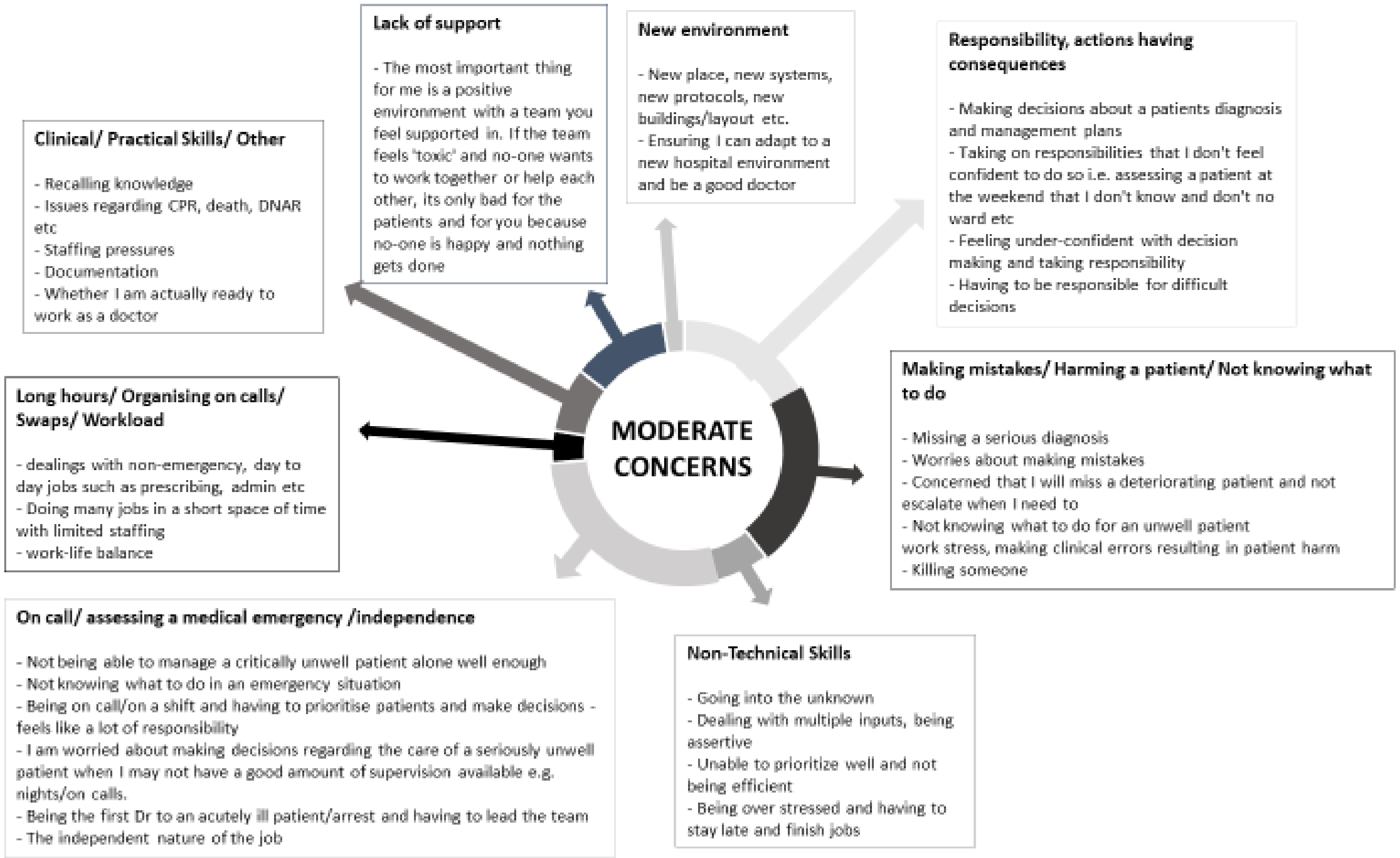


Figure 4-4 – Participants who answered that their concerns were moderate with the associated example quotes, split into themes as per Table 4-13.

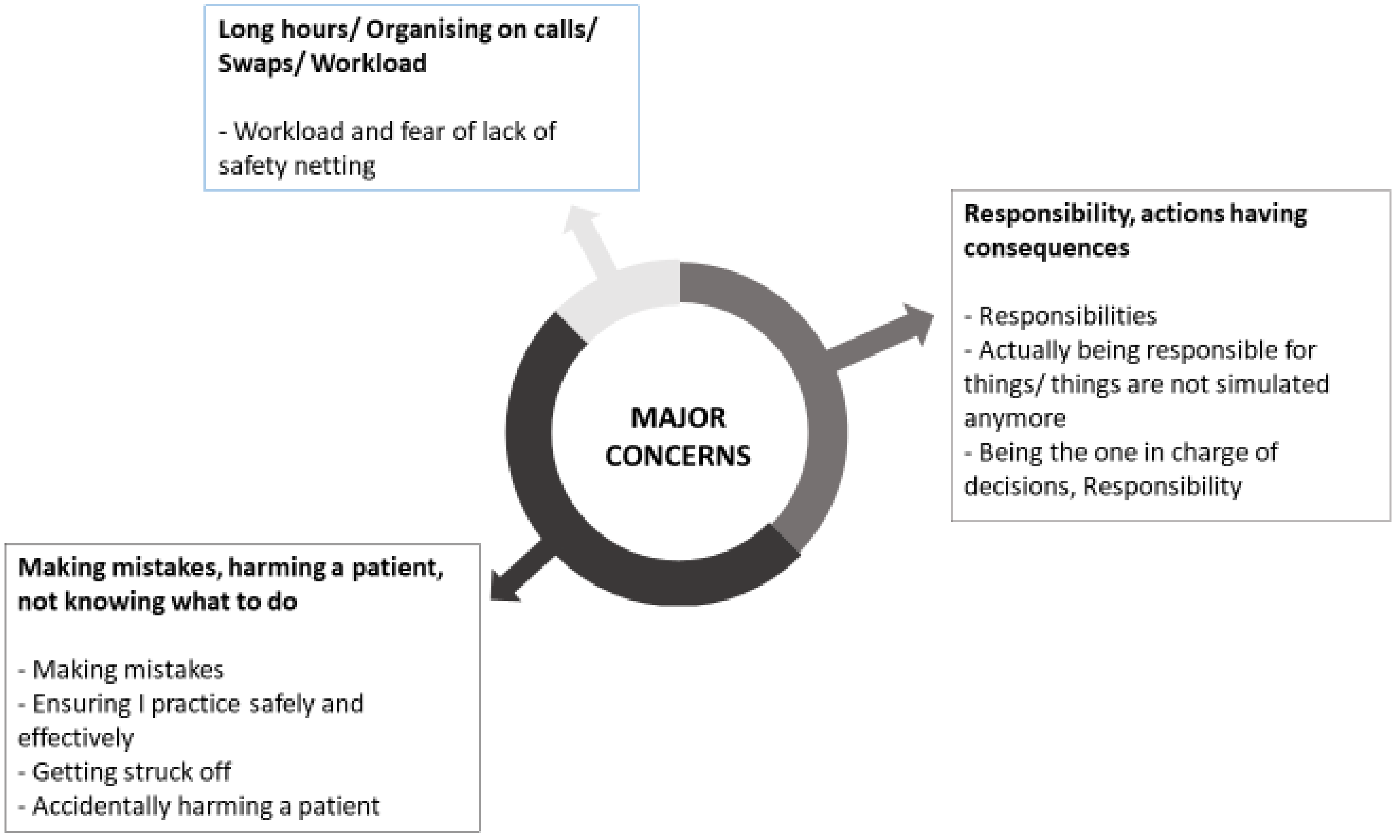


Figure 4-5 – Participants who answered that their concerns were major with the associated example quotes, split into themes as per *Table 4-13*

4.3.4 Stresses and concerns for FY1 doctors

Much of the FY1 data fell into the same themes as the student and stakeholder data, and concerns expressed by students became real-life stressors when they became FY1 doctors.

Participants described many different stresses they faced in their day-to-day jobs, but most commonly stress related to being on call and having to deal with the increased responsibility. Participants felt stressed both during their shift and when they got home.

> *There's certainly days that you come back and think I'm so stressed just because of the volume of workload, or after on calls now, particularly after weekends or nights because there's more patients to see, and less senior staff around you do feel like your managing stuff to a much greater degree of independence than you would have been previously. FYD 4, interview*

On calls were the main area where participants felt they had most independence, which was a significant cause of stress and anxiety. Despite having graduated, participants did not feel ready for the responsibility of management decisions.

> *Managing patients on my own initially, more on calls than anywhere else, making actual management decisions and feeling like I should be running them past somebody else. You know that I wasn't qualified to be making these decisions on my own! FYD 3, interview*

Dealing with subtler presentations and knowing how and when to discount more serious diagnoses were also sources of stress. Participants felt that they had not been well-prepared for this, and again, it was more of a problem when on call where support may not be readily available.

> *I don't think you're that well trained for the lower level problems, so generic chest pain, they probably aren't having a heart attack, so just going to review the patient and when I first started I wasn't sure what exactly I should be doing... I examine them top to toe and I know you need to do an ECG but if there's nothing on the ECG then what do I do? It's the confidence to go, its musculoskeletal chest pain rather than investigating to the nth degree. FYD2, interview*

Although not mentioned to be specifically stressful, all participants spoke about making prescription errors, and of the benefit of support in this area such as ward pharmacists, e-prescribing systems.

> *I've had some prescription errors, but they weren't a near miss or anything like that, it's just been a pharmacist saving me! We have electronic prescribing and a ward pharmacist. FYD6, interview*

A perceived lack of support, whether on-call or in their day-to-day roles on the wards, was another source of anxiety. The importance of appropriate support immediately following the transition was a major theme that emerged from the student and stakeholder data and was further developed in the doctor data. Lack of support was a key concern mentioned by participants in the student phase free-text comments; however, it appears on the whole participants were well supported during the transition.

Support from those immediately senior was variable and depended on a number of factors, including how busy the more senior doctors were perceived to be and on their personality. Despite this, participants felt generally reassured by having their support available by phone or in person.

> *Only one doctor has been sort of snappy, and then this person is known to be snappy so I think it's not me personally […]. Yeah, particularly on call I've felt more supported than I do in the day job. FYD4, interview*

> *The seniors have all been really supportive, I've been surprised how easy it is if you are concerned about something to get in contact with them. FYD1, interview*

The medical registrar position was quickly recognised to be a busy and stressful job; this affected participants accessing their advice when on call. Participants were sometimes reluctant to ask for help due to this reason.

> *With the medical registrar, you feel bad phoning them to ask questions because you know how busy they are, I think I've definitely delayed asking them questions at times, […] So I will ask for help if I'm not sure, because it's safer to do that, but sometimes you feel a bit unsure about it. FYD3, interview*

Despite concerns, most participants had supportive interactions with the medical registrar and other members of the on-call team. Support from seniors helped participants feel more confident on call.

> *The med registrar in handover was like – run every decision by someone, make sure you ask […] I mean every single person I've worked with on call has been happy to answer questions, and that hasn't really waned as it's gone on. FYD4, interview*

When working on the ward day to day, overall the support was good. Participants described having a 'good team' around them, and this was associated with enjoying the job more, particularly for the busier wards.

> *I had a really good team around me which have all been very supportive from core trainees right through to Registrars and consultants, but because it's been so busy it has been quite stressful at times but enjoyable because everybody shares that burden. FYD5, interview*

There were some instances where the support on the ward was not good, but in this case, it seemed to be down to one individual and not reflect an overall problem.

> *The SHO on the ward with me asked the registrar for help and she wasn't very helpful, and she left the ward, and we had to call the consultant, who was off-site that day… and then we had to phone her again later, to ask her to come and help us manage this patient because she wasn't improving and she refused to come back up to the ward and so there was a patient safety incident form about that. FYD3, interview*

The importance of peer support was clear. Participants described their FY1 colleagues as a further source of assistance, contributing to the 'good team' ethos.

> *I've enjoyed the challenge, it's been a lot busier, but it's got a nice team feel to it cos there's 14 or 15 of us [foundation doctors], and we all share an office, and we help each other out. FYD1, interview*

Despite this support, participants were sometimes expected to perform independent ward rounds, without seniors. Participants felt out of their depth and unsupported in this role and felt that this would affect patient care.

> *On my second day, I was asked to do a ward round, so I did which obviously I felt really out of my depth, to begin with. FYD6, interview*

On the other hand, this gave the FY1s the chance to make independent decisions. One participant, while having the same concerns about independent ward rounds, also relished this opportunity.

> *We're having to lead ward rounds on our own, […] I just expected every other ward has a consultant ward round in the morning where the FYD1 makes very few decisions, it's just doing some jobs in the afternoon, so it has been nice to have a bit of responsibility for making those decisions. FYD4, interview*

In contrast to this, participants working on wards or in specialities that had daily ward rounds felt that they did not need as much help (due to having support on the ward round).

> *The day job doesn't really require much senior support, obviously there's things like chase this scan, do these bloods, but because they do morning and afternoon rounds anyway. FYD6, interview*

Support did seem to vary between specialities. In some of the surgical specialities, participants noted there not to be as much provision for managing patient's medical problems, and this was left to them. This independence made participants feel underprepared and concerned.

The consultants are much more interested in the surgical side rather than the patient's wellness! I feel like you almost move from being the FY1 to sometimes being the FY1 and the Registrar. FYD2, interview

Participants on these wards described being asked to make important decisions about patient management considerably beyond their experience level.

There was a gentleman where he couldn't swallow very well because he had dementia […], people keep coming to you with these problems, and your consultant isn't really answering your questions. So, people are like; do we put an NG tube in this poor 90-year-old gentleman with dementia who has fallen over and appears to be at the end of his life or not, and it's left up to you. FYD2, interview

Sometimes a lack of support was seen in different ways. Participants reported sometimes feeling intimidated speaking to other specialities (referrals or advice), usually over the phone.

A lot of difficulties I've had really with the non-technical skills like communicating with people is when just colleagues are just being obstructive for no real reason, you're trying to order something or get something done, and someone's being what feels like purposefully awkward. FYD5, interview

It appears that although student participants were concerned about a perceived lack of support when they became FY1's, this was not the case; generally (with a few exceptions) FY1 participants felt well supported, in part due to becoming better at asking for help.

There was actually more support than what I thought there would be, there are always people to ask, and I think I've got better it. You kind of learn who to ask, which takes a while. FYD2, interview

This data illustrates that support for FY1s in their first few months is vital; where participants felt unsupported, either on the wards, on call or when faced with difficult colleagues this led to worry and feelings of stress. It also, in some instances, affected patient care. On the other hand, where FY1s felt well supported and had a 'good team' around them, this resulted in participants enjoying their work and feeling less stressed.

4.3.5 Reflections on preparedness and learning on the job

With the benefit of several months of experience as an FY1, participants felt looking back, following the transition, they had been prepared for the transition to professional practice. Their preparedness was reinforced by positive feedback from senior colleagues.

I was relatively well-prepared, and the verbal feedback that I've received from my consultants and SHOs was that I was relatively well-prepared, and I'm doing a decent job. FYD3, interview

Preparedness for later postgraduate training was less certain. Although they felt prepared for the immediate transition, participants were unsure how prepared they felt for further training. Additionally, the concept of preparedness for the participants seemed to be a short-term idea, rather than thinking about their careers as a whole.

> *I felt prepared to be an FY1. For further training, I don't know if the academic rigour of [university] is as good as other universities and I don't know if the... I feel like the [university] grads are good at communication skills and that sort of thing perhaps at the expense of clinical acumen, […] So yes, as an FY1 I felt well-prepared but not necessarily for later training. FYD4, interview*

Some participants felt that the fifth-year medical school curriculum was designed for short-term preparedness for foundation training, and this was feeling was reinforced by colleagues further on in training.

> *Quite well, I think the 5th year at [university], well it's kind of designed to prepare us for the foundation programme, isn't it? I've heard from colleagues who are now further on they feel like [university] prepared them well for foundation year but maybe not particularly well for later on. FYD1, interview*

Compared to when they were students, participants felt more able to judge if they were prepared or not in retrospect; participants felt that as students they did not have an understanding of what it might be like, therefore it was impossible to tell at that time whether they were fully prepared.

> *Quite well, actually. I think when you're at medical school you think it's terrible and it's not very well organised; I don't think you can tell before you start if you are or you're not you just have to find out, take a leap of faith. FYD2, interview*

The idea of being prepared but still scared continued, with many of the same themes reiterated from the student data. Participants acknowledged that it would be difficult to know everything before the transition, and indeed impossible to have faced every scenario they would face as an FY1. Furthermore, participants' uncertainty about the realities of being an FY1 and what they may face contributed to feelings of being 'prepared but still scared'.

> *There's an element of that you'll never feel fully prepared for something until you go and do it. You're always going to worry there's something you've missed, you just can't know until you go and do it whether you're ready or not, and I guess it's hard to judge how prepared you are until you've seen what the reality is. FYD3, interview*

Hand in hand with being prepared but still scared was the significance of being able to learn on the job. Participants described many ways in which they had become more confident over time due to their experiences on the wards.

Ultimately, participants felt they had been well-prepared, in particular for foundation training, but were less sure of their preparedness for further training. Participants acknowledged, in agreement with their thoughts as students, that they were 'as prepared as they could be' and that there were some areas that they were prepared, but still scared about facing when they started their foundation jobs. Areas that caused particular stress were on calls, diagnostic decision-making, and dealing with sick patients, which echoed the concerns of the student participants. Support from peers and senior colleagues was crucial to the FY1s both during and after the transition, and this helped mediate the stress caused by the areas mentioned. Participants gave many clear examples of learning on the job during the first few months of work which developed their skills, particularly in decision-making, managing their workload and prioritisation.

4.4 Summary

This chapter has given an overview of the data related to the research question 'how does simulation affect students' perceptions of their preparedness for the transition to professional practice'

While students feel prepared for basic tasks such as history taking, examination, selecting investigations and formulating differential diagnoses, they feel less prepared for end of life care, death certification and reporting clinical errors and adverse drug reactions. LMS students feel significantly more prepared than MMS students for seven of the core competencies including some of the competencies that overall, students felt less prepared for. There were no significant differences in opinions on preparedness for these competencies across the transition, however, there were significant differences between student and stakeholder views on students' preparedness for core procedures, with stakeholders feeling that overall, that cohort of students were less prepared than they judged themselves to be.

Moving on from individual competencies, overall, medical students reported feeling prepared to start work as a doctor. This perception did not change significantly following the transition from student to doctor, and stakeholders also felt students were similarly prepared overall (in contrast to the data on individual competencies). Despite this, over 70% of students felt both stressed and anxious regarding the transition to professional practice. When participants looked back at how stressed they had felt in the past, participants felt most stressed immediately before commencing work as an FY1, but the stress levels had reduced by the time of data collection in the doctor phase. There was a significant positive correlation between stress levels before and at the start of FY1, and when they were surveyed, 3-4 months into FY1. This correlation suggests that interventions aimed at reducing stress and at increasing preparedness before transitioning from being a student to working as an FY1 may reduce stress in FY1 doctors.

Although following the transition from student to doctor there were no significant changes in participants views on preparedness, students still had numerous concerns about the transition to professional practice. The three most commonly mentioned were on-calls and assessing a medical emergency (see next chapter), having sole responsibility for patient care, and making mistakes. The free-text responses from the questionnaire, along with the qualitative data, suggest that students are ‘prepared, but still scared’.

Students and stakeholders also recognised that there was only so much their medical school could do in terms of preparedness, and that preparedness does not end on the graduates first day as an FY1. There must be an appreciation that there are some skills that graduates will need to learn and develop on the job, and so support before, during and after the transition is vital. It may also be that students can never feel truly prepared for practice as in reality, even basic history taking may be challenging in an emergency, and the challenges even greater for more difficult tasks and procedures.

Looking back as FY1s, participants continued to lend support to the concept of being ‘prepared but still scared’. They gave examples of the same concerns that they had as students; being on call and dealing with sick patients, dealing with the day-to-day job and on call independently. They also described the importance of support, both from seniors and their peers, and this helped them do their job and feel less stressed. Learning on the job was demonstrated, and this made the participants feel more confident in their role.

5 Preparedness for practice: the role of simulation

Chapter 4 described how prepared students felt for the transition to professional practice, and examined students' ideas, concerns and expectations both prior to and following the transition to being a working doctor. How preparedness was conceptualised by student and stakeholder participants was also illustrated, along with participants' real-life experience of the transition and reflections on their preparedness. Having described how prepared students felt before and after the transition, this chapter aims to explore the data relating to how simulation may have a role in participants' perceptions of preparedness, and how these views may change across the transition.

5.1 The role of simulation for preparedness

Overall, 88.5% of students strongly or somewhat agreed that simulation had 'set them up well' for working as a foundation doctor. No students disagreed with this statement. There were no statistically significant differences between views on simulation across the two sites; students across both MMS and LMS felt that simulation had prepared them for working as a foundation doctor (MMS 91% agree, LMS 85% agree, p= 0.341).

Following the transition from student to doctor, while the levels of agreement were similar (88.5% students agreed, 88.9% FY1 agreed), fewer doctors neither agreed nor disagreed (11.5% students, 7.4% FY1) and more doctors disagreed (0% students disagreed, 3.7% FY1 disagreed that simulation had set them up well for working as an FY1). The numbers in the doctor phase were much smaller, although the proportions were slightly different this only represented one or two participants, and there were no statistically significant differences found between the student phase and doctor phase for this question. The questionnaire in the student phase was completed immediately after the simulation, which may positively influence students' opinions on simulation; however, the results from the doctor phase reflect the student phase. This makes it more likely that the student views are an accurate reflection of the participants' views and experiences.

Stakeholders were asked how important they felt simulation was to prepare students for professional practice (5-point Likert scale, extremely important – not at all important). Overall, over 90% felt it was extremely, very, or moderately important (Table 5-1).

Table 5-1 – Frequency table demonstrating stakeholders views on simulation for preparedness for practice

How important do you think simulation is to prepare medical students for practice?	n=	Extremely Important % (n)	Very Important % (n)	Moderately Important % (n)	Slightly important % (n)	Not at all important % (n)
	24	29.2 (7)	37.5 (9)	25.0 (6)	4.2 (1)	4.2 (1)

Stakeholders were asked specifically about the simulation courses offered locally (ward simulation and bleep simulation). Thirty-nine per cent of stakeholders did not know what simulation was offered locally, but all answered 'yes' or 'maybe' when asked 'do you think the simulation courses provided locally are beneficial to prepare students for practice?'. This suggests that stakeholders believe simulation as a concept is useful in whatever form to prepare students for practice.

Stakeholders ranked educational components in fifth year from most important (1) to least important (7) concerning preparedness for practice (Table 5-2).

Table 5-2 – Educational components that stakeholders ranked from most important to least important (a score of 1 = most important, 7 = least important).

Ranking	Educational method
1	Student Assistantship
3=	Curriculum Design
3=	Clinical Skills training
4	Shadowing
5	Simulation
6	Course style (e.g. PBL, traditional lecture-based)
7	Other - Free-text response included; Case-based discussions (CBDs), Students attitude/learning during SAMP communication skills

Stakeholders ranked the student assistantship as the most important factor in preparedness, with curriculum design and clinical skills training joint third most important. Course style followed shadowing and simulation. Other suggestions include students' attitudes and learning during student selected placements, communication skills and CBDs.

In summary, students feel that simulation is essential for preparation for practice, with no significant differences between MMS and LMS or following the transition from student to doctor. Stakeholders also feel that simulation is valuable when asked directly, although simulation was ranked fifth out of seven options for what they considered was the most important for preparation for practice. Students were not asked to rank educational elements of fifth year; it is difficult to make a comparison between the two groups. Students and FY1s may value simulation more than stakeholders overall, and this is further evidenced by the qualitative data in 5.3 and 5.3.2.

5.2 <u>'Learning by doing': medicine in theory and in practice</u>

Experiential learning is an essential component of medical training. This was demonstrated in the qualitative data obtained, where many participants referenced the importance of experiential learning for their development. They felt this both as an overall generalisation and in reference to individual components of training received in the fifth year of medical school; for example the assistantship and simulation, which will be discussed later in this section.

This section describes participants' views on current experiential learning opportunities in the fifth year of medical school, while 5.3 describes ideas on how experiential learning in medical school should be developed to improve preparedness for the transition to working as an FY1 doctor.

It's all just practice I think that makes you more confident in your abilities […], it's just having the opportunity to be part of the team and do things. S12, interview

Experience and 'active participation' within the clinical environment were vital. The concept of actions having consequences for patient care was introduced here; something that students were concerned about and was mentioned by both students and stakeholders.

Actively participating and then being aware, it's not about just doing something, it's looking at what the outcome of that, taking into account, it's a continuous process. SH6, interview

Textbook learning is used early in the undergraduate medical curriculum for basic sciences; this was juxtaposed with learning in the clinical environment by participants. While they recognised that basic knowledge could be learnt from these, it was essential to consolidate their learning in clinical (or simulated) practice.

I do think medicine is a speciality where experience is extremely important, seeing things is extremely important, you can't just read everything in books cos nobody comes from a textbook description of things. SH1, interview

Having the opportunity to convert theoretical knowledge into practical knowledge in the clinical environment was essential. Students and stakeholders referred to the importance of experiencing real clinical problems throughout the data; practical, hands-on experience made students feel more prepared.

Spending time on the ward, shadowing the F1 and really getting to grips with what their job is going to be. I think that's – you can't teach that in a classroom. SH2, interview

Having the opportunity to learn from mistakes in practice is an integral part of training. Students felt it was much harder to ignore mistakes when they occur in clinical or simulated practice, compared to a textbook or online learning, and this was directly related to learning.

It's good to do it practically cos you learn from your mistakes, S12, interview

Despite this, in the free-text comments from the questionnaire, students were still concerned about making mistakes when they graduated.

One participant described learning medical knowledge in the classroom in the same way as learning a language in school. Although they had an academic understanding of the language, they could not have a conversation when they went on the language exchange programme. They likened this to learning medical knowledge; if the knowledge is not used in practice, whether that be in simulation or with real patients on the ward, then it would be difficult to apply the knowledge into clinical reasoning and diagnosis.

That's how I felt a little bit about medicine on that day, I have a lot of theoretical knowledge, but actually, when you're in the situation, I had no idea how to deal with some of those situations which you know I'll be expected to deal with in 3 months' time. S5, interview

This data demonstrates the overall importance of experiential learning. The following sections discuss simulation and the assistantship in more detail with respect to their contribution to experiential learning.

5.2.1.1 Simulation

Simulation was referred to throughout the data both specifically (ward and/or bleep) simulation, and generally as being a useful educational intervention. The effectiveness of simulation is brought about by several components, including the debrief/feedback, repetition or deliberate practice and the realism of scenarios; many of these components became themes across the data.

Simulation enables users to have a 'trial run' and develop strategies for assessing and dealing with specific problems. These include the ABCDE approach (airway, breathing, circulation, disability, and exposure) and SBAR (situation, background, assessment and recommendation) handover. Students and stakeholders referred to several different strategies throughout the data.

When you first start you feel almost as though you have to do everything, remembering to start at the basics. A lot of people will go in and go right, I need the drugs now, whereas going over 'no actually, I need to do my ABCDE first' going over and over and over in your head or in the scenarios, helps you when you're in that situation you just go onto autopilot – ABC. SH7, interview

Feedback following simulation is vital to ensure meaningful learning, by rectifying poor practice and encouraging good practice. Both students and stakeholders referred to the importance of feedback throughout the data to ensure that areas of poor practice may be rectified. This feedback is not always so readily available in the clinical environment compared to simulation.

A debrief is really useful, identifying lessons learnt, it wouldn't be as useful if you didn't have the debrief, so I think the debrief tops it all really. SH9, interview

It's all important, the debrief is probably what you get the most from because again you gave conversation about what you could and should have done differently. S12, interview

Developing a standardised approach through deliberate practice during simulation allowed students to feel more prepared. Participants, particularly students, felt that this would enable them to go into any scenario in real life with a standardised approach which would give them more confidence in facing the unknown, which was highlighted as a concern in the free-text comments.

It's almost like, you know like driving, you start the steps, so it's almost like going into that automatic mode how you assess a patient, what to do so that that will give them the confidence in facing that situation. SH6, interview

Forming cognitive pathways and strategies in simulation is transferable to clinical practice. Students and stakeholders referred to this as a major benefit of having simulated practice before real clinical practice, specifically with reducing anxiety and stress surrounding those situations.

It's a bit like pattern recognition, so if they're in a situation where they don't know what to do if they've done enough simulations on that subject there will be a bit of automatic memory that kicks in, so I think that's really good, to take the edge off the anxiety that surrounds that situation. SH10, interview

Deliberate, repetitive practice allowed students to feel more confident and comfortable with scenarios. Repetitive practice developed strategies that participants intended to use in their future practice; simply the exposure to certain cases made them more confident in managing similar scenarios in the future. The direct application of knowledge and skills gained from simulation has been demonstrated in the doctor data (5.3.2).

I think the repetitiveness is the most important aspect of my learning. So I know if I have a scenario like that in the future, I think back and think oh that's what happened in the simulation, this was the consequence of that action, on take that on board and use that information to inform my decision at the time. S6, interview

Repeating similar scenarios in a deliberate practice style reinforces learning. Students and stakeholders referred to this throughout the data as being a particular strength of simulation over any other teaching modality.

If you do a simulation, even if it's gone fine sometimes they feel a bit exhausted and a bit defeated by it. If you quickly do it again with all those changes, all those recommendations, from the feedback or even with an expert leading it, it makes them feel a bit more positive about it afterwards and reinforces all that learning. SH10, interview

Despite the focus on the benefits of repetition in simulation, students must eventually step beyond the 'safe' world of simulation and encounter real patient scenarios. Participants felt that a balance must be struck between simulated and real practice, and some students may need encouragement to leave the simulation centre.

It's a balance, I think you need some practice at simulation level, but you do need to work up to actually seeing patients. I think everybody's different but I think there does come a point where I think you do just have to practice on a real patient. SH2, interview

Even if students do encounter certain situations on the wards, it is likely only to be once or twice. Simulation allows repeated exposure to such cases that is not possible in the clinical environment, which participants felt would enhance students' confidence and competence.

Nothing can replace real experience with the patient, but because of the shift system they are working or the number of hours there working, they may not get all the opportunity to enhance their competence and confidence. SH6, interview

Although experience in the real environment is essential, simulation, particularly simulation with high levels of fidelity can complement these placements and have an essential role in training. This was illustrated throughout both interview and free-text data.

Certainly, it's as real as it can be, so I don't think it detracts from real patient's experiences, it's a different way of seeing something that you wouldn't necessarily Be able to guarantee to see on the wards. S11, interview

There are things that the real patient experience is unlikely to provide medical students which we can provide by simulation. SH3, interview

The realism of simulation allows learners to fully immerse themselves when participating in scenarios. Full immersion in a scenario was felt by all participants to be vital to the success of the simulation, but this may be more difficult for some learners. Resistance to simulation as a method was felt to be associated with a reduction in efficacy

That suspension of disbelief in simulation, if we can just step past that, and interact with a simulated environment as if its real, then I think it helps you build the cognitive pathways and the physical pathways to deal with those things. SH3, interview

Some students resist it because they feel that it's never going to be the same as real life, and they don't throw themselves into it 100% partly because of that reason. SH10, interview

Using real-life, common FY1 scenarios was beneficial to prepare students for practice. Student participants particularly spoke about using such scenarios regularly, which helped them feel more prepared. This was echoed by some of the later data discussed in the data from the doctor phase.

To feel confident, you need to feel comfortable, you need to do things repeatedly, so I would argue that they should make us do the most common scenarios faced by an F1 doctor more frequently. S6, interview

Because there were a lot of situations there that I'm sure happen all the time, but we'd never come across as a student, and I feel we've not really been prepared for. S5, interview

Putting theory into practice is an essential part of a medical curriculum and has been mentioned in reference to clinical placements (section 5.2.1.2). Students and stakeholders suggested that simulation was another way to enable this learning prior to and alongside clinical practice.

It will help them make the jump from the theory to that practical reality of it, and it will help them realise that not all cases follow a textbook pattern. SH10, interview

Simulation allows students to think independently and step out of the observer role referred to in 5.2.1.2. Independent management was emphasised throughout the data from students as being a benefit of simulation over real clinical practice as they felt there was less opportunity.

It puts you in a position that you don't normally get to be in as a student, where your sort of in the thick of it, you're normally in a sort of observer role as a student, which is understandable, and you don't necessarily always come across these situations in clinical practice. S12, interview

Maintaining patient safety can prohibit students from caring for patients independently, which makes simulation vital for developing independent clinical reasoning. Both students and stakeholders referred to simulation being a safe environment in which to practice skills and management independently while being non-judgemental.

Simulation allows you to think about patients on our own […]. Otherwise, I don't think we get the opportunity to make our own decisions. S10, interview

Experience with real patient's complexities over time could never be fully replaced with simulation, nor should it be, however, simulation can be a useful adjunct both prior to and alongside clinical training. Some stakeholders were more against simulation for this reason.

I'm not a major believer in simulation, and that's maybe because I have seen that nothing can overcome the time and exposure and experience of dealing with the real thing. SH11, interview

5.2.1.2 Assistantship and direct roles in patient care

The student assistantship, where a medical student works closely with a junior doctor (usually a FY1 doctor) with a supervised direct role in patient care (2) has been discussed in 1.4.2.1. Both students and stakeholders felt that this assistantship or ward placement was one of the most valued parts of the fifth year (and stakeholders ranked it most important for preparedness in the quantitative data); they valued the opportunity not only to get involved with direct patient care but also to become part of the team. Becoming part of the team helped students to feel more involved with patient care. Throughout the data, students expressed their view that they both learnt from experiences of team-working and would value more opportunities to experience it.

Being part of the team, not just the observer on the side who sometimes gets asked questions, but a lot of the time just is there watching! S12, interview

In earlier clinical placements, students have a passive, observer role. Becoming more involved with patient care brought about more active learning. Particularly in the fifth year, students felt it was essential to step past the passive observation as having an active role in patient management prepared them better for commencing FY1.

Assistantship compared to normal placement though because that is when I'm actually doing stuff and being proactive and doing jobs and looking after patients. I have done that on other placements, but it's not been the priority. S10, interview

Stepping beyond this passive observer role meant students gained more from a placement. Stakeholders echoed this concept and felt that this would make them more prepared for professional practice.

By the nature of things, they can't be independent, but that's very much up to the student themselves as well. Some students are ready, and they'll grab it with both hands, and other people really do have that psychology of being a student right up until the very end; those are the ones that tend to struggle more than the others. SH11, interview

Despite this push for active roles in patient care, in some situations, students could still learn by being passive observers or being 'peripheral participants' in a clinical case. Stakeholders felt that for more complex situations, even having a passive observer role could contribute to preparedness.

Anything that people are seeing as a peripheral participant in 5th year or anywhere else in medical school is going to make you feel a lot better stepping into that in real life. And I guess that goes for simulation as well, things that you have participated in even at the periphery, if you've seen it from the outside, your one step closer to the middle of that circle and to leading those situations. SH3, interview

Some situations are difficult for students to have an active role in as an undergraduate. An example of this is for cardiac arrest calls, where having a passive role, but not being involved in the resuscitation, was important for students learning.

The students started carrying the crash bleep, we wanted them to have the actual anxiety of having the crash bleep and having to respond to the crash call, that's something we wanted them to experience SH2, interview

Overall, the focus was on active, not passive roles in patient care and clinical placements, particularly emphasising the opportunities to 'practice being an FY1'.

In summary, the practical application of knowledge and development of clinical reasoning was the most valued in making students feel more prepared for practice. There were the most opportunities for this during simulation and the student assistantship, where students could practice being an FY1 and become responsible for patient care. Where this was not always possible in practice for various reasons, simulation provided an adjunct to allow students to practice independent clinical reasoning and learn from mistakes in a safe environment. The following section describes data relating to expanding on learning by doing, both from the qualitative interviews and free-text questionnaire data.

5.2.2 <u>The role of simulation for preparedness for assessing medical emergencies and non-technical skills</u>

'Learning by doing' is a key feature of undergraduate medical education that students' value, as discussed in 5.2. 5.2 also covers the overall interaction between the student assistantship and simulation; data specific to assessing medical emergencies and non-technical skills is covered here.

Despite the emphasis on having a balance between simulation and the clinical environment, described in 5.2, due to the unpredictability of medicine, students recognised that medical emergencies do not always happen when they want them to. Therefore, students may miss learning opportunities.

> *In clinical practice, you're not always on the ward when the patient goes off, so I think you could easily miss out on a lot of these situations if you didn't have simulation. SH12, interview*

Students felt that without simulation prior to real emergency situations, they would struggle to manage and that would contribute to them feeling out of their depth, and therefore for some situations, simulation, certainly initially, experience with simulated patients may be valued over real patients.

> *You cannot plan medical placements around emergency scenarios, yes there's probably more to be gained from dealing with that situation in a real work environment, but there's less you can do if you've not been in the simulation before. […] So, doing the simulation allows you to plan ahead of time what scenarios you be willing to see and, if you do come across them in real life you know where you're going to fit in. S11, interview*

Students must have some experience of dealing with acutely deteriorating patients before facing these situations independently as an FY1, as usually decisions must be made rapidly, and treatments instigated to prevent further deterioration. Participants felt that simulation allowed students to manage such scenarios independently, where it would be unsafe to do so in the real clinical environment.

> *Simulation is really good for those things like management of acutely ill patients the things that although they might see, they are not actually managing, you know that's something that they can't possibly do as a year 5 student, um, they need that practice of simulation to start to think about what decisions they might be making. SH4, interview*

As mentioned in 5.2.1.2, in critical situations such as cardiac arrests, it would be impossible for students to become actively involved in this management. Simulation provides a safe environment in which to manage this situation. Participants felt this was an important area where students should have simulated experience.

Most situations where someone is critically unwell if someone is not part of the team caring for them they can be in the way. So it's difficult for medical students to encounter those sorts of situations apart from simulation. SH3, interview

Despite the various benefits of simulation discussed here and in the previous chapter, there are some drawbacks. Patients are becoming more complex with various co-morbidities. In addition, some of the more frightening and emotive aspects of an acute situation may be difficult to emulate with mannequins. Stakeholders felt that some scenarios with such patients might be difficult to recreate in simulation.

The emotional impact of someone who is actually having a heart attack has the sort of cold sweat and the terrified eyes and clutching the chest that can't be replicated until you actually see it. SH8, interview

What is common to both the assistantship/ward placement and simulation is the student's aspiration to 'practise being an FY1'. This brings together the experiential learning gained from active patient management on the wards or simulated patient management while alleviating the fear of the unknown.

It was a bit of a new skill to be bleeped in the middle of taking a history and deciding whether to go and deal with your bleep or to finish taking a history, but I really liked that, and it gave me a perspective of what really might happen. S2, interview

Having a bleep and being on call is an essential role of the FY1. The bleep simulation allowed students to prepare for holding and answering a bleep, which lessened their fears about what they might face as a doctor and allowed them to prepare strategies with which they could deal with problems they may encounter; this made participants feel more prepared for practice.

On the other end of the phone where you're in a situation where there isn't as much information as you'd like to make the decision, that made me think a bit more about how you'd handle uncertainty. So, having a chance to see the actual day-to-day bleeps was valuable. S11, interview

Replicating some of the roles of a foundation doctor in simulation made students more aware of 'what it would be like' as an FY1, reducing their fear of the unknown, which made them feel more prepared for professional practice.

It's given me a better idea of what it's going to be like really, I have obviously spent time with junior doctors, but you don't spend loads of time with them. It's given me a better idea of what the job actually involves. S4, interview

Having the bleep simulation gave students more 'practise being an FY1'. Students demonstrated feeling more confident in handling a bleep, understanding what it meant to be on call and what was expected of them.

> *I'd never even held a bleep before, I didn't know what the buttons did and that kind of thing, and it was good that they had a mix of scenarios to give us as well so that it was some things that you could do over the phone and some things you couldn't. I suppose I never really understood exactly what being on call is, I mean I've shadowed people on call and things, but I'd never really thought about what actually would be expected. S7, interview*

In particular, the bleep simulation allowed students to practise telephone communication and triage and taking referrals; participants recognised this as an essential skill that they had not had the opportunity to practice extensively as an undergraduate.

> *It was really good, really helpful; it was good to practice phone skills, had never done that before, to see how a bleep actually works I'd never held a bleep before. S12, interview*

> *Holding the on-call bleep, when it goes, that itself, not knowing who is calling. It's about being alert and then what is the sort of information you need over the phone, so when you take a phone call you need to be able to know what information you are getting, so you are making a mental picture of a patient who is not in front of you by listening to what he is giving you. SH6, interview*

Prioritisation is a crucial skill for junior doctors, particularly when on call, holding a bleep and extracting relevant information over the phone. Students felt that other than in simulation, they would not have the opportunity to practice this key skill.

> *Because we'd never really had the chance to answer bleeps and see what that was like and to be given patients over the phone and have to make a decision, and that is what we're going to have to do at some point, so it was nice to have a go at that in a safer environment. S8, interview*

In addition to simulation, both stakeholders and students described students needing increased exposure to acute environments such as A&E. This would allow students to become used to assessing a medical emergency, which in turn would make these patients less intimidating.

> *A&E is doing a pretty good job of that, I think that's taken away a lot of the areas that perhaps I was a little nervous about, seeing realistic patients because you're engorged in it, there's loads of sick people around so it doesn't become as scary. S3, interview*

The acute environment allowed the students more autonomy, and repeated exposure to the fast-paced emergency department can help to remove some of the fear associated with it. This was a key area that students and stakeholders felt needed developing.

The environment in A&E although it's very scary, it's quite a big learning curve because it's so busy you just have to get on and do things, they're so short-staffed there's not somebody there to watch them all the time so they get quite a lot of autonomy. So, maybe just a couple of weeks of twilight shifts in A&E might be pretty good. SH10, interview

As discussed throughout the previous chapter, students want to 'practice being an FY1' as much as possible throughout 5th year, whether that is as a prolonged student assistantship, on call with the FY1s, with teaching sessions on 'how to be an FY1' or in simulation. This was a theme throughout the data and resulted in students wanting to have more opportunities to do this.

The practical thing of how to actually answer the bleep, and then there's the clinical side of things just going, prioritise patients having to actually think about patients on our own,[…]. Otherwise I don't think we get the opportunity to make our own decisions. S10, interview

A benefit of the bleep simulation was the opportunity to practice telephone communication including referrals and handover. Participants wanted more chances to practice this essential skill.

More simulation e.g. learning about how to have phone consultations/handovers. SFTQ

Simulation is a particularly useful way of preparing for medical emergencies. Participants described this throughout the data and wanted more opportunities for emergency simulation scenarios, which they felt they would not be able to manage in real life as students.

More simulation style teaching. In order to experience emergency situations possibly not experienced in clinical practice. SFTQ

The difference between the FY1s from Lancaster who have done ward attachments in final year for seven weeks, and other FY1s is apparent early on. e.g. with respect to confidence on call, death certificates, drug charts, TTOs. Simulations could add some of that, especially the dealing with a sick patient in the middle of the night. SHFTQ

5.3 Developing the opportunities for ‘learning by doing’ to improve preparedness

Following on from 5.2, it was clear from the data that experiential learning via simulation and from the assistantship programme was vital in helping students prepare for practice. This section describes the data suggesting that both students and stakeholders felt that expansion and development of the current experiential learning opportunities was vital to improve preparedness. The two main areas that students and stakeholders both wanted to develop were simulation, and the assistantship/ward placement. Any experience where the students work closely with an FY1 such as in the assistantship period (MMS), ward placement (LMS) or shadowing was given high importance.

5.3.1.1 Simulation

Students relished the opportunity to think and act independently during simulation sessions; something they are unable to do in the clinical environment fully. This led to an expression that more simulation sessions are needed, and reflecting an awareness of the problems with gaining appropriate clinical experiences within the current constraints of the health service

> *Simulation would give Lancaster students the opportunity to practice in these scenarios in much more detail because I don’t think personally we get enough acute exposure to these scenarios. S6, interview*

Deliberate practice and repetition in simulation have been mentioned previously in this chapter (section 5.2.1.1) in reference to simulation. Students felt that to feel confident they should be exposed to common scenarios that they may encounter as an FY1 more frequently than they had.

> *To feel confident, you need to feel comfortable, you need to do things repeatedly, so I would argue that they should make us do the most common scenarios faced by an F1 doctor more frequently. S6, interview*

> *More simulation training with real-life situations like yesterday’s session, i.e. nurses trying to pressure you, etc. SFTQ*

Reinforcing learning throughout the year with simulated deliberate practice can enhance preparedness and confidence. Stakeholders and students stated that they would like repeated simulation sessions over the year to strengthen learning and improve preparedness

> *Ideally, it wouldn’t be one event, two events. Ideally, you do it more regularly wouldn’t you with smaller groups and enable them to see their own development and reflect on progress. SH3, interview*

Should be part of the curriculum and followed by observed practice on wards/clinics. SHFTQ

Although students and stakeholders alike expressed the need for more and varied simulation, it was also recognised that there is a cost implication, and it may be a finite resource, particularly with increasing medical student numbers.

That's useful, and the students say why can't we have more of this? But I think part of the issue is that it's very costly in terms of staff time, let alone actual cost. SH4, interview

An increase in medical student numbers will also lead to clinical areas and staff being stretched, meaning other modalities, including simulation may be required to fill the gap.

Much of the simulation encountered by medical students is done in groups of two or more students; it is very rare for them to tackle a simulation on their own. In contrast, an FY1 will be expected to deal with a variety of situations independently. While students appreciated within a group dynamic, they were able to learn from each other, they also wanted more opportunities to undertake repeated simulation training alone and recognised that to enable this would require an increase in the number of simulation sessions.

Where you're on your own with the patient I think you could practice that all day every day and it would still be quite scary, so I would have more of that. S3, interview

When using simulation for deliberate practice, participants can initially start in groups, repeating scenarios in smaller groups and finally undertaking scenarios on their own to gradually introduce independent decision-making. Students felt that this would have been a useful exercise.

Doing it for the first time was somebody else was quite nice. But realistically that's not going to happen in real life you'll be on your own so I think it was nice doing in pairs and I think that maybe doing it again on our own would be interesting as well as the how you deal with the entire situation on your own. S5, interview

However, some students felt that individual simulations would have been too much pressure and that only group sessions were appropriate.

Smaller numbers would have been great, maybe 2-3 but doing it on my own would have been too overwhelming just having to make decisions and thinking about the clinical situation and doing all the other skills involved would have been too much. S10, interview

In the clinical setting, much of the care is undertaken as a multidisciplinary team, rather than individually. Because of this, some participants felt that the group simulation was more realistic to how it would be as an FY1, and they would have liked more opportunity to do this.

> *I think the groups are really good because like I said before you each get your role beforehand, and I do think a lot of the time it's what it would be like in real life S4, interview*

A group dynamic can foster collaboration, but also may make participants reliant on the stronger members of the team. Students felt that sometimes this might inhibit their learning from a scenario.

> *You can maybe get a bit comfy when you work with the same people, you know each other's strength and weaknesses. There's a guy in the year who did A&E for a year so if he's in your group it's very easy to sit back and let him take the lead, cos he knows what he's doing but that's not necessarily the best thing to do for my learning! S12, interview*

Overall, the data suggest that participants would like an increase in the number of simulation sessions, with a mixture of group and individual sessions, spaced throughout the year.

> *More often and in small groups, having both technical and non-technical skills learning objectives. SHFTQ*

5.3.1.2 Assistantship and direct roles in patient care

Both students and stakeholders across the interviews and questionnaires described the assistantship as most helpful, and many expressed a desire for more assistantship-type placements, some even suggesting that the whole fifth year should be based around this. By doing multiple assistantships in different specialities, the fifth year would become more of an internship or apprenticeship. Stakeholders and students felt that this would be beneficial and make students feel more prepared.

> *I would like them to do more than one student assistantship. I think certainly semester two they could have two or maybe three, in different fields, so more like an internship I think, I'd certainly like to see that. SH8, interview*

Furthermore, a more extended period of assistantship would allow greater involvement in patient care and allow students to practise being an FY1. Participants felt that a longer period immediately before commencing FY1 would make students more prepared for the transition.

> *You're never going to be able to prepare them for their first job because it's their first job! But probably the closest you'd get would be to have an FY1 environment for the last few months of their training. SH10, interview*

Increase the length of the student assistantship placement in order to gain more experience fulfilling the role of a junior doctor. SFTQ

By increasing the assistantship placements, students would be able to have more active roles in patient care. One participant even suggested allowing students to locum (i.e. filling vacant FY1 jobs) in the final six months of the year.

More one on one teaching in clinics and wards encourage student assistantships and locum FY1 jobs in the last six months of final year. SHFTQ

Having an active role in patient care has been previously demonstrated to be highly useful for students developing their clinical reasoning; however, not every placement, particularly non-assistantship placements, allowed for this. Students felt that all placements should enable them to have direct roles in patient management, and this would result in them feeling more prepared.

Often you feel very detached as a medical student just tagging onto a ward round and not necessarily having any involvement in the outcome of the case. S11, interview

As a student, your experiences with patients are very limited anyway. […] you're not in situations where people are applying pressure to you…. Whereas when you're in a situation all the time, you know, and people are applying pressure you have to know what to do, how to respond and what to say in those sort of situations. I don't think you get that as a student. S5, interview

More active roles of medical students in patient care. SFTQ

As referred to in the previous section, becoming part of the clinical team was vital to allow students more responsibility. Participants felt that the length of the placements (often only four weeks) did not enable this integration into the team, and therefore increased time on the assistantship was emphasised throughout the data.

Spending time on the ward, shadowing the F1 and really getting to grips with what their job is going to be. I think that's – you can't teach that in a classroom. SH2, interview

Traditionally medicine was structured in a 'firm-based' system, meaning a consultant had junior doctors (usually at least a registrar and an SHO) allocated to their team, and they all looked after that consultant's patients as a team. There was a reference to the loss of this 'firm-based' system meaning that students now have a much shorter time on placement, and this meant that they would not fit as well into a new team, which would affect their learning experience both from the student and stakeholder perspective.

Further to this, students especially valued placements in which doctors supervising them allowed them to have an active role in patient care. They were less enthusiastic about placements that did not, suggesting the onus is on the supervising doctors (foundation doctors and trainees that are more senior) to allow medical students more independence.

[In reference to making decisions regarding management] A little bit on my student assistantship because we had a good registrar if we went and saw a patient and we'd come back, and she be like 'what do you think we should do?' but probably not as much as I would have liked. S12, interview

An obstacle to the quality of supervision is the lack of time; students acknowledged that sometimes there was not enough time to allow them to do the tasks as they would take longer to complete, and the supervising doctor was under extreme time pressure.

I think it all links back to if we had more time on the wards with the F1s and spent more time with them and if it was said to them 'oh can you let the student prescribe, and then check it and do it'. You go around so quickly, and you never get to know any of them that well and they just think I don't have time to do this. S4, interview

Some placements are designed with preparedness in mind, such as the student assistantship, where other placements were less focused on this. Students expressed throughout the data that in the last six months of medical school, they wanted to focus on 'practising being the FY1', and placements that did not allow for this were criticised.

If the med school could give us a longer student assistantship and make it more specific and say to everyone in the team 'this is the student that's supposed to be learning how to be an F1 can you make sure they're with the F1 the whole time'? S4, interview

Do a longer student assistantship - cut down the student selected component and make the assistantship longer, SFTQ

Out of hours shifts were recognised as another valuable learning opportunity from which students benefitted. They recognised that there are many out of hours responsibilities that an FY1 will have and that the support from seniors would be less at these times, giving them more responsibility end experience to learn from. Out of hours experience was a further area that both stakeholders and students felt they wanted to develop.

It would have also been useful to do some on calls doing ward cover, cos I've never done that, and I don't know what that involves. S12, interview

Shadowing an FY1 on a weekend day helping them with the bleep, i.e. answering for them, assessing patients with their supervision. SFTQ

Encouraging more out of hours experience. SHFTQ

Some stakeholders felt that students were not well-prepared due to a lack of sustained and substantial clinical experience, suggesting that there is a need to increase the time spent in the clinical environment.

> *They have a lot about communication skills, but I think we're maybe a little heavy on the communication skills to the detriment of actual clinical exposure. SH1, interview*

> *More hands-on practice, shadowing, assistantship in relevant areas, on-call medicine and surgery. SHFTQ*

Alongside this emphasis on increasing experiential learning in the clinical environment was an acknowledgement from both students and stakeholders that it was not always possible to get the full experience on the wards. This is due to the unpredictability of medicine and the need for appropriate supervision to maintain patient safety. Stakeholders established a theory that modern medical students are 'mollycoddled' or overprotected by not having enough clinical exposure compared to their own training.

> *They just have less exposure, and that kind of continues through the training because to me it seems they've gone from one extreme to another from where we threw everyone in at the deep end where if you didn't swim you sunk, and you went out of medicine[…], to now being super mollycoddling them not exposing them. SH1, interview*

The old apprenticeship style of medical education has largely been replaced; stakeholders felt that this was to the detriment of the students. This emphasises the importance placed on experiential learning on the wards and the need to increase, not reduce this element of medical curricula.

> *Medical students should be on the wards more; they should be apprentice, intern, semi-house officers, which is something that used to be heavily emphasised in medical curricula and I think that's something that has dropped out of use a little bit. SH8, interview*

In addition, stakeholders worried that students were not pushed to manage patients independently and that continued through to their first foundation jobs. Many contrasted this with examples of their own training like the quote above.

> *Too often we allow them to say no I'm not ready for that I'm not doing it, so we need to strike a balance, yes you want to feel comfortable, but sometimes you have to just do things, and then you will feel confident. SH1, interview*

Introducing more autonomy into medical students' final placements is key to prepare students for what was ahead upon graduation. This was discussed by both students and stakeholders throughout the data, particularly with respect to clinical reasoning and decision-making.

Maybe a little bit more autonomy before that time because they are quite nurtured and you know quite a lot of support is provided for them right up until the very end. SH11, interview

Patient safety is paramount when training medical students. Nonetheless, some stakeholders felt that this had been taken too far to the detriment of undergraduate training, with too much supervision and other, perhaps non-clinical areas being emphasised in the curriculum.

That they can struggle with a basic level skill, you know examining, assessing patient, reaching a diagnosis, and the reason for that is that there is a lot of emphasis over the past few years on very censored structured training and patient safety so your only allowed to do a limited number of tasks under very heavy supervision. SH8, interview

One problem is the restrictions on the number of things that students are allowed to do. SHFTQ

While practice of being an FY1 was the goal, whether that be in the clinical environment or simulation, most of the participants discussed it in relation to simulation, reinforcing the concept that undergraduates find it difficult to gain full independence in the clinical environment. Simulation may be a useful way to fill this gap.

In summary, students describe ‘learning by doing’ both in the form of an assistantship or simulation. The assistantship placements in which students learnt the most were those in which the doctors on the ward allowed them to assume the role of an FY1 and have active roles in patient care, stepping beyond the passive student role into the active doctor role and becoming part of the clinical team. This took away the feeling of ‘going into the unknown’ and brought about feelings of increased preparedness. Participants felt that to improve preparedness there should be more assistantship-type placements in varying specialities, with an emphasis on the doctors in the clinical team to allow students to have greater responsibility for patient care. However, there must be a balance between student autonomy and patient safety.

Simulation, on the other hand, was also valued highly as a complementary way of learning by doing. Simulation allowed students to manage scenarios repeatedly, with feedback encouraging good behaviours and changing poor practice, which is less readily available in the clinical setting. This repetition made students feel more confident in managing the same conditions in real life. In addition, simulation allowed students to experience conditions that they may not experience in clinical practice, and further to this, it allowed them to manage those cases independently, which would not be possible in real life. Students wanted more opportunities to take part in both group and individual simulation, particularly simulating on calls and medical emergencies.

Despite acknowledging that simulated practice cannot replace real practice, students also recognised that the feedback and repeated exposure to clinical cases was something they could not get in real life. They also felt that you could not simulate every scenario, and therefore, clinical experience is also paramount. This cycle suggests that the assistantship (and active roles in patient management) and simulation have a symbiotic relationship; one is not valued over the other. Instead, they work in combination to produce confident and competent doctors.

5.3.2 FY1 doctors' reflections on 'learning by doing'

The value of 'learning by doing' continued to be expressed when students were followed up as FY1 doctors. Having direct roles in patient care, particularly medical emergencies as undergraduates, allowed participants to feel less stressed when they were managing similar cases as an FY1. This was particularly evident for one participant who felt much more confident compared to his FY1 colleagues due to increased exposure to acute environments (through intercalating and student selected components) as a student.

> *People panic; in the first six weeks, everyone was terrified of being on call! I just didn't feel that at all […] but I just think, me having that much more experience in acute management earlier helped. FYD4, interview*

Looking back, participants did not feel they had been prepared for being on-call and working out of hours due to a lack of experience of this as an undergraduate. They felt strongly that they should have had more on-call experience before starting FY1.

> *I think that [on-calls] would have been quite helpful really because a lot of the people tend to go off at night, and you're the first one there to deal with it. During the day you've got all the Regs around whereas when you're on call, the calls come in for you and you're having to go and deal with the issue so I think that would have been helpful to have more experience of. FYD5, interview*

Having medical students shadowing them made participants reflect on their own experiences of shadowing and the student assistantship. Not only did this make participants' value on call experience as a student, but it inspired them to encourage students shadowing them to make more of this opportunity.

> *We've had 5th years here shadowing at the beginning of the year and I said to the 5th year 'I wish I'd had more opportunity to shadow an F1, would you like to come and shadow me not necessarily have to do anything but just to see the sort of decisions you have to make'? He came 2 or 3 times with me on call and said that it was very different to what he expected it to be. FYD4, interview*

More time on call as a student was also a theme from the student phase, doctor phase, and stakeholder free-text data. Simulated on-calls and the simulated bleep session were valued as participants appreciated that even if they had done more on-calls as medical students, it would be difficult ever to have 'enough' and would not be able to manage patient independently in the same way as they would be able to in simulation.

> *More realistic [simulation] scenarios. I mean they try to get you to do on calls when you're a student, but I don't think you can do enough on calls, particularly six months of on calls to learn this, you can't do that as a medical student. FYD2, interview*

On-calls were not only stressful because of the physical workload, but also the mental exhaustion from working long hours; for most new doctors, this would be the first time that they had engaged in full-time work. Consequently, participants felt that students should experience this physical and mental exhaustion while they still had direct supervision as an undergraduate.

> *It would be useful if they shadowed the F1 on their work rota, even if it wasn't necessarily eight weeks because that's a long time. But a two-week block that includes some on calls, that they can just do the day and the on call for those two weeks, and so they could experience not just the tasks that you have to do on call but also have to do a full day's work and having to do on call and other stuff. FYD4, interview*

Despite all participants expressing a wish for more on-call experience as an undergraduate, it may be that this is only something they realised the importance of in retrospect, and one participant doubted whether students would 'buy in' to the benefits of shadowing a foundation doctor on call.

> *More on calls? I think yeah on paper that would be really useful, but I don't know if people would actually turn up? Because I didn't! For my evening on I stayed till like 6. FYD6, interview*

This is further evidenced by the free-text comments from the questionnaires; only two students mentioned wanting more on-call experience, whereas free-text data from the stakeholders and doctor phase was more focused on increasing on-call experience, real and simulated.

Participants that had experience of on-calls as an undergraduate also recalled that experience several months later (in the doctor phase), mainly if they had been able to have a more active role

I was doing on-calls with the F1 I was placed with, she would sometimes give me her bleep and so if she was doing something I could answer her bleep for her. That was quite good practice because learning to ask the nurses the relevant questions, getting used to that concept of answering the bleep and trying to prioritise the jobs list was quite useful. FYD1, interview

Becoming part of the team and stepping past the observer student role into an active role was still relevant to the participants when they became doctors. Participants could see the difference now that they had medical students of their own shadowing them; they could see the progression of skills and confidence of those students that got involved with patient care and the team.

You get med students coming on the ward here and they just don't really get involved they're just in the background, not really doing a lot, and I think you're not really going to achieve much by doing that. Whereas we get some who get really involved and you can see the progress that they make within a few weeks, and that's the only way of preparing yourself as best you can. FYD5, interview

Participants recalled 'good' placements as those where the doctors on the ward made them feel part of the team and encouraged them have a degree of independence in managing patients. Participants felt that ward shadowing and the assistantship were examples of such placements; these placements made participants feel prepared.

Time on the wards, the student assistantship was my main placement where I really felt like I was part of the team, people got me involved in managing patients day-to-day, I think that was probably the most useful thing I did in medical school. FYD3, interview

Similarly, placements that were felt not to be useful for preparedness were those in which they were not doing the jobs of an FY1 (albeit supervised). Recollections of specialist placements and those not focused on preparedness for FY1 prompted participants to suggest that the whole of fifth year should be assistantship style.

I think maybe a longer ward placement, different departments. The problem with [student selected placement] is that we end up doing specialities that we like, but you end up working very much like a medical student on those firms. So, and so you're not really doing anything useful. […] You might learn something about that speciality, *but in terms of practical experience to prepare you for work, it's not as useful. FYD1, interview*

Again, participants acknowledged that there was an onus on the clinical team on the ward to make sure students feel like part of the team and were allowed to be 'hands-on'. This was suggested to make placements more useful for preparedness.

It would just be good if there was more of a culture on placements that you are part of the team, rather than just the student tagging around on the ward round and the disappearing in the afternoon because there's nothing for you to do. Just being more involved and hands-on. FYD3, interview

Even after 3-4 months of experience as a doctor, participants spoke about using skills learnt in simulation in their clinical practice, thus demonstrating a change in behaviour resulting from simulation training.

The bleep simulation allowed participants to use their training in SBAR handover and practice telephone communication, including this tool. This made doctors more confident in both using SBAR, telephone handovers and the confidence to interrupt a colleague who was giving an ineffective handover.

The session taught me about using the SBAR format to handover information and to prompt other people to use this format when handing over to me […] I've probably become more confident to interrupt people and guide the handover a bit more! And to write all the important information down, I realised during the bleep session how easy it is to miss patient DOB/hospital number and things like that! FYD3, interview

Having specific and realistic FY1 simulated scenarios as a student gave doctors more confidence in the same scenarios in real life once they graduated. Having an experience with a difficult simulated colleague asking for patient sedation was particularly relevant for one participant, who felt more confident when experiencing a similar situation in real life.

There was a patient on my nights the other day who was confused and kicking off on the ward and the nurses were trying to get me to prescribe haloperidol but actually he was in pain because he hadn't been prescribed any pain relief. So maybe I would have been more tempted to do that had I not had the simulation training. FYD1, interview

On the other hand, some participants still felt that they had been unprepared for dealing with difficult colleagues, mainly via telephone communication, and thought that there should be more of this simulated at medical school

Practising that a little bit, dealing with difficult people, I don't think we did a lot at medical school, we did in communication skills dealing with difficult patient and *difficult relatives but we never really dealt with difficult colleagues, who are just obstructive for no reason, and then just hang up the phone. FYD5, interview*

Having a realistic bleep simulation gave participants a better idea of what an on-call would be like. Participants felt that this took away the fear of the unknown and uncertainty

It's a good reflection of what it's like to be on call the scenarios from what I remember were realistic as to what you actually get. FYD4, interview

Simulation was seen as a good 'rehearsal' for a real-life scenario and facing something that they had never seen before was a commonly cited concern from the questionnaire data. Participants felt reassured that the problems they encountered in real clinical practice were nothing that they had not seen in simulation; in retrospect, this contributed to their preparedness.

The selected things that we had was representative of the types of unwell patients that you see on call, and there haven't been many presentations that I don't think we'd had something that resembled it in simulation. FYD4, interview

More experience with a bleep simulation would allow students to have a better understanding of what to expect when carrying the bleep and how to cope with that workload. Participants, therefore, felt they should have more opportunities to participate in this simulation.

The bleep session, the sim bleep? I think that was very helpful; I think there should be more of that. But I think after I'd done my first week of holding a bleep it was fine. Definitely more during final year. FYD6, interview

Participant acknowledged that there is a limit to what simulation can provide, and it will never be exactly the same as the real clinical environment. Despite this, participants still valued simulation and felt that it helped change and improve knowledge and behaviours.

I don't think you can ever be fully prepared – you can simulate it but it will never be quite the same as doing it for real. But its good practice and it certainly makes you think and reflect on what you have done and how you acted and how you may or may not act in the future, how to respond to challenges in the future. FYD5, interview

This was compounded by clinical experience; participants recognised that patients in real life could be more complex and therefore harder to simulate

Real patients are often more complicated than the ones you've seen in simulation sessions. You might have someone with pulmonary oedema due to heart failure in a sim session, but then in real life that patient also has an AKI on CKD and a history of COPD and all this other stuff as well and they have dementia so they can't really talk to you very much about how they're feeling! So the reality of dealing with that patient is different to the sim session. FYD3, interview

The real patient may have more subtle symptoms and signs (compared with more straightforward symptoms pointing to a specific diagnosis in simulation), making diagnosis and management more difficult. To better prepare students, participants felt that undergraduate simulation scenarios should also focus on these subtler presentations.

> *At medical school, you give the patient a treatment, and you get instant feedback as to whether it's worked or not but in real life, you might give someone 48-72hrs of antibiotics before you write it off and change it. I suppose in med school you give them penicillin – now the patient has improved – you just don't get that in hospital! FYD4, interview*

Despite these drawbacks noted, doctor participants continued to feel that simulation was essential to fill the gaps in clinical training

> *It exposes you to clinical scenarios that are common, but because we're never on the ward enough to find it common and having been exposed to those scenarios in simulation I think it prepared us a little bit more. FYD6, interview*

Participants clearly continue to value the role of simulation once they have gone through the transition to professional practice, as it provides the opportunity to manage situations in a safe environment prior to experiencing similar situations in real life.

5.3.2.1 Reflections on undergraduate experiences and simulation for assessing medical emergencies and non-technical skills

Both simulation and the student assistantship provided experience in non-technical skills and assessing medical emergencies that made students feel more prepared for the transition. Once FY1 doctors, participants continued to emphasise the role of these educational experiences for developing these vital skills.

During the bleep simulation, participants were given information about several simulated patients in a short space of time. This encouraged participants to prioritise which patients to see, and this practice made students more confident to do this once they became foundation doctors because of the bleep simulation.

> *What I took from it was trying to stratify which patients to see first. I seem to remember feeling relatively confident in triaging, you know this person is really unwell, so I'm going to see them first, this one can wait, that sort of thing and you can never have too much practice at that, because you just have to hone your skills, you know see what comes when. FYD4, interview*

Participants still struggled with some prioritisation tasks and managing their workloads, particularly when determining if a patient needed seeing at all. Participants suggested that this should be included more in simulation.

> *I still struggle to say no when you get bleeped for things, I'm more inclined to still go and see them. I think having some more scenarios where it is acceptable to say 'well actually no that's not an on-call job that doesn't need to be seen out of hours' would be useful, just to have people to practice saying no, because I think you know in a safe scenario its fine. FYD4, interview*

Having experience of dealing with a difficult colleague in a simulated ward enhanced doctors' confidence in challenging the decisions of others and led to an appreciation that in most situations, unless there is a life-threatening emergency, there is time to ask for help. Participants felt more confident as doctors to take a step back, review patient information and ask for help because of their experience in the simulated ward.

> *The one that always sticks in my head is when *staff name* was being awkward about prescribing midazolam for a patient […] And feeling really pressured, and it made me think I need to just take a step back, very few things need immediate action […]. I've had things now happen to me in real life, and I've had the confidence to say – well actually […] let me have a think, look things over and then speak to the med reg […] You don't have to make a decision about that in that moment, because it's not a life-threatening thing that needs acting immediately. FYD5, interview*

Simulation allows users to deal with scenarios without senior support, which allows independent decision-making. This is particularly helpful for acute scenarios that they are unable to manage in real life due to patient safety concerns. These helped participants feel more prepared as FY1s, particularly in situations where support was not freely available

> *They gave you some experience with dealing with a sick patient, making your own decisions rather than always asking for help, because that happens lots as an F1, you don't always have loads of support. FYD2, interview*

This links back to the symbiotic relationship in undergraduate training of real patient experience and the assistantship and simulation.

> *I don't know how you would possibly tackle acutely unwell patients unless you'd had a lot of opportunities to do it in a safe environment with decent feedback. You just don't get feedback anymore, […] every unwell patient you manage, they either become better, or they don't, and if they don't then you ask for help and they suggest something else, they rarely give you feedback. FYD4, interview*

5.4 Summary

Both the quantitative and qualitative data suggest that students view simulation as an essential tool for preparation for practice, an opinion held equally by students from MMS and LMS, and between students and FY1 doctors. This suggests that while the two institutions, Lancaster and Manchester medical schools, had different approaches to simulation, both simulation courses are equally useful in preparing students for practice.

This was also reflected in the data from chapter 4, which described that stakeholders, when asked directly, felt simulation to be important. However, they ranked simulation was ranked only fifth out of seven options for what they considered to be the most important factor in preparing students for practice. This may suggest that students and FY1s value simulation more than stakeholders overall, and this is further evidenced by the free-text and qualitative data.

Students and stakeholders value simulation and the assistantship because they allow experiential learning and the conversion of knowledge into clinical reasoning and decision-making. The data implies that the assistantship and simulation have a reciprocal relationship, with simulation providing the opportunity for the independent management of clinical cases that students may not experience or be allowed to manage independently in the clinical setting. Simulation also allows students to make mistakes in a safe environment and create cognitive pathways for dealing with problems in real life. The assistantship, however, enables them to practice being an FY1, thus reducing the fear of the unknown, and simulation can never fully recreate some patient problems, so experience with real patients is essential.

Given the three biggest concerns from students' free-text comments were making mistakes, having responsibility, and dealing with medical emergencies/being on call, simulation allows all three of these to be practised in a safe environment. In contrast, having full responsibility and making mistakes with real patients would have serious implications.

Looking back, FY1s described using the specific skills they learnt in simulation in their professional practice. Doctors also recall how essential it was to have experience of real and simulated on-call working as that was an area that still elicited fear. Simulation was felt to be essential to fill the gaps that the clinical experience was lacking. Equally, they expressed a desire to have had more assistantship placement to practice being an FY1 in the clinical setting.

Put together with the results from the previous chapter, the data suggest that students feel prepared, but still scared about various aspects of the transition to FY1, and both simulation and the assistantship together are essential for training confident and competent doctors that are prepared for the transition to professional practice.

6 Discussion: Addressing the preparedness issue

6.1 Overview

This chapter discusses the results from the preceding two chapters and puts them into the context of the established knowledge about simulation for preparedness (which was presented in chapters one and two).

The chapter is structured around three key findings – situating the results within the recognised evidence of how and why simulation is effective and how that affects preparedness for practice. Kirkpatrick's levels will be referred to throughout (KP1-4), demonstrating the level of evidence provided. The key findings are as follows:

1. Simulation is associated with student self-reported preparedness, but students are still concerned about the transition
    a. Simulation was associated with perceived preparedness for assessing medical emergencies and non-technical skills
    b. Simulation was associated with perceived overall preparedness for the transition
    c. There were no differences in preparedness of participants between the two simulation courses despite their differing formats
    d. Simulation has an important role alongside the student assistantship to prepare students for professional practice
2. There is a considerable contrast between student and stakeholder views on simulation and preparedness
    a. Students may value simulation more highly than stakeholders for preparing themselves for the transition
    b. Students feel more prepared for assessing medical emergencies and non-technical skills than stakeholders judge them to be

3. There may be a ceiling of preparedness, meaning that medical educators can never fully prepare students for the realities of being an independent practitioner

6.2 Simulation is associated with student self-reported preparedness, but students are still concerned about the transition

6.2.1 Both simulation courses were associated with perceived preparedness for assessing medical emergencies and non-technical skills

Assessing a medical emergency is a vital skill for FY1, and its importance has been established throughout this thesis. The quantitative data suggest that students feel well-prepared to assess a medical emergency (94% students agreed they felt prepared). However, the qualitative data from this thesis suggests that students and FY1s feel concerned about assessing a medical emergency, especially alone and out of hours/on-call. This is in keeping with findings from the wider literature (119, 128, 137, 140, 158, 308). This may suggest that the simulation courses under study have contributed to students' preparedness for assessing a medical emergency, but that in practice, dealing with a medical emergency is scary. Across the crucial transition from student to doctor, despite students expressing concerns through the qualitative data, there was no significant difference between student and FY1 views on preparedness for assessing medical emergencies. However, the trend was towards FY1s not feeling as prepared as they had thought they were as a student for managing medical emergencies (93.8% students agreed, 89.3% FY1 agreed). Although there were no statistical differences, this may have practical significance, suggesting possible overconfidence as a student, or that students are not best placed to judge their own preparedness prior to experiencing the transition. Assessing a medical emergency is a skill that has the potential to be improved with simulation, which would allow independent management of cases not possible in clinical practice.

According to the literature, non-technical skills are another field that students may be unprepared for (110, 128, 135, 139, 140). The results from this thesis are inconclusive in this area; students felt less prepared for adapting to change and uncertainty, leading a team and working independently, but they felt better prepared for team-working and prioritisation. In the qualitative data from this thesis, as for assessing medical emergencies, students described significant concerns about taking on independent responsibility. As FY1s they regularly stayed late at work to deal with medical emergencies but also routine jobs, suggesting difficulties with time management and prioritisation. Although staying late at work and being unable to manage the workload may be due to understaffing, participants demonstrated their time management improving with more experience on the wards. In addition, the new junior doctors' contract formalised exception reporting; an arrangement which means employers are contractually obliged to change working patterns or give time back in lieu should doctors miss their rest breaks or stay late to provide patient care (309). FY1s may be happier to stay late at work because they will now be adequately compensated for this. The impact of these factors makes it difficult to understand whether or not simulation has an effect on time management skills; however, time management is just one component of non-technical skills.

Across the transition from student to doctor, there were no significant differences in students' views on preparedness for non-technical skills. Again, the trend was towards FY1s not feeling as prepared as they had thought they were as a student for working independently (74.3% students agreed, 67.9% FY1 agreed), working in an MDT (98.2% students agreed, 92.9% FY1 agreed), and adapting to changing circumstances and uncertainty (67.6% students agreed, 64.3% FY1 agreed). FY1s felt they were more prepared for leading a team and prioritisation than they had perceived as a student. Apart from for the competency 'leading a team', the trends noted in the FY1 participants (less prepared for adapting to change and working independently, more prepared for working in an MDT and prioritisation) mirror the findings from the student participants. Although these differences were not statistically significant, they add to the wider concerns about new doctors' non-technical skills and reinforce the complexities associated with assessing preparedness. Simulation has been used in postgraduate training to improve healthcare teams' non-technical skills (23, 310), and there is some evidence of its use with undergraduates (see 2.2.3). Therefore, simulation has the possibility to improve medical students' non-technical skills to make them more prepared for practice. The results from this thesis suggest that although simulation is associated with some confidence in non-technical skills, this may not be maintained long term, or translate into changed behaviours having an effect on patient care.

Overall, this thesis provides evidence of the varying levels of preparedness for assessing medical emergencies and non-technical skills. Although preparedness for assessing a medical emergency was high in the quantitative data, students still feel concerned, particularly alone and out of hours. These quantitative findings are contrary to the available literature, with many studies reporting low objective and self-reported levels of confidence in students for assessing medical emergencies (189, 192, 193, 230). However, these studies are primarily pre/post studies looking at how an educational intervention affects students' skills in this area. Studies looking only at preparedness mainly collect data from FY1 doctors retrospectively; therefore, this thesis provides new evidence in this area (135, 311). Furthermore, students reported varying levels of preparedness for non-technical skills in the quantitative data, and again, felt concerned, particularly about independence as an FY1. Across the transition from student to doctor, there were no significant differences in views on preparedness, but the trend was generally towards FY1s feeling less prepared than when they were students.

6.2.2 *Both simulation courses were associated with perceived overall preparedness for the transition*

Overall, there has been an upward trend in the preparedness of UK medical graduates over the last 20 years. In 2000, only 36.3% of graduates felt prepared for their first job (127). By 2014, 69.9% of graduates felt prepared; the figure has remained static since then (131). Considering that between 2009 and 2014, preparedness improved from 49% to 69.9%, one must wonder why further improvements to preparedness are not being realised. How students feel is vitally important with respect to preparedness, as if they feel prepared, they are likely to perform better than if they feel unprepared. FY1 doctors who feel unprepared for the transition to professional practice are more likely to have inadequate ARCP outcomes (118).

The results from this thesis suggest that following the simulation courses under study, 72.5% of students felt prepared for practice. This supports the broader evidence that levels of preparedness have not changed in five years, despite substantial developments in medical education.

The transition to professional practice was associated with high levels of stress and anxiety. In fifth year (the student phase), 70.8% of students agreed they felt stressed at the thought of becoming a doctor. In the doctor phase, 78% of participants agreed that the realities of being a doctor made them feel stressed, implying that the realities of being a doctor were more stressful than they imagined. Furthermore, level of stress before commencing FY1 posts was positively and significantly associated with stress upon commencement of FY1. This means the most stressed students became the most stressed doctors. Lachish et al found that having poor experiences of the transition with little support affected new FY1s' enjoyment of their job and intentions to work in the UK (121).

Given the evidence from this thesis and the wider literature that the transition is extremely stressful, one might expect that new FY1s' views would change significantly across the transition. However, there was no significant difference in views on preparedness across the transition (72.5% students and 70.4% FY1s agreed they were prepared). These are similar to the trends seen for assessing medical emergencies and non-technical skills (6.2.1).

The wider literature on the transition to professional practice is limited, and often does not collect data from fifth-year students. Instead, most studies collect data immediately prior to the transition, when it is likely that students will feel stressed, with follow-up into FY1. This thesis provides data from earlier in the fifth year and FY1, thus providing new insight into this crucial transition.

In this thesis and other studies in this area (140, 160, 177, 308), there is significant overlap between the concepts of being unprepared and concerned; several studies interpret students' concerns about various competencies as a lack of preparedness (139, 140, 197), but in fact, the two may not be mutually exclusive. The data from this thesis suggest that students may feel prepared for a task or procedure, but still concerned or scared about facing it in the real clinical environment, where multiple different factors may be in play. This has led to a view that students are unprepared, where in fact, they may feel prepared, but still concerned about facing specific situations. In addition, it may be true that we cannot fully prepare students for professional practice as no matter how prepared they are for OG2015 (3), there may be factors in the work environment that will affect how an FY1 can complete a task (see 6.4). This perception of being prepared but still scared is discussed in 6.4.

In summary, this thesis provides further evidence for the static levels of preparedness of medical students. Despite the transition to professional practice being highly stressful, demonstrated by this thesis and the broader evidence, students' views on how prepared they felt did not change significantly across the transition from student to doctor.

6.2.3 There were no differences in preparedness of participants between the two simulation courses despite their differing formats

As described in 3.4.1.2, the simulation courses investigated in this thesis were designed to improve overall preparedness in addition to assessing how prepared students were in terms of non-technical skills and assessing medical emergencies. However, the formats of the simulation courses were different at MMS and LMS. Furthermore, MMS has a more established simulation curriculum throughout the years of the medical degree course as well as in fifth year, meaning students have several other simulation sessions in addition to the bleep course. This is not the case at Lancaster. Despite these differences, these results showed no significant differences between participants' views on preparedness for non-technical skills or assessing medical emergencies, and no differences in overall preparedness between the two courses (69.8% MMS felt prepared, 72.3% LMS felt prepared, p= 0.614) (KP2).

Conversely, significant differences were found in students' preparedness levels between the two sites for several administrative tasks. LMS students feel significantly more prepared for reporting drug reactions (p=0.001) and clinical incidents (p=<0.001), death certification (p=<0.001) and preparing a discharge summary (p= 0.001) than did MMS students. These are also the competences that overall, students felt less confident with. The reasons for these differences are unclear, but as neither simulation course included these tasks, the differences may be due to other elements of the curricula, for example, LMS may provide more teaching on reporting clinical incidents and death certification.

The cost of the simulation courses under study has been impossible to estimate, in part due to the complexity of simulation. If both simulation courses are equally effective, it would be sensible to provide the most cost-effective; however, estimating cost does not take into account the difficulties of organising such an event or the staffing requirements. Given the current financial austerity, there should be a focus towards economical but effective simulation.

This lack of difference in the major outcomes between the two sites suggests that despite variation in format, simulation is associated with developing students' non-technical skills and management of acute patients and can contribute to overall preparedness for practice. Furthermore, the amount of simulation in the fifth year does not seem to affect the quantitative results. Despite this, the qualitative data from this thesis suggests that to improve preparedness, students and stakeholders want more practical experience, both simulated and real-life (section 5.3).

The findings above contradict evidence from the literature suggesting that preparedness varies widely between medical schools (118, 127, 129, 130, 157, 170), although one large study found few differences in preparedness (140). The similarities between the two schools studied in this thesis may mean that educators have taken on the suggestion that medical schools should collaborate to improve preparedness; for example, locally there is an annual

Association for the Study of Medical Education (ASME) medical education forum. This is attended by educators from the medical schools across the North-West. This thesis had a relatively small sample size and only sampled a portion of students from MMS's fifth year (approximately 1/3 students in the fifth year will be at LTHTR, the rest at the other base hospitals). This may mean that results are not generalisable to the rest of the UK or internationally (see 7.1).

To meet the GMC's standards, all medical schools must produce doctors that are competent in all key competencies and skills (laid out in the GMC's document OG2015) (3). In practice, students' confidence in their competence will vary, which explains why students feel differently about their preparedness and have different concerns. This is reflected in the data from this thesis; the quantitative data suggests students feel prepared, but the qualitative data highlights concern and lack of confidence in the areas (see 4.3.2). If it is confidence, not competence that fluctuates, educators need to focus on building students' confidence before the transition. Building confidence can be easily facilitated by the repetitive nature of simulation, allowing safe experiential learning. Safe experiential learning through simulation was highlighted throughout the qualitative results of this thesis as being vital in addition to real-life experience to make participants feel more prepared.

In summary this thesis provides new evidence that despite different formats, both simulation courses are equally effective to develop students' competence. This supports the use of simulation in different forms to enhance medical students' confidence in OG2015(3).

6.2.4 Simulation has an important role alongside the student assistantship to prepare students for professional practice

Learning experientially during clinical placements with safe supervision is fundamental. Kolb (50) describes knowledge being gained from experiencing situations and reflecting on the experience which allows learners to form new cognitive pathways (1, 50). Experiential learning theory then merges into Ericsson's deliberate practice (49); repetitive, deliberate practice alongside experiential learning is the final component of Kolb's theory, to allow learners to use their new cognitive pathways and allow the new knowledge to be retained (49, 50). These two theories are highly relevant to the learning described later in this section.

The GMC emphasise the importance of both real and simulated experiential learning to ensure students' preparedness for professional practice (2). Although preparedness is affected by internal factors such as learning style, external factors including undergraduate placements are crucial, suggesting that successful undergraduate placements should improve preparedness (140): “medical students that have a more hands-on assistantship seem to have a smoother transition to working as a doctor” (118). Due to “increasing limitations for clinical training opportunities,” simulation may be a useful addition to clinical experience (33).

The two primary sources of experiential learning specific to the fifth year are the student assistantship (1.4.2.1) and simulation. Several studies describe the benefits of clinical experience for making students more prepared (108, 128, 163). Assistantships have been shown to ‘demystify’ the FY1 job (134), and improve students’ confidence across the board (136, 146); increased responsibility improved preparedness (136, 145). The results of this thesis emphasised the importance of having the opportunity to become more actively involved in patient care, a concept that is highlighted in the literature (145). The data from this thesis suggests that the supervising doctors play a vital role in facilitating increased responsibility for students, which is echoed in the literature (134).

Simulation has been shown in both postgraduate and undergraduate training to improve users’ knowledge and behaviours (KP2-3), and in postgraduates, the benefits have stretched further to better patient outcomes (KP4) (85, 86, 89, 91, 312). Far-reaching effects are more difficult to ascertain in the undergraduate field. As discussed in 4.2, simulation results in undergraduates feeling more prepared for assessing a medical emergency and some non-technical skills, as shown by the results of this thesis (KP2). Furthermore, simulation is effective in improving the essential skills required for the transition and making students feel more prepared (KP2); this thesis supports the use of simulation for preparedness for practice. Despite the heterogeneity of interventions, the broader literature on simulation for preparedness (2.2.2) supports this conclusion. Students agreed that simulation had prepared them for professional practice, an opinion that remained following the transition from student to doctor (KP2). Specifically, simulation gave students the ability to develop their skills in dealing with common FY1 scenarios, reduced the fear of the unknown and allowed them to make mistakes in a safe environment, which made them feel more prepared. Having independent responsibility for patient management in simulation was vital for preparedness; demonstrated across the literature and the results of this thesis (KP2) (197, 212).

Stepping beyond KP2, the qualitative data from this thesis demonstrates the simulation courses bringing about a self-reported change in the behaviours of students across the transition. FY1s described using their training in SBAR handover and the ABCDE approach in their day-to-day practice, which gave them confidence, particularly when trying to prioritise and deal with medical emergencies (KP3). It is likely that this positively affected patient care; how far the change of behaviours affected patient care was not directly measured, unlike Blencowe et al, who found a reduction in self-reported incidents in participants undertaking simulation (158).

Despite there being no statistical difference between the two simulation courses, having a bleep (in the bleep simulation) allowed students to practise being an FY1 and improve their prioritisation skills, especially over the phone (KP2). The literature on bleep simulation suggests that it improves preparedness (171, 199) and confidence in holding a bleep (196) and significantly improves decision-making skills (KP2) (196). The ability to practise telephone communication and reproducing the on-call experience was a vital benefit of the bleep simulation in this thesis, and directly addresses one of the students' key concerns about on-call/out of hours working. Despite a suggestion that bleeps may be phased out (to be replaced with mobile applications), these transferable skills will continue to be important (313). The literature suggests that students value simulated on-call experience (199). Increasing the on-call experience, both simulated and real, is discussed in 6.2.4.

The essential components of simulation were discussed in 1.2.1; several systematic reviews illustrate the power of an effective debrief, especially as there is rarely the opportunity for in real clinical practice (33). The results from this thesis suggest that for undergraduates, the repetitive, deliberate practice (endorsed by Ericsson (49)) allowed by simulation is just as important as a debrief. This suggests that at the undergraduate level, repeated simulation may be essential for students to attain basic competence. For skills that cannot be practised independently in the clinical environment, for example, dealing with deteriorating patients, deliberate practice in simulation may be particularly relevant.

Getting the balance right between simulation and clinical practice is complex. Despite one study in the literature describing a bigger educational impact from real-life clinical experience compared to simulated experience (but both were associated with increased preparedness) (163), in this thesis real-life and simulated practice were found to be equally important to students. Through the student assistantship and simulation, participants described becoming more confident with diagnostic reasoning, management, and practical procedures. Students particularly felt that simulation was vital to have alongside clinical placements. This leads to the hypothesis of a symbiotic relationship between the student assistantship and simulation, with both contributing equally to preparedness (*Figure 6-1*).

Even with the benefit of the experience of FY1, participants still talked about the importance of both methods. FY1 participants discussed concerns and difficulties they had experienced in their first few months of working, and these difficulties appeared to directly link to their suggestions for developing and improving the medical curriculum: for example, many participants described worry about on-call working, and therefore suggested this be increased in the undergraduate course, both real and simulated.

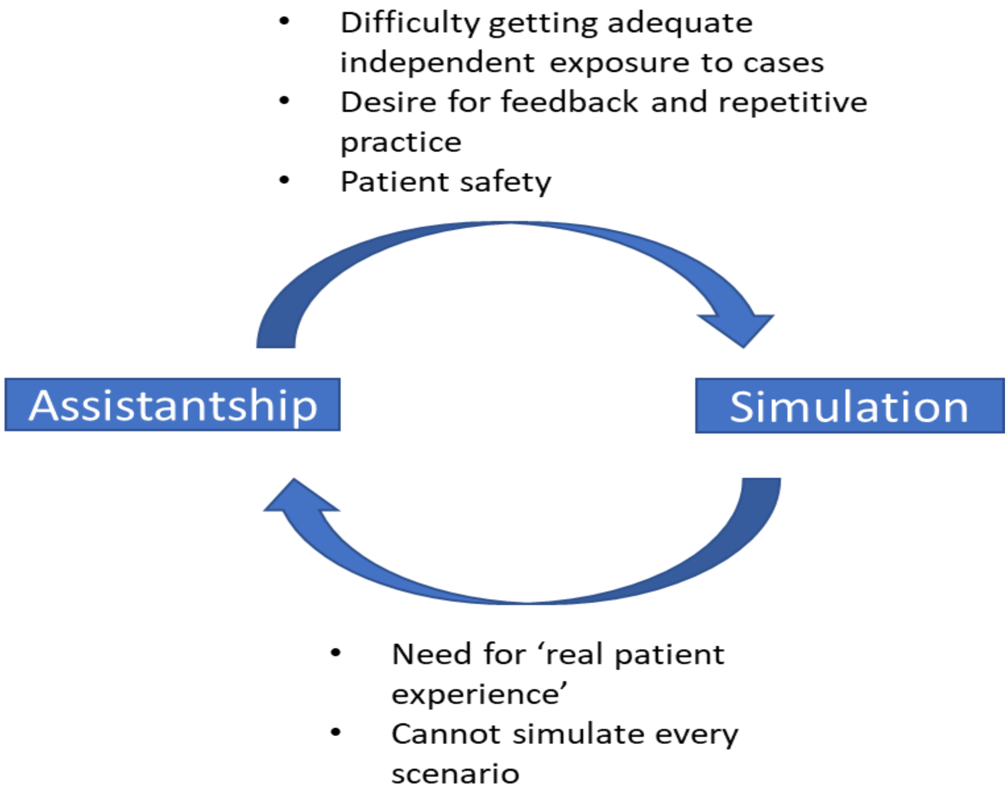


Figure 6-1 – Symbiotic relationship between assistantship and simulation

This proposed relationship is supported by a discussion paper by Kneebone et al that suggests that simulation should be used for "more complex clinical situations, recreating the challenges of real life," but that to work, rather than being entirely separate for the clinical setting, simulation needs to be linked carefully and used alongside clinical experience (314). This aligns with the BEME guide's recommendation that simulation should have curriculum integration (1.2.1).

Participants in this thesis suggested that to improve preparedness, efforts needed to be focused on increasing both the simulation component of medical training alongside better assistantship-style placements. For deliberate practice to be effective, the BEME suggests that simulation should be frequent and varied (33). Students felt that the fifth year should be made up of only assistantship-style placements with a focus on becoming an FY1, including out of hours work, as the most useful placements were those in which students became more involved with patient care. Having final examinations prior to the fifth year may facilitate this apprenticeship-style, FY1-focused fifth year (7). Simulation alongside and integrated into the focus towards FY1 would help prepare students for the transition. This is reinforced by evidence in this area suggesting that students need increased practical experience (110, 139, 141), both throughout curricula of medical schools (108, 133, 140) and through assistantship (134, 136).

Despite student/FY1 participants' experience of the transition (high levels of stress, see 6.2.2), recommendations for improving preparedness and the value of simulation had not changed following the transition from student to doctor. This finding that views had not changed strengthens the recommendations for increased responsibility and simulation in the fifth year. This recommendation is supported by the literature; prior on-call experience and practice being the FY1 made the transition easier, and importantly, participants who felt prepared had a better transition experience (108).

Given the cost and resources required, it is crucial that simulation is directed towards those areas with the greatest benefits and integrating simulation for these areas through the curriculum; this will ensure "a more goal-directed and sustained use of the tool" (32). Specifically, areas that students cannot have independent experience of as an undergraduate (for example, assessing a medical emergency) may be better suited to simulated learning than areas such as incident forms, where students can practise in reality without causing patient harm. Incorporating simulation alongside clinical placements like assistantship will enhance medical students' experiences and make them more prepared for practice.

In summary, experiential learning in the fifth year is vital for producing well-prepared doctors. This thesis provides some evidence that simulation has a role alongside and integrated with the assistantship to increase confidence and maintain patient safety, specifically for areas that students would be unable to manage alone in the clinical environment. Allowing students full responsibility for patients on the wards is fraught with difficulties and dependent on the confidence and availability of those directly supervising. Increasing the assistantship component while encouraging supervising doctors to allow students to have direct patient care roles may improve preparedness. Furthermore, increasing the simulation component alongside the assistantship may further improve preparedness on the wards.

The benefits of simulation specific to undergraduate education are grounded in experiential learning and deliberate practice. The repetitive practice that simulation allows appears to be vital to undergraduates' learning through this thesis. The debrief may be more important for postgraduate trainees who are refining their basic skills. Few studies on preparedness discuss the role that simulation may have. Although some studies directly address simulation as an intervention to improve preparedness, it is not widely considered within the preparedness literature. Educators must consider how best to increase students' experience of direct management of patients safely, and the crucial role simulation has in this process.

6.3 There is a considerable contrast between student and stakeholder views on simulation and preparedness

6.3.1 Students may value simulation more highly than stakeholders for preparing themselves for the transition

The benefits of simulation divided students and stakeholders. In this thesis, although stakeholders value simulation, they ranked the assistantship as most important for preparedness. This fits with the emphasis on experiential learning discussed in 5.2. Students were not asked to rank the educational elements in the same way as the stakeholders, so this data must be interpreted with caution. Nonetheless, participants in the student and doctor phases were asked their views on the most important elements of the fifth year; they almost exclusively described the assistantship and simulation as the most vital elements of the final year that contributed to their preparedness.

Despite the high value placed on the assistantship, stakeholders felt 'overprotected' students were less prepared due to not having direct roles in patient care, although they acknowledged that maintaining patient safety was vital. It may be the stakeholders' perception that modern medical students are 'mollycoddled' and 'overprotected' (see 5.3.1.2) that is contributing to their views on the benefits of simulation for preparedness for practice. Stakeholders felt that students should have more real-life experience, but there must be a balance between allowing students to step past the passive observer role and take on the management of patients while keeping patients safe. It may be that currently this balance is not quite right. This paradox is not likely to change, and simulation may have a role to allow the independent management of patients in a safe environment. There is little literature that includes stakeholders' views on simulation; therefore, this thesis gives new insight into this group. Some stakeholder participants (for example year five lead, undergraduate dean) already have a role in educational development. Involving all stakeholders, including supervisors who will often provide the majority of support and bedside teaching for FY1s, is key. It is possible that students recognise to a greater extent how simulation can fill the gap between having independence in managing patients while maintaining patient safety, due to the differences in medical training between current models and medical training 20-30 years ago.

In summary, this thesis provides new evidence of the divide between students' and stakeholders' views on simulation and how it contributes to preparedness. However, stakeholders acknowledge the difficulties associated with medical students gaining adequate exposure to common clinical scenarios, due to worries about patient safety. Although stakeholders' views were about the cohort of students as a whole, rather than individual students, this data gives an impression of a significant difference, which requires more investigation. Although student and stakeholder views on preparedness have been studied previously (110, 311), views on simulation and how it impacts preparedness have not. More work needs to be directed towards safe ways in which students can take on more independence; one clear way to provide this is with more simulation

6.3.2 Students feel more prepared for assessing medical emergencies and non-technical skills than stakeholders judge them to be

Stakeholders agreed with students' views on their overall preparedness (75% stakeholders agreed students were prepared, 73% students agreed they were prepared, p= 0.73). However, significant differences were found between stakeholders' and students' views on many important competencies (from OG2015(3)) necessary for the transition to professional practice. Stakeholders felt students were significantly less prepared for non-technical skills including prioritisation (p= 0.003), working independently (p= <0.001) and leading a team (p= <0.001), and also for assessing a medical emergency (p=<0.001). They also felt that students were significantly less prepared for eight of the twelve core procedures (p values between 0.008 and <0.001), importantly venepuncture, IM and SC injections, ECG and catheterisation, which are not only key skills that an FY1 would need to do frequently, but also, if done or interpreted incorrectly, may have serious consequences for patients.

These findings supplement the limited evidence in this area, suggesting that stakeholders feel that students and FY1s are unprepared for the realities of life as a doctor (125, 135, 141). One study provided contradictory results, with stakeholders agreeing with FY1s' reflections on their preparedness (110). In this study, FY1 and stakeholder participants felt that that FY1s were prepared overall, but unprepared for non-technical skills and assessing a medical emergency (110). Stress may be related to competence in emergency situations; therefore it is vitally important that new FY1s have confidence in managing emergencies, and stakeholders have confidence in them (308).

The reasons for this disconnect between stakeholders and students are likely to be complex and depend on multiple factors such as stakeholders' own personal experiences, and their experiences with students and FY1 doctors. Individuals tend to remember both the excellent and the very poor students/doctors (and less so the ones in the middle) and this may influence their answers. In addition, stakeholders may have unrealistic expectations of students and new FY1s (141).

A concept that was touched upon in 6.3.1 that has evolved from the qualitative data in this thesis is that stakeholders feel that students are overprotected or 'mollycoddled' with respect to having direct patient roles. Stakeholders perceived this might result in poorly prepared doctors because modern graduates are not getting the same clinical experience as they used to, both as students and as FY1 doctors. This is also reflected in 6.3.1, with data demonstrating that stakeholders feel student assistantship is most important for preparing students. Medical training has changed substantially over the last 20 years (chapter 1). Senior doctors may think that modern trainees have it 'easy' due to changes resulting from the EWTD. As described in chapter one, before the EWTD, postgraduate training consisted of long hours with no enforced breaks or rest days, which resulted in more clinical experience but was less safe for patients (315). Anecdotally, consultants talk about this training, sometimes not acknowledging the patient safety issues, or how it affected their work-life balance and personal relationships. Although there is a need to increase experiential learning and working independently as students, this should not be to the detriment of patient safety. There needs to be a balance with enough clinical exposure to prepare students and FY1s but maintain patient safety; simulation may be an effective way to fill this gap.

It is difficult to say whether students' views are more accurate, and the stakeholders are comparing students and FY1s to an unrealistic, antiquated model, or if the stakeholders' views are more accurate due to their experience. It may take some years to gain enough experience and introspection to look back and accurately assess preparedness. Furthermore, in this thesis, while students were reflecting on their own individual preparedness, stakeholders were considering the preparedness of the cohort as a whole.

6.4 There may be a ceiling of preparedness, meaning that we can never fully prepare students for the realities of being an independent practitioner

What is clear from the data in this thesis is that students may feel prepared, but they still feel stressed and worried about certain aspects of being an FY1. As discussed in 1.4, preparation for practice not only encompasses competence and confidence, it also includes professionalism and employability (118), both short and long term (119). In this thesis, both competence and confidence were fundamental to participants' understanding of preparedness. Participants expected students to be competent at the skills required to be an FY1, and confident to undertake these skills, including knowing when to escalate. This competence may be built up by teaching, simulation, and clinical experience, but confidence comes from repetition or deliberate practice giving familiarity; repetition is more easily facilitated by simulation.

The transition to professional practice has been discussed many times in this thesis, but still, the enormity of the step up in responsibility cannot be underestimated. It is therefore understandable that no matter how prepared the student is, there may be some trepidation. Indeed, overconfidence and a lack of any apprehension may be a worrying sign, considering these young doctors are often the first medical responders to medical emergencies in secondary care. The GMC agrees with this: "Many medical graduates report not feeling fully prepared, although to some extent moving from academic study into a stretching work environment is inherently difficult to cope with" (118). The data in this thesis suggests that for many competencies and skills, students simply cannot have full independence before the transition, and because of this, they can never feel 100% prepared. The unpredictability of medicine means there will always be a condition or symptom or sign that they have never come across before and therefore do not know how to deal with. Participants suggested that without simulation, they would never be able to have the opportunity to assess a medical emergency independently, emphasising its importance within medical curricula. Despite feeling prepared, the situation on the wards in real life as an FY1 may be more stressful for various reasons, leading to FY1s feeling unprepared. A graduate may know how to manage an acute exacerbation of COPD, but adding in a busy medical ward, with other sick patients, patients' relatives asking questions, nursing colleagues requesting discharge summaries for patients ready for discharge, and unfamiliarity with local policies or IT systems, would likely result in stress, anxiety, and feeling underprepared. The impact of these complexities is supported by some of the literature in the area, where students and FY1s felt prepared overall, but when the environment or situation was more challenging, or there was not support, this leads to feeling unprepared (119, 140, 308). More difficult circumstances may make FY1s feel unprepared where they previously felt prepared, suggesting that preparedness is not linear, but fluctuates depending on the situation (119).

Further to being prepared but still scared, participants also expressed the idea that they were 'as prepared as I can be,' suggesting that students could not identify any areas that their medical school could do to improve training and highlighting the importance of continued development and learning while being an FY1. In addition, there is some evidence from the qualitative data to suggest that students may not be able to tell what they are prepared or unprepared for as a student; it is only when they become doctors with the benefit of experience that they realise. This may be particularly the case for aspects like on-call experience. These ideas suggest that preparedness is a continual concept that spans before, during and after the transition, and is dependent on not only the individual but also the team around them and the hospital environment. The idea of the continual nature of preparedness is supported by Kilminster et al, who describe transitions as "critically intensive learning periods; performance is situated and relational" (122). Performance is, therefore, dependant on details like environment, colleagues, and support.

The importance of learning on the job was highlighted throughout this thesis, with participants describing multiple areas that could only be learnt when the students were FY1s. FY1 participants also described the importance of experience as an FY1 contributing to further learning and development of their skills. This idea of having to learn on the job adds to the theory that students can never be *fully* prepared. The GMC recognises that FY1 and FY2 allow a range of clinical experience to build on doctors' undergraduate education (118). Other literature in this field highlights the significance of learning on the job as an FY1, giving doctors more confidence and competence over time (KP2) (110, 119) and this is also described in the FY1 data from this thesis. Upon graduation, students are awarded provisional registration with the GMC. Learning on the job should be expected and encouraged, given the provisional title.

The other major factor in continued preparedness is appropriate support. There is evidence for the importance of support both during and after the transition throughout the literature: if support is good, FY1s not only enjoy the job more but also it increases confidence (KP2) (121). If an FY1 feels unsupported they will feel unprepared, stressed, anxious and be more likely to suffer burnout, or at the extreme, leave medicine altogether (121). Concern about a perceived lack of support in this thesis made students worry about the transition, but participants realised when they were FY1s that there was good support available. This made participants feel more confident and made the job more enjoyable. This may not be the case for all FY1 posts, so the importance of good support for new doctors must not be forgotten. Reflecting on Kirkpatrick's levels (1.3.1), Kirkpatrick suggests that there is "little or no chance of change (in behaviour) due to training if the climate is preventing or discouraging" (94 pg23-25). No training programme can, therefore, be successful if the work environment is not supportive.

In summary, students feel prepared but still concerned about many aspects of the transition to professional practice. Students and stakeholders feel this is due to the difficulties of striking a balance between medical students having responsibility for patient care and sustaining patient safety and high standards of care. Furthermore, students cannot fully experience the realities of on-call working and may not have experience of the range of clinical cases they will be expected to manage as an FY1. Even for those students who feel completely prepared, factors within the clinical environment may make them feel unprepared when faced with the realities of the medical workplace. Perhaps students cannot be fully prepared for the transition, and students are 'as prepared as they can be'. The transition to professional practice is a critical period that must be managed carefully to ensure patient safety, but also to support and nurture students and junior doctors to ensure the future of the medical workforce. However, the GMC found that students who feel unprepared were more likely to get an unsatisfactory outcome at their ARCP (120), and underconfident and underprepared doctors pose a risk to patients; therefore, it is still important to strive to improve preparedness, confidence, and competence.

6.5 Summary

The results presented in this thesis have highlighted some of the intricacies of adequately preparing medical students for professional practice. Although students report feeling prepared in general for the transition, and for the knowledge and skills required for the transition (including non-technical skills and assessing medical emergencies), they still feel worried about many aspects of professional practice. Furthermore, there were high levels of stress and anxiety surrounding the transition, and levels of stress prior to the transition correlated with perceptions of stress in FY1. Adding to this dichotomy, stakeholders felt students were significantly less prepared than the students rated themselves for non-technical skills and assessing medical emergencies.

In this thesis, both simulation courses, despite their differences, were associated with similar perceptions of general preparedness and preparedness for assessing medical emergencies and non-technical skills. Simulation was felt to have an essential role alongside the student assistantship to ensure students had the relevant skills and knowledge to feel prepared for FY1, and looking back, participants recalled using skills they learnt in simulation in their practice as doctors.

The findings of this thesis raise the possibility of there being a ceiling of preparedness, suggesting that we may never achieve 100% preparedness. There may always be some students who feel unprepared for professional practice; feeling unprepared may not indicate someone who is incompetent, but rather an individual that has appropriate insight into their abilities and a healthy apprehension about a major and important transition. Burnout, stress and mental illness are increasing in the medical profession, and ensuring new doctors feel prepared and confident to work independently may go some way to reducing the stress and anxiety associated with the transition. Separating students who perceive themselves to be unprepared and those who truly are unprepared or do not have the necessary skills to be a safe doctor is vital in order to protect doctors and ultimately ensure safe patient care.

7 Conclusions

This thesis was designed to explore whether simulation training can improve medical students' preparedness for practice.

Chapter one of this thesis illustrated the transformation of medical education over the last 20 years and the expansion of technology-enhanced learning with the increased use of simulation prior to and as an adjunct to clinical experience. The issues surrounding students' preparedness for practice were described, along with various interventions implemented to improve preparation.

In chapter two, effectiveness at KP2 (Change in attitudes or acquisition of knowledge/skills, see 1.3.1) was established for simulation training in undergraduates for non-technical skills, assessing medical emergencies and preparation for practice. Nevertheless, when compared with other methods (such as CBL/PBL or didactic teaching), the benefits of simulation are less clear. The literature review demonstrated a paucity of data for undergraduates at KP3-4 (change in behaviours and effects on patients), few studies addressing perspectives of different informants, and a lack of comparative studies comparing different simulation formats. The data set out in chapters one and two also illustrated the heterogeneity of simulation in medical education and therefore, how difficult it is to analyse the body of evidence as a whole.

Chapter three laid out the theoretical underpinnings of this thesis and justified why using a mixed-methods longitudinal approach was so vital to fully explore the concept of preparedness and how simulation may have a role in preparing for this vital transition. Using qualitative and quantitative data, with multiple methods, participant groups and sites produced a large and rich data set with which to answer the research questions.

The data from this thesis was described over chapters four and five: chapter four first described data surrounding preparedness for OG2015 (3) and overall, with triangulating data from FY1 and stakeholders. It also described participants' conceptualisation of preparedness, and qualitative data on the transition; students' concerns, FY1 stressors and reflections on preparedness. This data was important, as to understand how simulation impacts preparedness, student and stakeholder views on preparedness must first be described. Chapter five then described data on the role of simulation for preparedness, including quantitative and qualitative data on the benefits of simulation for preparedness and how it interacts with other elements of the fifth year.

Chapter six described the key findings of the thesis and situated them in the wider evidence base. This final conclusion chapter aims to describe the strengths and limitations of the thesis and suggest recommendations for improving preparedness and further research.

Overall, this thesis provides evidence to support the use of simulation to prepare medical students for practice as doctors. It has drawn attention to doubts about how far preparedness can go and whether we can fully prepare graduates for life as doctors. It has also highlighted some significant differences between stakeholders' and students' views on preparedness.

The results from this thesis indicate that simulation is effective to develop confidence in some of the skills required to become an FY1 (KP2) and may result in some changes in behaviours that may affect and improve patient care (KP3), adding to the available literature. Proving the effects of simulation at KP4 in undergraduates remains elusive. To provide KP4 evidence would require large-scale longitudinal studies, following students up for many years, and would be prone to bias due to the constant learning happening in the clinical environment. It may be that proving that simulation improves self-efficacy and changes behaviours (KP2-3) may be enough for undergraduate educators. The results also suggest that differing the format and frequency of simulation does not seem to make a difference to students' views of their preparedness. This suggests that medical schools should be encouraged to find different approaches to simulation, allowing individual universities to adapt the method to work within their institution. It also may mean that lower-cost simulation can be used, which could particularly benefit lower-income countries. Lower-cost educational methods would also be welcomed in the UK, as educators seek efficiencies in teaching and assessment methods following increases in student numbers. Alongside simulation, having direct responsibility for patient care within a student assistantship is vital to produce competent, confident and prepared FY1s. Preparedness may ultimately be maximised by using simulation before and alongside clinical practice, in particular assistantship, to allow students to practise being an FY1 in simulation prior to practising on their assistantship. The repetition allowed by simulation was the key feature by which undergraduates learn from simulation from the results of this thesis. This repetition, along with being able to have responsibility for management without senior support and being able to safely make mistakes without repercussions, highlights the different priorities for undergraduate learners compared with postgraduates. This gives further evidence for the importance of simulation for undergraduates, as this repetitive practice could not be emulated in the clinical environment with such ease.

Undoubtedly, the transition from student to doctor is critical, and is associated with high levels of stress and anxiety, as seen both in this thesis and across the literature. Despite this, participants' views on their own preparedness did not change between the student and doctor phases. Through the transition, participants emphasised the importance of both assistantship and simulation for preparedness, further highlighting their symbiotic relationship. This thesis supports the idea that the transition is a "critically intensive learning period" (122); support and the ability to learn on the job are vital to ensuring new FY1s have as smooth a transition as possible.

Full preparedness may not be possible due to the concept of students feeling prepared, but still scared, particularly concerning high-stakes situations such as assessing a medical emergency alone. These situations may always be scary, no matter how prepared or how experienced doctors are. In addition, students cannot possibly experience every condition as an undergraduate, so they will always come across new situations which may lead to feeling underprepared or scared. FY1s are expected to learn on the job, and support in this critical transition is essential.

7.1 Strengths and limitations of the thesis

There are several limitations to this thesis. As discussed in 3.4.1.3, because the total population available was small, a sample size calculation was not undertaken as there was no way to increase the sample population. One possible consequence of this is that the ability of the study to detect small differences between groups might be limited. Cook et al acknowledge that this problem (that the available sample is inadequate to appropriately power a study) is common in medical education research (254). While the quantitative side of this thesis may be underpowered, some statistically significant differences were found, and the addition of qualitative data strengthened the thesis to allow conclusions to be made.

Although the response rate for the student participants was satisfactory (316), with the overall student phase response rate 52%, the stakeholder response rate was low at 32%, and there was substantial drop-out between the student and doctor phases. In year one of the thesis there was poor recruitment, but by year two, this improved dramatically. Poor recruitment in year one led to a methodological change, from focus groups to interviews. It is possible that this affected the results, as having shared experiences may encourage participants to divulge more information (256). Equally, it is possible that having individual interviews also encourages participants to divulge information that they may not have wanted to discuss with their peers present.

As discussed (3.4.2.2), the recruitment issues in year one of the study affected the design of the study. Individual supervisors could not be recruited, and, therefore, the new participant group of stakeholders was introduced. The recruitment issues in year one may have been due to delays in HRA approvals, delays in sending out the link to the questionnaire and students having difficulties expressing interest in focus groups; these issues were overcome in revisions put in place for year two. In addition, due to the recruitment issues, the data became more about perceptions of preparedness and simulation, shifting away from more objective assessment from supervisors and TAB forms (see also 3.3.1).

Although there was longitudinal follow-up, this was only done once, three-four months into FY1 (six months after initial contact). This time interval may not be long enough to demonstrate substantial and lasting change within participants. In addition, only student participants were followed up longitudinally. It is possible that stakeholders' views may also change over time, and therefore, further work is suggested to assess stakeholders' views longitudinally.

Certain information was not collected as part of this study, including ethnicity, gender, age, and personal attributes, mainly due to the anonymous nature of the questionnaires. This data has been collected and analysed previously by amongst others, the GMC (118). The evidence suggests that black and ethnic minority (BAME) students do not perform as well in undergraduate and postgraduate assessment and feel less prepared than their white counterparts. Students under 30 feel more prepared than students over 30, and female doctors feel more prepared than males. If this data had been collected, depending on the results, it may have been possible to develop simulation strategies to target the less-prepared individuals (for example, mature students). The focus of this thesis was not how demographics affect preparedness, and to maintain anonymity this information was not collected. Not collecting this data also kept the questionnaire concise to encourage students to complete it fully.

Due to time pressures, there was limited questionnaire testing, and the questionnaire is unvalidated. This may mean a lack of question clarity, which may affect validity and reliability. Many questions were the same for each participant group, but there were some differences, including the ranking of educational modalities (stakeholders were asked to do this and not students or FY1s) and different wording on the question about the significance of simulation for preparedness. For these items, it is difficult to compare the student and stakeholder participants. As part of the qualitative interviews, student participants were asked what they felt were the most important elements of the fifth year that contribute to preparedness; assistantship and simulation were the most commonly described elements. The questions in all questionnaire versions were mapped to OG2015 (3), which is similar to many studies in the literature, allowing comparison and adding validity. Again, it is important to note that although broad comparisons can be made, stakeholders were commenting on the cohort of students as a whole, rather than individual students.

Because the student questionnaire was completed immediately after the simulation, this may have affected students' views on simulation. As the FY1 views on simulation were almost identical, it is more likely that the student results are an accurate representation of the participants' beliefs and experiences and were not influenced by the proximity of the simulation.

Although the participating medical schools were chosen for their similarities, there are some differences between the curricula (Table 3-4). Both are PBL courses, with early clinical placements, in similar geographical areas. As the data was from two medical schools in one area of England, it may not be generalisable to areas further afield, and represents a snapshot. In addition, there are specific 'preparedness for practice' elements that medical schools must offer in the fifth year, including assistantship and shadowing. However, MMS is a much larger medical school when compared with LMS (see chapter three methods for details) and has more simulation in the fifth year (another two to three sessions of university standardised emergency scenarios). Some Lancaster students had an additional bleep simulation at a different hospital trust, but the number was small. Despite the differences described, the data did not find many significant differences between the two sites, and therefore, it is unlikely that the differences described have affected the results.

Furthermore, considering the other educational modalities in the fifth year, it cannot be said with certainty that preparedness is directly the result of simulation. Other modalities such as assistantship, other teaching and experience on wards will also contribute to preparedness. The data from this thesis suggests that assistantship/practical experience goes hand in hand with simulation to improve preparedness.

The issues with self-report data have been discussed in chapters one to three; in this thesis, self-report data was triangulated with stakeholder data to provide another viewpoint. In addition, the original study design included the TAB form as a more objective measure; following analysis, these forms were not included as they brought no new data or ideas.

Another factor that may have influenced the type of participant recruited and the results is my relationship with the participants. I had a direct undergraduate role at MMS, including involvement in the simulation course under study. I was also involved in the simulation course at Lancaster but did not have a direct role in teaching the undergraduates in the same way that I did at MMS. However, Liamputtong states that “interactions between participants and researchers can help improve the quality of the data” (277 pg60-62). Moreover, this may have improved recruitment for both students and stakeholders. It is possible, like other volunteer studies, that only participants with favourable views of simulation participated in the study. However, the results show a range of attitudes and that assistantship and clinical experience were equally as important as simulation.

Following on from this, qualitative data is usually collected and analysed by two or more researchers. This helps to ensure that no significant themes are missed when analysing the data. Having a single researcher collect and analyse the data introduces the possibility of bias due to preconceived ideas on the topic. In contrast, having a single researcher may have made the qualitative interviews more standardised than they would be with multiple researchers conducting interviews.

Kirkpatrick’s levels have been used throughout this thesis to judge the impact of educational interventions. A drawback of these levels is that the hierarchy implies that level-four outcomes are more important than those at level one. In medical education it is hard to find a more important issue than an intervention impacting patient care and safety (level four). Medical education is more multifaceted than the original context in which Kirkpatrick developed the levels (business), and also some methodologies used in medical education research are not suited to analysis with these levels (96). However, in this thesis the levels fitted well with the available evidence and the results produced in the thesis, and the levels are used throughout medical education literature in their pure or adapted form (101).

Although the stakeholder data provides a measure with which to compare student data, this is general data about stakeholders’ views on the whole cohort. This is in contrast to the student data, which is perceptions of their own individual preparedness. This must be considered when interpreting the differences, as the stakeholders’ views on individual students would likely vary depending on the perceived individual competency of each student.

The major strength of this thesis is the triangulation of questionnaires and interviews, with multiple participant groups and multiple sites, giving a considerable data set to explore how simulation contributes to preparedness. The prospective design allowed the measurement of preparedness in real time and ensured no recall bias. Although the total population was small, statistically significant different views on students' preparedness were found, in particular between stakeholders and students. The response rate for student participants was over 50%, which is considered satisfactory for questionnaire studies (263, 316)

Although the longitudinal follow-up was limited, data was collated across the transition to professional practice. Very few preparedness studies attempt this, particularly those focused on simulation. Even where attempted, the first data was often collected immediately prior to commencing work (and then repeated data collections during FY1 year or equivalent), not earlier during the fifth year (128, 139). Only two other studies have collected data across this important transition, one looking at curriculum design and learning outcomes (308), the other looking at a simulation boot camp for surgical residency in the US (198). Although the latter study is evaluating a simulation course, it does not compare two simulation courses or triangulate multiple informants and methods.

This large data set has provided some results that concur with the wider literature, but also some new findings to add to the literature in this area. This thesis showed that both bleep and ward simulation are effective to prepare students for practice. No previous studies have compared two diverse simulation courses with multiple informants and followed up participants longitudinally. Furthermore, this thesis adds to the few studies in the literature using triangulation of methods, participants and sites, providing diverse data on preparedness and the value of simulation.

This thesis adds to the small number of studies demonstrating KP3-level outcomes by describing students' self-reported change of behaviours as an FY1 using longitudinal data as a direct result of simulation.

Although the relationship between real and simulated clinical learning has been discussed in the literature previously, this data gives new evidence of the symbiotic relationship between real and simulated learning for preparation for practice and provides evidence to support the integration of simulation throughout the fifth year, combined with increased assistantship-style placements focused on preparation for practice. These placements should replace clinical experience not directly focused on preparation for practice, and supervisors should be encouraged to facilitate students' directly managing patient care.

7.2 Recommendations

There are several recommendations from the results of this thesis. These recommendations have been divided into recommendations to improve preparedness and recommendations for further research.

7.2.1 Improving preparedness

To improve preparedness, there should be an increase in on-call experiences, both simulated and real (because students and stakeholders both feel that this will improve preparedness). Simulation may be expanded in a reasonably low-cost way without the use of expensive integrated mannequins. For example, a simulation may be set up like the bleep simulation in this thesis, but without the need to attend a simulation centre. A simulation like this would simply require a telephone, a bleep, a simulation technician and some scenarios.

Students require a more active role in patient care throughout their fifth year, with emphasis on health care professionals working closely with students on the wards to facilitate this. Students and stakeholders feel this will improve preparedness, and placements where ward staff did not facilitate this were not felt to be as beneficial.

It is essential that there be a focus on reducing stress and anxiety around transition. Students still feel anxious and stressed about the transition, and there is a positive correlation between stress levels before and after the transition. Furthermore, the wider evidence indicates that this affects patient care and increases burnout in junior doctors – already experiencing increasing levels of mental health issues. Some of this may be a fear of the unknown, and therefore increased active roles, out of hours shifts and simulation may reduce this.

To align stakeholder and student judgements on preparedness, stakeholders should be involved in discussions regarding improving preparedness, and further work should focus on the reasons for stakeholders' lower judgements of preparedness. Furthermore, to improve preparedness, stakeholders, including FY1 and FY2 doctors, should be more involved in the design of the fifth-year curriculum.

There should be more research into whether resilience and non-technical skills training would mediate students' fears of the unknown and making mistakes. Simulation may be used for resilience training to allow students to make mistakes in a safe environment, without the fear of repercussions, helping students to find strategies to deal with mistakes when they occur in real life. In combination with clinical placements and simulation, resilience training would give students strategies with which to deal with the repercussions of making a mistake and continue to be an effective clinician. Resilience training may, therefore, reduce the fear of making mistakes and make students feel more prepared. The GMC has reported that FY1 doctors often feel that they have to deal with problems that are beyond their abilities (118, 120). Inevitably FY1 doctors will have to deal with the unexpected. With a good follow-up and debrief, these can be valuable learning experiences.

Further work should investigate the reasons for the differences between the two sites for administrative tasks, including reporting drug reactions and clinical incidents, death certification, and preparing a discharge summary. This may help develop strategies to improve preparedness in these areas.

7.2.2 Future research

There is a pressing need for further longitudinal studies following doctors up after foundation years to see how preparedness or lack of preparedness affects their future careers; for example, performance in postgraduate examinations.

Information is not available on how and what simulation is used in UK medical curricula. It is possible that simulation usage in individual medical schools is affecting how prepared their graduates are, as many other elements in the fifth year are standardised (for example, student assistantship). Therefore, a national collaborative programme investigating simulation strategies utilised in UK medical schools would allow educators to see what works, what does not, and how simulation affects students' preparedness. Collaboration may enable educators to find the most effective simulation strategies to improve students' preparedness and reduce stress. A collaboration may also allow standards to be set for undergraduate simulation.

Cost-effectiveness is a massive issue in the current financial climate: the cost of simulation can be difficult to estimate and is often not included in simulation studies. More work needs to focus on the cost-effectiveness of educational methods including simulation.

Ultimately, if there is a ceiling with respect to self-reported preparedness, as suggested by this thesis, the education community must consider whether there is a better way to assess and collect data regarding preparedness. In addition to self-reported data, multiple informants and methods should be used to gain a better and more holistic understanding of graduates' preparedness in the UK.

7.3 Dissemination of research findings

The results from this thesis have been presented at the Association for the Study of Medical Education (ASME) conference 2018, and at the Association for Simulated Practice in Healthcare (ASPiH) conference 2019, with an abstract published in the BMJ for Simulation and Technology Enhanced Learning. The intention is to submit the thesis data for publication in a medical education journal, either as one or multiple manuscripts.

7.4 Summary

Preparedness for professional practice is clearly multifaceted and difficult to describe and measure, as there is no single definition and currently no validated tool to assess preparedness. Although this thesis has provided mainly self-report data on the topic, it has attempted to provide multiple triangulating data using different methods, participants and locations. Furthermore, it is also difficult to establish how simulation directly affects preparedness, due to the multitude of confounding factors within medical education. Nevertheless, data from this thesis suggests that simulation has a key role with the student assistantship, no matter the format, to help students feel more prepared for professional practice.

Ultimately, there may be a ceiling of preparedness, as students will likely always be apprehensive about the transition and have concerns, even about matters that 'on paper' they feel prepared for. Despite this, educators should still strive to improve preparedness, even if 100% preparedness is not achievable. Further work should focus on the disconnect between stakeholder and student perceptions and finding an alternative method of measuring preparedness, potentially combining multiple methods and informants to gain a more comprehensive view of preparedness. This would allow a better appreciation of whether interventions to improve preparedness are successful. Simulation should be integrated into a 'preparedness for FY1' focused fifth year with an emphasis on increasing students' patient care responsibilities and incorporating resilience training. Students may feel unprepared due to the expectation of FY1 not reflecting the realities. Managing expectations in undergraduates is therefore key to preparing for the transition. This may include real experience of the realities of independent working throughout medical curricula, integration of simulation with student assistantship, and ensuring good support before, during and after the transition to enable FY1 doctors to continue to learn on the job. Efforts must continue to enable medical schools to produce safe, confident, resilient doctors who can cope with the demands of the modern NHS.

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APPENDIX 1 – Search strategies

	Database(s)	Search Term
3	Medline	exp "EDUCATION, MEDICAL, UNDERGRADUATE"/
5	Medline	(simulation).ti,ab
6	Medline	exp "SIMULATION TRAINING"/ OR exp "PATIENT SIMULATION"/
7	Medline	(5 OR 6)
9	Medline	(3 AND 7)
10	Medline	9 [DT 2000-2017] [Languages English]
11	EMBASE	exp "MEDICAL STUDENT"/
12	EMBASE	(simulation).ti,ab
13	EMBASE	exp SIMULATION/
14	EMBASE	(12 OR 13)
15	EMBASE	(11 AND 14)
16	EMBASE	15 [DT 2000-2017] [English language]
18	CINAHL	exp "STUDENTS, MEDICAL"/
19	CINAHL	(simulation).ti,ab
20	CINAHL	exp SIMULATIONS/
21	CINAHL	(19 OR 20)
22	CINAHL	(18 AND 21)
23	CINAHL	22 [DT 2000-2017] [Languages eng]
25	PubMed	(medical undergraduate*).ti,ab
26	PubMed	(medical student*).ti,ab
27	PubMed	(25 OR 26)
28	PubMed	(simulat*).ti,ab
29	PubMed	(27 AND 28)
31	EMBASE	15 [DT 2000-2018] [English language] [Humans]
32	Medline	9 [DT 2000-2018] [Languages English] [Humans]

	Database(s)	Search Term
33	CINAHL	22 [DT 2000-2018] [Languages eng]

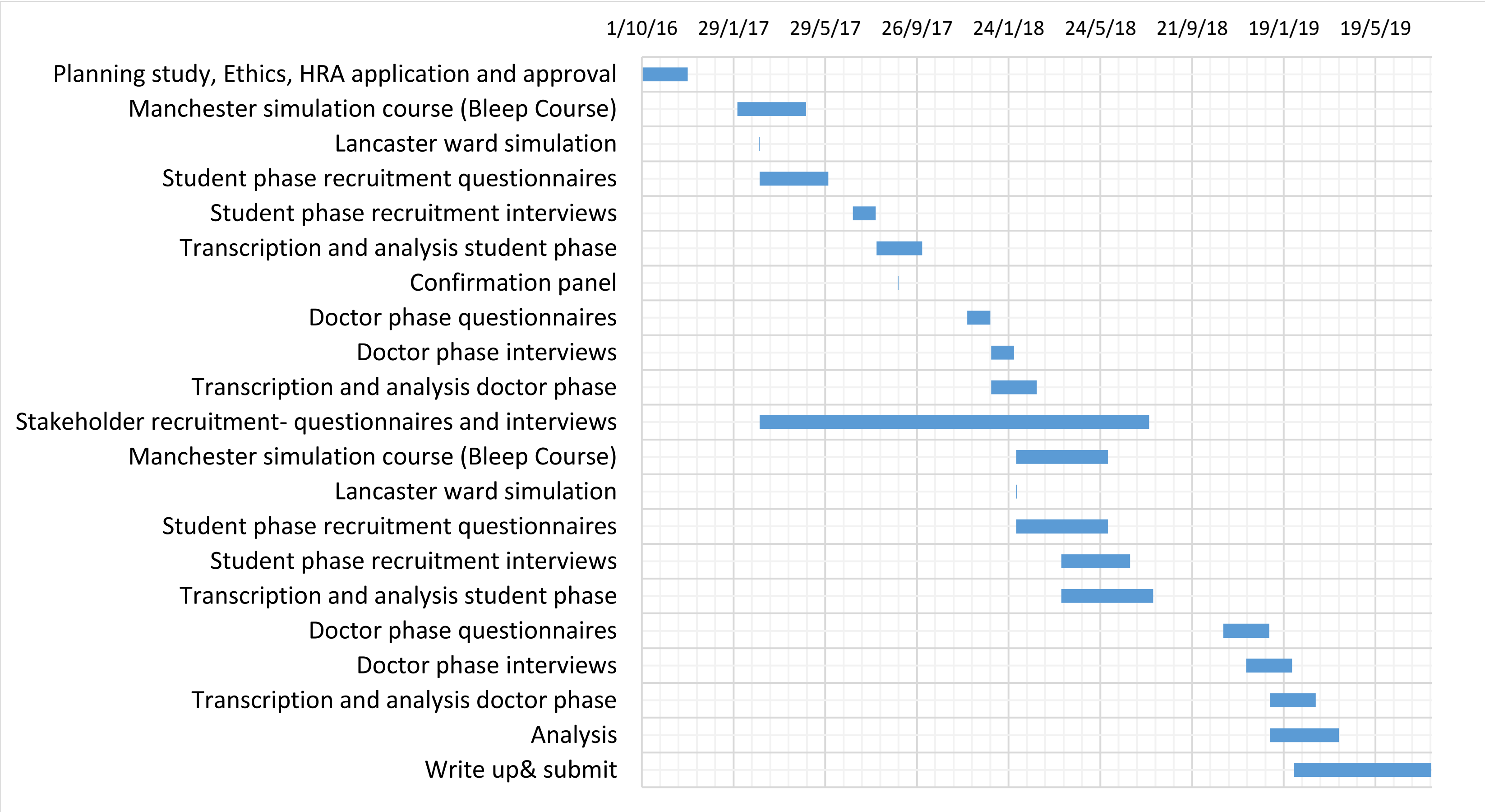
	Database(s)	**Search Term**
1	Medline	(non-technical skills).ti,ab
2	Medline	(human).ti,ab
3	Medline	(factors).ti,ab
4	Medline	*(2 AND 3)*
5	Medline	exp "EDUCATION, MEDICAL, UNDERGRADUATE"/ OR exp "EDUCATION, MEDICAL"/
6	Medline	*(1 OR 4)*
7	Medline	*(5 AND 6)*
8	Medline	(simulat*).ti,ab
9	Medline	*(7 AND 8)*

	Database(s)	**Search Term**
1	Medline	(deteriorating patients).ti,ab
2	Medline	(acutely unwell patients).ti,ab
4	Medline	exp "EDUCATION, MEDICAL, UNDERGRADUATE"/ OR exp "EDUCATION, MEDICAL"/
5	Medline	exp "HIGH-FIDELITY SIMULATION TRAINING"/ OR exp "PATIENT SIMULATION"/
6	Medline	(simulat*).ti,ab
8	Medline	(sick patient).ti,ab
9	Medline	*(1 OR 2 OR 8)*
10	Medline	*(5 OR 6)*
11	Medline	*(4 AND 9 AND 10)*

APPENDIX 2 – Information collected in TAB

Attitude and/or behaviour	*No concern*	*Some concern*	*Major concern*	***COMMENTS:*** *Anything especially good? If you cannot give an opinion due to lack of knowledge of the foundation doctor say so here.* ***You must specifically comment on any concern about behaviour*** *and this should reflect the trainee's behaviour over time – not usually just a single incident.*
Verbal communication skills • Gives understandable information. • Speaks good English, at the appropriate level for the patient.				
Attitude and/or behaviour • Listens. • Is polite and caring. • Shows respect for patients' opinions, privacy, dignity, and is unprejudiced.				
Team-working/working with colleagues • Respects others' roles, and works constructively in the team • Hands over effectively, and communicates well • Is unprejudiced, supportive and fair				
Accessibility • Accessible • Takes proper responsibility. Only delegates appropriately. • Does not shirk duty • Responds when called. Arranges cover for absence				

APPENDIX 3 – GANNT chart of thesis



APPENDIX 4 – Ethics approvals

NHS
Health Research Authority

Dr Ciara Carpenter
Educational research fellow in Obstetrics and Gynaecology,
Lancaster University
Lancashire teaching Hospitals NHS Trust
Royal Preston Hospital
Sharoe Green Lane
Fulwood, Preston
PR2 9HT

Email: hra.approval@nhs.net

16 February 2017

Dear Dr Ciara Carpenter

Letter of HRA Approval

Study title:	**Investigating the effectiveness of simulation to prepare medical students for professional practice; A mixed methods study**
IRAS project ID:	**216791**
REC reference:	**17/HRA/0083**
Sponsor	**Lancaster University**

I am pleased to confirm that HRA Approval has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications noted in this letter.

Participation of NHS Organisations in England

The sponsor should now provide a copy of this letter to all participating NHS organisations in England.

Appendix B provides important information for sponsors and participating NHS organisations in England for arranging and confirming capacity and capability. **Please read *Appendix B* carefully**, in particular the following sections:

- *Participating NHS organisations in England* – this clarifies the types of participating organisations in the study and whether or not all organisations will be undertaking the same activities
- *Confirmation of capacity and capability* - this confirms whether or not each type of participating NHS organisation in England is expected to give formal confirmation of capacity and capability. Where formal confirmation is not expected, the section also provides details on the time limit given to participating organisations to opt out of the study, or request additional time, before their participation is assumed.
- *Allocation of responsibilities and rights are agreed and documented (4.1 of HRA assessment criteria)* - this provides detail on the form of agreement to be used in the study to confirm capacity and capability, where applicable.

Page **1** of **9**

Amendment to study ID 216791 - Google Chrome

University of Lancaster [GB] | https://exchange.lancs.ac.uk/owa/?ae=Item&a=Open&t=IPM.Note&id=RgAAAAAKKee8WXIESLs5GYrXO0zIBwAoK%2bI8IxDaT5okdX2C5j8wAAAAmI9BAAAoK%2bI8IxDaT5okdX2C5j8wAA

Reply Reply All Forward

Amendment to study ID 216791

Carpenter, Ciara

To: AMENDMENTS, Hra (HEALTH RESEARCH AUTHORITY) [hra.amendments@nhs.net]

Cc: ali.hussain2@nhs.net

Attachments: (3) Download all attachments

Appendix 1_Research Propo~1.docx (279 KB) [Open as Web Page]; non-substantia lminor-ame~1.docx (25 KB) [Open as Web Page]; Ciara Carpenter %28FHMREC1~1.pdf (73 KB) [Open as Web Page]

Friday, April 07, 2017 10:45 AM

From: AMENDMENTS, Hra (HEALTH RESEARCH AUTHORITY) [hra.amendments@nhs.net]
Sent: Monday, March 27, 2017 11:22 AM
To: Carpenter, Ciara
Cc: Brewster, Liz; Vince, Gill; Hopkins, Diane; 'gemma.whiteley@lthtr.nhs.uk'
Subject: RE: Amendment 17/HRA/0083/AM01 , IRAS Project ID: 216791 - Category A

Dear Dr Carpenter,

IRAS Project ID:	216791
Short Study Title:	Simulation to prepare medical students for practice
Date complete amendment submission received:	22/03/17
Amendment No./ Sponsor Ref:	NSA #1
Amendment Date:	04/03/17
Amendment Type:	Non-substantial

Thank you for submitting the above referenced amendment. In line with the UK Process for Handling UK Study Amendments I can confirm that this amendment has been categorised as:

Category C - An amendment that has no implications that require management or oversight by the participating NHS organisations

As such, the sponsor may implement this amendment **as soon as any relevant regulatory approvals are in place** (for participating organisations in England, please see 'Confirmation of Assessment Arrangements' below).

As Chief Investigator/Sponsor, it remains your responsibility to ensure that the research management offices and local research teams (if applicable) at each of your participating organisations are informed of this amendment.

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15:00
10/07/2017

REC Reference: 17/HRA/0083, IRAS Project ID: 216791- Category B - Google Chrome

University of Lancaster [GB] | https://exchange.lancs.ac.uk/owa/?ae=Item&a=Open&t=IPM.Note&id=RgAAAAAKKee8WXIESLs5GYrXO0zIBwAoK%2bl8lxDaT5okdX2C5j8wAAAAml8%2fAAAoK%2bl8lxDaT5okdX2C5j8wA

Reply Reply All Forward

REC Reference: 17/HRA/0083, IRAS Project ID: 216791- Category B

AMENDMENTS, Hra (HEALTH RESEARCH AUTHORITY) [hra.amendments@nhs.net]

To: Carpenter, Ciara

Cc: Hopkins, Diane; 'gemma.whiteley@lthtr.nhs.uk'; Ethics (RSO) Enquiries

Monday, April 10, 2017 12:50 PM

- You forwarded this message on 4/10/2017 2:30 PM.

Dear Dr Carpenter,

IRAS Project ID:	216791
Short Study Title:	Simulation to prepare medical students for practice
Date complete amendment submission received:	07/04/17
Amendment No./ Sponsor Ref:	Protocol Update - 30/03/17
Amendment Date:	30/03/17
Amendment Type:	Non-substantial

Thank you for submitting the above referenced amendment. In line with the UK Process for Handling UK Study Amendments I can confirm that this amendment has been categorised as:

- **Category B** - An amendment that has implications for, or affects, SPECIFIC participating NHS organisations

You should now provide this email, together with the amended documentation, to the research management support offices **and** local research teams at your participating NHS organisations in England that are affected by this amendment.

If you have participating NHS organisations in Northern Ireland, Scotland and/or Wales that are affected by this amendment, you should communicate directly with the relevant research teams to prepare them for implementing the amendment, as per the instructions below. You do not need to provide this email or your amended documentation to their research management support offices, as we will pass these to the relevant national coordinating functions who will do this on your behalf.

Subject to the four conditions below, you will be able to implement the amendment at affected participating NHS organisations in England **35 days after you notify them of the amendment**. A template email to notify participating NHS organisations in England is provided here.

- You may not implement this amendment until and unless you receive all required regulatory approvals, including REC favourable opinion where applicable, (for participating organisations in England, please see 'Confirmation of Assessment Arrangements' below). You should provide regulatory approvals to the research management support offices and

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14:58
10/07/2017

FW: IRAS 216791. Confirmation of Amendment Categorisation as Category A - Google Chrome

University of Lancaster [GB] | https://exchange.lancs.ac.uk/owa/?ae=Item&a=Open&t=IPM.Note&id=RgAAAAAKKee8WXIESLs5GYrXO0zIBwAoK%2bl8IxDaT5okdX2C5j8wAAAAml8%2fAAAoK%2bl8IxDaT5okdX2C5j8w

Reply Reply All Forward

FW: IRAS 216791. Confirmation of Amendment Categorisation as Category A

AMENDMENTS, Hra (HEALTH RESEARCH AUTHORITY) [hra.amendments@nhs.net]

To: Carpenter, Ciara

Wednesday, July 05, 2017 9:56 AM

- You replied on 7/5/2017 10:49 AM.

Sent: 03 July 2017 15:12
To: ciara.carpenter1@nhs.net
Cc: drciara@msn.com; ethics@lancaster.ac.uk; Gemma.whiteley@lthtr.nhs.uk
Subject: IRAS 216791. Confirmation of Amendment Categorisation as Category A

Dear Dr Carpenter,

IRAS Project ID:	**216791**
Short Study Title:	**Simulation to prepare medical students for practice**
Date complete amendment submission received:	**21 June 2017**
Amendment No./ Sponsor Ref:	**Amendment no 3, 30/05/17**
Amendment Date:	**20 June 2017**
Amendment Type:	**Substantial**

Thank you for submitting the above referenced amendment. In line with the UK Process for Handling UK Study Amendments I can confirm that this amendment has been categorised as:

- **Category A** - An amendment that has implications for, or affects, ALL participating NHS organisations

You should now provide this email, together with the amended documentation, to the research management support offices **and** local research teams at your participating NHS organisations in England.

If you have participating NHS organisations in Northern Ireland, Scotland and/or Wales, you should communicate directly with the relevant research teams to prepare them for implementing the amendment, as per the instructions below. You do not need to provide this email or your amended documentation to their research management support offices, as we will pass these to the relevant national coordinating functions who will do this on your behalf.

Subject to the three conditions below, you will be able to implement the amendment at your participating NHS organisations in England **35 days after you notify them of the amendment.** A template email to notify participating NHS organisations in England is provided here.

Subject to the same three conditions, you will be able to implement your amendment at participating NHS organisations in Northern Ireland, Scotland or Wales on 26 July 2017.

- You may not implement this amendment until and unless you receive all required regulatory approvals, including REC favourable opinion where applicable, (for participating organisations in England, please see 'Confirmation of Assessment Arrangements' below). You should provide regulatory approvals to the research management support offices and local research teams at your participating NHS organisations in England, plus to local research teams at any participating NHS organisations in Northern Ireland, Scotland or Wales*.
- You may not implement this amendment at any participating NHS organisations which inform you within the 35 day period that they require additional time to consider the amendment, until they notify you

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14:54
10/07/2017

APPENDIX 5 – Participant consent form

Lancaster University
Medical School

APPENDIX 4A

Consent Form

Study Title: What type of Simulation is most effective to prepare Medical Students for Practice?

We are asking if you would like to take part in a research project looking at what type of simulation course (Ward based, Bleep style,) is most effective to prepare medical students for practice.

Before you consent to participating in the study we ask that you read the participant information sheet and mark each box below with your initials if you agree. If you have any questions or queries before signing the consent form please speak to the principal investigator, Dr Ciara Carpenter.

Statement	Please tick
I confirm that I have read the information sheet and fully understand what is expected of me within this study	
I confirm that I have had the opportunity to ask any questions and to have them answered.	
I understand that my focus group/ interview will be audio recorded and then made into an anonymised written transcript.	
I understand that audio recordings will be kept until the research project has been examined and/or published.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my academic training or legal rights being affected.	
I understand that once my data have been anonymised and incorporated into themes it might not be possible for it to be withdrawn, though every attempt will be made to extract my data, up to the point of publication.	
I understand that the information from my interview and questionnaires will be pooled with other participants' responses, anonymised and may be published.	
I consent to information and anonymised quotations from my interview and questionnaires being used in reports, conferences and training events.	
I understand that the researcher will discuss data with their supervisor as needed.	
I understand that any information I give will remain confidential and anonymous unless it is thought that there is a risk of harm to myself or others, in which case the principal investigator will need to share this information with their research supervisor.	
I consent to Lancaster University keeping written transcriptions of the interview for 10 years after the study has finished.	
I consent to my supervisor being contacted and filling out a questionnaire about me (but understand it is anonymous, data will be amalgamated and will not be linked to me)	
I consent to take part in the above study.	

Name of Participant__________________ Signature____________________ Date ___________

Name of Researcher __________________Signature ____________________Date ___________

V2
30/5/17

APPENDIX 6 – Study advertisements

Calling all final year MEDICAL STUDENTS….

Have you done/ are you going to be doing a simulation course in the next few months?……

Are you interested in how your medical school prepares you for working as a doctor, and improving this?…..

Can you spare some time to take part in a research study on the use of SIMULATION TO PREPARE MEDICAL STUDENTS FOR PRACTICE?

DON'T WORRY! It's no extra work/exams/courses

We just would invite you to fill out a questionnaire after your Ward/Bleep Simulation, and potentially take part in a focus group/Interview telling us about your experiences.

We would also send you another questionnaire about 4 months into you Foundation jobs and invite you to another focus group/interview telling us about how you found the transition.

At both stages with your consent we would like your supervisors to fill out a questionnaire about how prepared you were/are

Please contact Ciara (lead researcher and junior doctor) if you would like more information or to take part

You could win a £50 Amazon voucher if you participate in the focus group/interview!

Thanks for reading!

c.carpenter@lancaster.ac.uk

V.2
30/5/17

Facebook advert

Are you in Final year?

Can you spare some of your time to fill out a questionnaire and be part of a focus group/interview for a research project?

We are undertaking a research study looking at the best way to use simulation for preparation for practice and are looking for Lancaster/Manchester *delete as applicable* medical students to answer a quick questionnaire and take part in a focus group/interview about your experiences and how prepared you feel to start work.

Full participant information may be found here *insert participant info sheet*

You could win a £50 amazon voucher if you participate in the focus group/interview!

Please contact Ciara (lead researcher) if you would like to be involved;

c.carpenter@lancaster.ac.uk

Twitter

Final year students!

Can you spare some time for a research study looking at use of simulation?

c.carpenter@lancaster.ac.uk for details140 characters.

V2
30/5/17

APPENDIX 7 – Student PIS

Lancaster University Medical School

Participant Information Sheet

Investigating the effectiveness of simulation to prepare medical students for professional practice.

My name is Ciara Carpenter and I am conducting this research as a student in the doctoral research programme at Lancaster University, UK. I also work as an Obstetric registrar at Lancashire teaching hospitals NHS Trust.

What is the study about?

We are looking at the best way to prepare medical students for practice as doctors, using simulation. As you will know, there is a wide variety of type and uses for simulation, but in this context we mean the use of high fidelity simulation (e.g. SimMan) scenarios concentrating on acute care and non-technical skills. There is a great deal of variation in how simulation is undertaken and used by medical schools throughout the UK; we want to see if a Bleep style course (in which students take a bleep/pager and respond to various tasks incorporating simulation) or a Ward simulation course would improve preparation

Why have I been approached?

You have been approached because you are a medical student, currently in the final year of university.

Do I have to take part?

No. It is completely up to you whether you take part or not; You will not be disadvantaged in your training should you decide not to participate.

What will I be asked to do if I take part?

If you decide to take part, we will invite you to complete a questionnaire after you have completed the simulation course that is offered by your university. You will then be invited to take part in a focus group/interview after the course has been completed. You will then be contacted in November-December time once you have been working for a few months for a further online questionnaire. At this stage you will be invited for an interview about your experiences (which will take place in January), and we would ask for a copy of your TAB (team assessment behaviour) form from your educational Eportfolio to see how you are progressing. With your consent, we will also be asking your supervisors to complete a questionnaire at both stages. Although the supervisor will be filling out the questionnaire about you directly, when analysed this data will be anonymous; it will be amalgamated and not analysed individually. This feedback is broadly similar to feedback the you would receive from your supervisor outside of the research study, so if there were any concerns this would routinely be highlighted via the usual routes rather than via the research data. Unfortunately, it would not be possible for you to see this feedback as the questionnaire is anonymous, but you may be able to approach your supervisor to discuss this. You are welcome to do all, or part of the study if you wish, by completing the questionnaires that does not mean you are obliged to take part in the focus groups or interviews.

We will also be asking key supervisors and stakeholders for year 5 students to comment GENERALLY regarding their impression of how prepared the year 5 students are in their hospital and what role simulation plays in this. This will be via a questionnaire +/- Interview.

V.2
30/5/17

Will my data be identifiable?

The information you provide is anonymous. The data collected for this study will be stored securely and only the researchers conducting the study will have access to this data;

- Audio recordings will be deleted once the thesis has been completed. The files will be encrypted (no one other than the researcher and supervisors will be able to access them) and the computer password protected
- At the end of the study the questionnaire will be kept online in a password protected and encrypted account.
- The typed version of the focus group/ interviews will be made anonymous by removing identifying information including your name. Anonymised direct quotations from the focus groups may be used in the final report so your name will not be attached to them. This data will not be accessible to other researchers unless approved by the faculty of Health and medicine
- When attending a focus group or interview, although what you say will be confidential, if the sessions are taking place on NHS property (rather than by phone or skype) they can never be truly anonymous
- Data from the questionnaire will be deposited in the Lancaster University repository and will be freely available to other researchers on application.
- All your personal data will be confidential and will be kept separately from your focus group data.

There are some limits to confidentiality: if what is said in the focus group/interview makes me think that you, someone else, or a patient is at significant risk of harm, I will have to break confidentiality and speak to a member of staff about this. If possible, I will tell you if I have to do this.

What will happen to the results?

The results will be summarised and reported in a thesis and may be presented at a conference or submitted for publication in an academic or professional journal. A summary of the findings will also be emailed to you.

Are there any risks?

There are no risks anticipated with participating in this study. However, if you experience any distress following participation you are encouraged to inform the researcher and contact the resources provided at the end of this sheet or your clinical/educational supervisor.

Are there any benefits to taking part?

Although you may find participating interesting, there are no direct benefits in taking part. As a thank you for taking part in the focus groups/interviews I will enter all those participants into a draw to win a £50 amazon voucher

Who has reviewed the project?

This study has been reviewed and approved by the Faculty of Health and Medicine Research Ethics Committee at Lancaster University, the Health Research Authority and Manchester University ethics committee.

Where can I obtain further information about the study if I need it?

If you have any questions about the study, please contact the main researcher:

Dr Ciara Carpenter, Education Research Fellow, Lancashire Teaching Hospitals NHS Trust and MD student at Lancaster Medical School.

c.carpenter@lancaster.ac.uk

Supervisors;

Dr Liz Brewster, Lancaster University

Lecturer, Lancaster Medical School, Lancaster University
Tel: 01524 595 018
e.brewster@lancaster.ac.uk

Dr Gill Vince, Lancaster University

Director of Medical Studies, Lancaster Medical School, Lancaster University

Tel: +44 (0)1524 593733

g.vince@lancaster.ac.ukg.vince@lancaster.ac.uk

Complaints

If you wish to make a complaint or raise concerns about any aspect of this study and do not want to speak to the researcher, you can contact:

Professor Roger Pickup, Associate Dean for Research, Faculty of Health and Medicine, Lancaster University. Tel: +44 (0)1524 593746; email: r.pickup@lancaster.ac.uk

Other sources of support

Lancaster student support;

http://www.lancaster.ac.uk/student-based-services/wellbeing-counselling-and-mental-health/

Manchester student support;

http://www.studentsupport.manchester.ac.uk/health-and-wellbeing/

The BMA

BMA Counselling (24-hours a day, seven days a week) and the Doctors Advisor Service
call **0330 123 1245**

DocHealth is a new confidential, not for profit service giving doctors an opportunity to explore difficulties, both professional and personal, with senior clinicians.

http://www.dochealth.org.uk/

APPENDIX 8 – Email invitation to student participants

Lancaster University Medical School

Initial Email to student participants

Investigating the effectiveness of simulation to prepare medical students for professional practice; A mixed methods study

Dear Colleague,

My name is Ciara Carpenter and I am a student in the MD Medicine programme at Lancaster University, UK. I also work as an Obstetric Registrar at Lancashire Teaching Hospitals NHS Trust.

I am conducting a research project investigating the use of simulation to prepare medical students for professional practice and would like to invite you to take part.

After your simulation day/Bleep course you would be required to fill out a short questionnaire, which can be accessed on paper on the day or online in the following weeks and attend a focus group or Interview asking about your experience and how prepared you feel for your Foundation jobs

I would then contact you in Nov-Dec to invite you to fill out another short questionnaire and I will invite you to take part in an interview about your experiences. I would also like feedback about your preparedness from your supervisors at both stages which I'll ask you to consent to at the focus group stage. Although your supervisor will be filling out the questionnaire about you, when analysed this data will be anonymous; it will be amalgamated and not analysed individually. This feedback is broadly similar to feedback you would receive from your supervisor outside of the research study, so if there were any concerns this would routinely be highlighted via the usual routes rather than via the research data

The final thing I will ask for is a copy of a summary of your Team Assessment Behaviour form from your foundation Eportfolio.

If you only wish to fill in the questionnaires and not take part in any focus groups or interviews you are very welcome to do so.

I hope that this will not take much of your time, you will be contributing to the education of future generations of doctors and I will keep you updated of the results.

If you are happy to take part, please find please find below your unique, single use link to the study questionnaire.

Please see the attached information for further details.

This study has been approved by Lancaster Faculty of Health and Medicine Research Ethics Committee (Ref: FHMREC16037) and the HRA, **IRAS ID 216791, Ref 17/HRA/0083**

If you have any questions, please feel free to drop me an email.

Should you wish to contact my Supervisor about any concerns or questions, her details are below.

Kind Regards

Ciara

c.carpenter@lancaster.ac.uk

Supervisor; Dr Liz Brewster

e.brewster@lancaster.ac.uk

V.3
30/05/17

APPENDIX 9 – Student phase questionnaire

Lancaster University
Medical School

Preparedness for Practice Questionnaire - Student Participants

This questionnaire is asking you to report how prepared you now feel for practice as a doctor in a range of domains, taken directly from the GMC 'Outcomes for Graduates' and 'Tomorrow's Doctors'. Please answer the questions as honestly as you can, your answers to the questions are confidential and will not affect your academic progress or future career. By completing this questionnaire, you are confirming that you have read the information provided to you (please see attached) and that you consent to the information from this questionnaire being analysed anonymously and published. Participant information sheet students

Q1. Are you a student at
- ○ Manchester Medical School
- ○ Lancaster Medical School

Q2. Lancaster students; What simulation have you taken part in this year?
- ○ Simulation day at RLI
- ○ Bleep course at Blackburn
- ○ Both of these
- ○ None of these

Q3. At this moment in time, I feel my training has prepared me to;

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Take a thorough medical history	○	○	○	○	○
Perform an appropriate physical examination	○	○	○	○	○
Select appropriate investigations	○	○	○	○	○
Answer patients questions and concerns	○	○	○	○	○
Respect and understand principles of patient centred care	○	○	○	○	○
Interpret results of basic diagnostic tests (e.g. Bloods, ECG, X-Rays	○	○	○	○	○
Formulate a differential diagnosis	○	○	○	○	○
Undertake a mental state examination	○	○	○	○	○
Deal with patients with dependance issues or self harm	○	○	○	○	○
Assess patients capacity in line with GMC guidance	○	○	○	○	○
Formulate a diagnosis and management plan	○	○	○	○	○
Prescribe appropriate medications	○	○	○	○	○
Report an Adverse Drug Reaction	○	○	○	○	○
Plan a patients' discharge	○	○	○	○	○
Look after a patient at the end of their life	○	○	○	○	○
Break bad news to patient/family	○	○	○	○	○
Complete a discharge summary	○	○	○	○	○
Communicate with difficult/violent/angry patients and those with mental illness	○	○	○	○	○
Assess and recognise a medical emergency/deteriorating patient.	○	○	○	○	○
Perform basic and intermediate life support	○	○	○	○	○
Fill out a Death certificate and Cremation form	○	○	○	○	○
Adapt to changing circumstances and uncertainty	○	○	○	○	○
Manage time appropriately and prioritize tasks	○	○	○	○	○
Work independently and autonomously, taking responsibility for decisions	○	○	○	○	○
Teach colleagues and students	○	○	○	○	○
Work in a multidisciplinary team	○	○	○	○	○
Lead a team	○	○	○	○	○
Report a clinical error	○	○	○	○	○
Understand and practice concepts of infection control	○	○	○	○	○

V2
31/5/17

Q4. At this moment in time, I feel prepared to undertake the following procedures

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Temperature, Pulse, Respiration rate, Blood Pressure	O	O	O	O	O
Venepuncture	O	O	O	O	O
Cannulation	O	O	O	O	O
Blood Cultures	O	O	O	O	O
ECG	O	O	O	O	O
Urine analysis including pregnancy testing	O	O	O	O	O
Blood transfusions	O	O	O	O	O
Intramuscular and subcutaneous injections	O	O	O	O	O
Administer local anaesthetic	O	O	O	O	O
Catheterisation	O	O	O	O	O
Skin suturing	O	O	O	O	O
Wound care	O	O	O	O	O

Q5. Please select an answer to the following statements

	Strongly agree	Somewhat agree	Neither agree nor disagree)	Somewhat disagree	Strongly disagree
"The thought of becoming a doctor makes me feel stressed"	O	O	O	O	O
"I am anxious about the transition to becoming a doctor"	O	O	O	O	O
"I feel adequately prepared for my first job as a doctor"	O	O	O	O	O
"The skills I have learnt through simulation have set me up well for working as a foundation doctor"	O	O	O	O	O

Q6. What is the one issue that MOST concerns you about starting work as a Doctor?

Q7. Are these concerns regarding preparedness a

- O Minor concern
- O Moderate concern
- O Major concern

Q8. What (if anything) could your medical school have done to better prepare you for starting work as a Doctor?

I consent to being contacted approximately 4 months into my FY1 job to fill out another questionnaire (please provide an email address you will have access to)

I am happy to be contacted to take part in a focus group about my experiences

- **Yes**
- **No**

With your consent, we would like to ask your Clinical Supervisor to complete a questionnaire regarding how prepared they feel you are for practice. Although the supervisor will be filling out the questionnaire about you directly, when analysed this data will be anonymous; it will be amalgamated and not analysed individually. This feedback is broadly similar to feedback the you would receive from your supervisor outside of the research study, so if there were any concerns this would routinely be highlighted via the usual routes rather than via the research data. Unfortunately, it would not be possible for you to see this feedback as the questionnaire is anonymous, but you may be able to approach your supervisor to discuss this.

I am happy for my supervisor to be contacted to fill out an anonymous questionnaire as detailed above

- **Yes**
- **No**

Please provide name and email (if known) of your most recent clinical supervisor

Thank you for completing this questionnaire!

APPENDIX 10 – Foundation doctor questionnaire

Lancaster University
Medical School

Preparedness for Practice Questionnaire - Foundation doctor Participants

Q1 This questionnaire is asking you to report how prepared you now feel for practice as a doctor in a range of domains, taken directly from the GMC 'Outcomes for Graduates' and 'Tomorrow's Doctors' Please answer the questions as honestly as you can, your answers to the questions are confidential and will not affect your academic progress or future career By completing this questionnaire you are confirming that you have read the information provided to you (please see attached) and that you consent to the information from this questionnaire being analysed anonymously and published. Appendix 4 participant information sheet students

Q9 Were you a student at
- Manchester Medical School (1)
- Lancaster Medical School (2)

If Manchester Medical School Is Selected, Then Skip To What UK deanery do you now work within?

Q19 Did you undertake the 'Bleep simulation course' at the Royal Blackburn Hospital?
- Yes (1)
- No (2)
- Don't remember (3)

Q17 What UK deanery do you now work within?
- North East (1)
- North West (2)
- Yorkshire and the Humber (3)
- East Midlands (4)
- West Midlands (5)
- East of England (6)
- Thames Valley (7)
- Wessex (8)
- South West (9)
- Kent, Surrey, Sussex (10)
- South London (11)
- North, Central and East London (12)
- North West London (13)
- Wales (14)
- Scotland (15)
- Northern Ireland (16)
- I do not work in the UK (please specify) (17) ____________________

V.2
30/5/17

Q2 At this moment in time, I feel my medical school prepared me to;

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Take a thorough medical history (1)	○	○	○	○	○
Perform an appropriate physical examination (2)	○	○	○	○	○
Select appropriate investigations (3)	○	○	○	○	○
Answer patients questions and concerns (4)	○	○	○	○	○
Respect and understand principles of patient centered care (5)	○	○	○	○	○
Interpret results of basic diagnostic tests (e.g. Bloods, ECG, X-Rays (6)	○	○	○	○	○
Formulate a differential diagnosis (7)	○	○	○	○	○
Undertake a mental state examination (8)	○	○	○	○	○
Deal with patients with dependence issues or self harm (9)	○	○	○	○	○
Assess patients capacity in line with GMC guidance (10)	○	○	○	○	○
Formulate a diagnosis and management plan (11)	○	○	○	○	○
Prescribe appropriate medications (12)	○	○	○	○	○
Report an Adverse Drug Reaction (13)	○	○	○	○	○
Plan a patients' discharge (14)	○	○	○	○	○
Look after a patient at the end of their life (15)	○	○	○	○	○
Break bad news to patient/family (16)	○	○	○	○	○
Complete a discharge summary (17)	○	○	○	○	○
Communicate with difficult/violent/angry patients and those with mental illness (18)	○	○	○	○	○
Assess and recognise a medical emergency/deteriorating patient. (19)	○	○	○	○	○
Perform basic and intermediate life support (20)	○	○	○	○	○
Fill out a Death certificate and Cremation form (21)	○	○	○	○	○
Adapt to changing circumstances and uncertainty (22)	○	○	○	○	○
Manage time appropriately and prioritize tasks (23)	○	○	○	○	○
Work independently and autonomously, taking responsibility for decisions (24)	○	○	○	○	○
Teach colleagues and students (25)	○	○	○	○	○
Work in a multidisciplinary team (26)	○	○	○	○	○
Lead a team (27)	○	○	○	○	○
Report a clinical error (28)	○	○	○	○	○
Understand and practice concepts of infection control (29)	○	○	○	○	○

Q3 At this moment in time, I feel my medical school prepared me to undertake the following procedures

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Temperature, Pulse, Respiration rate, Blood Pressure (1)	○	○	○	○	○
Venepuncture (2)	○	○	○	○	○
Cannulation (3)	○	○	○	○	○
Blood Cultures (4)	○	○	○	○	○
ECG (5)	○	○	○	○	○
Urine analysis including pregnancy testing (6)	○	○	○	○	○
Blood transfusions (7)	○	○	○	○	○
Intramuscular and subcutaneous injections (8)	○	○	○	○	○
Administer local anaesthetic (9)	○	○	○	○	○
Catheterisation (10)	○	○	○	○	○
Skin suturing (11)	○	○	○	○	○
Wound care (12)	○	○	○	○	○

Q4 Please select an answer to the following statements

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
"The realities of being a doctor makes me feel stressed" (1)	○	○	○	○	○
"I felt adequately prepared for my first job as a doctor" (2)	○	○	○	○	○
"The skills I have learnt through simulation set me up well for working as a foundation doctor" (3)	○	○	○	○	○

Q10 Have you been involved in or reported any clinical incidents?

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	>5 (6)	Don't know (7)
Reported (1)	○	○	○	○	○	○	○
Involved in (2)	○	○	○	○	○	○	○

If Reported - 0 Is Selected, Then Skip To How often do you stay late after work?If Involved in - 0 Is Selected, Then Skip To How often do you stay late after work?If Don't know Is Selected, Then Skip To How often do you stay late after work?

Q13 What was the severity of the incident(s)?

	0 incidents (1)	1 incident (2)	2 incidents (3)	3 incidents (4)	4 incidents (5)	> 5 incidents (6)
No Harm (no harm to patient/person) (1)	❍	❍	❍	❍	❍	❍
Low (Patient/person needed extra observation or minor treatment and caused minimal harm e.g repeat blood test, small cut) (2)	❍	❍	❍	❍	❍	❍
Moderate (Patient/person needed further treatment, cancelling of treatment, a surgical intervention, and caused short term harm e.g. fracture, laceration requiring suturing) (3)	❍	❍	❍	❍	❍	❍
Severe (Caused permanent or long term damage e.g fractured neck of femur following fall) (4)	❍	❍	❍	❍	❍	❍
Death (5)	❍	❍	❍	❍	❍	❍
Don't know (6)	❍	❍	❍	❍	❍	❍

Q14 How often do you stay late after work?
- ❍ Everyday (1)
- ❍ A few times a week (2)
- ❍ Once a week (3)
- ❍ Once a fortnight (4)
- ❍ Once a month (5)
- ❍ Occasionally (6)
- ❍ Never (7)

If Never Is Selected, Then Skip To How stressed did/do you feel;

Q15 Was this because;

	Yes (1)	Maybe (2)	No (3)
I needed to complete jobs (e.g. discharge summaries, check bloods) (1)	❍	❍	❍
I had to deal with a sick patient (2)	❍	❍	❍
I had to speak to family members (3)	❍	❍	❍
My senior asked me to (4)	❍	❍	❍
Other (please specify) (5)	❍	❍	❍

Q16 How stressed did/do you feel;
______ Before you started your foundation post (1)
______ When you commenced your Foundation post (2)
______ Now (3)

Q7 What (if anything) could your medical school have done to better prepare you for starting work as a Doctor?

Q8 Thankyou for completing this questionnaire

Redirected to on completion

Expression of interest form - doctors for interviews V2

Q1 I would be happy to participate in an interview about my experience of foundation training and how well prepared I felt for the transition   By completing this form and providing my email address I confirm I have read the participant information leaflet and am happy to be contacted regarding the interview
- Yes
- No

Q2 Please provide your email address in the box below

Q3 With your consent, we would like to ask your Educational Supervisor to complete a questionnaire regarding how prepared they feel you are for practice. Although the supervisor will be filling out the questionnaire about you directly, when analysed this data will be anonymous; it will be amalgamated and not analysed individually. This feedback is broadly similar to feedback the you would receive from your supervisor outside of the research study, so if there were any concerns this would routinely be highlighted via the usual routes rather than via the research data. Unfortunately, it would not be possible for you to see this feedback as the questionnaire is anonymous, but you may be able to approach your supervisor to discuss this.

Q4 I am happy for my supervisor to be contacted for an anonymous questionnaire as detailed above
- Yes
- No

Q5 Please give the name and email (if known) for your Educational supervisor

APPENDIX 11 – Email to stakeholder participants

Lancaster University Medical School

Email to stakeholders

Investigating the effectiveness of simulation to prepare medical students for professional practice; A mixed methods study

Dear Colleague,

My name is Ciara Carpenter and I am a student in the MD Medicine programme at Lancaster University, UK. I also work as an Obstetric Registrar at Lancashire Teaching Hospitals NHS Trust.

I am conducting a research project investigating the use of simulation to prepare medical students for professional practice and I would like to get opinions on this topic from key stakeholders involved with undergraduate medical students, in particular year 5.

This would be in the form of an online questionnaire, and if you would be willing, a short interview (either face to face or via telephone).

I hope that this will not take much of your time, you will be contributing to the education of future generations of doctors and I will keep you updated of the results.

Please see the attached information for further details

If you are happy to take part, please find below your unique, single use link to the study questionnaire.

This study has been approved by Lancaster Faculty of Health and Medicine Research Ethics Committee (Ref: FHMREC16037) and the HRA, **IRAS ID 216791, Ref 17/HRA/0083**

If you have any questions, please feel free to drop me an email

Should you wish to contact my Supervisor about any concerns or questions, her details are below.

Kind Regards

Ciara

c.carpenter@lancaster.ac.uk

Supervisor; Dr Liz Brewster

e.brewster@lancaster.ac.uk

V1
30/5/17

APPENDIX 12 – Stakeholder PIS

Lancaster University
Medical School

Participant Information Sheet

Investigating the effectiveness of simulation to prepare medical students for professional practice

My name is Ciara Carpenter and I am conducting this research as a student in doctoral research programme at Lancaster University, UK. I also work as an Obstetric registrar at Lancashire teaching hospitals NHS Trust.

What is the study about?

The purpose of this study is to establish the most effective way to prepare medical students for practice as doctors, using simulation. As you will know, there is a wide variety of type and uses for simulation, but in this context we mean the use of high fidelity simulation (e.g. SimMan) scenarios concentrating on acute care and non-technical skills. There is a great deal of variation in how simulation is undertaken and used by medical schools throughout the UK; we want to see if a Bleep style course (where students are given a bleep for 2-4hours and are asked to respond to various tasks incorporating simulation) or a Ward simulation course would improve preparation. We want to measure how prepared students are for practice in three ways; self-reported, reports from their supervisors and from their Team Assessment Behaviour summary form (TAB) from their eportfolio.

Why have I been approached?

You have been approached because this study requires information from stakeholders in the Undergraduate area, particularly year 5. By triangulating this data with data from the students it is hoped to produce a rich data set that will fully investigate this area.

Do I have to take part?

No. It is completely up to you whether you take part or not; You will not be disadvantaged should you decide not to participate.

What will I be asked to do if I take part?

If you decide to take part, once the students have undertaken their local simulation course you will be asked to complete an ***anonymous*** questionnaire asking how prepared in general you feel the students are for practice. If you would be willing, we would also like to conduct short interviews (either face to face or via telephone) to further assess opinions on this topic.

We will also be asking the students named supervisors for anonymous feedback. In the same way, we will contact the students approximately 6 months into their Foundation year to repeat the questionnaire; and we will also ask their clinical supervisor to also fill in a questionnaire. In addition, we will be requesting a copy of the TAB form in their Horus Eportfolio as an objective measure.

Will my data be identifiable?

The information you provide is confidential. The data collected for this study will be stored securely for 10 years on university approved encrypted cloud (Box) and deleted after this. Only the researchers conducting the study will have access to this data;

V.1
30/5/17

- Audio recordings will be deleted once the thesis has been completed. The files will be encrypted (no one other than the researcher and supervisors will be able to access them) and the computer password protected
- At the end of the study the questionnaire will be kept online in a password protected and encrypted account.
- The typed version of the interviews will be made anonymous by removing identifying information including your name. Anonymised direct quotations from the interviews may be used in the final report so your name will not be attached to them. This data will not be accessible to other researchers unless approved by the faculty of Health and medicine
- When attending an interview, although what you say will be confidential, if the sessions are taking place on NHS property (rather than by phone or skype) they can never be truly anonymous
- Data from the questionnaire will be deposited in the Lancaster University repository and will be freely available to other researchers on application.
- All your personal data will be confidential and will be kept separately from your focus group data.
- The files will be encrypted (no one other than the researcher will be able to access them) and the computer password protected
- At the end of the study the questionnaire will be kept online in a password protected and encrypted account. The data from this will be deposited into the Lancaster University data repository and will be freely available to other researchers on request.

There are some limits to confidentiality: if what is said in the questionnaire/interview makes me think that you, someone else, or a patient is at significant risk of harm, I will have to break confidentiality and speak to a member of staff about this. As the questionnaire is completely anonymous, you will not be able to be identified directly.

It is important to note that if you have concerns regarding any student these should be escalated appropriately outside of this research study. This study is not the place to highlight concerns for the first time.

What will happen to the results?

The results will be summarised and reported in a thesis and submitted for publication in an academic or professional journal.

Are there any risks?

There are no risks anticipated with participating in this study. However, if you experience any distress following participation you are encouraged to inform the researcher and contact the resources provided at the end of this sheet or your clinical/educational supervisor.

Are there any benefits to taking part?

Although you may find participating interesting, there are no direct benefits in taking part.

Who has reviewed the project?

This study has been reviewed and approved by the Faculty of Health and Medicine Research Ethics Committee at Lancaster University, the Health Research Authority and Manchester University ethics committee.

Where can I obtain further information about the study if I need it?

If you have any questions about the study, please contact the main researcher:

Dr Ciara Carpenter, Education Research Fellow, Lancashire Teaching Hospitals NHS Trust and MD student at Lancaster Medical School.

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Tel: +44 (0)1524 593733

g.vince@lancaster.ac.uk

If you wish to speak to someone outside of the Doctorate Programme, you may also contact:

Professor Roger Pickup, Associate Dean for Research, Faculty of Health and Medicine, Lancaster University. Tel: +44 (0)1524 593746; email: r.pickup@lancaster.ac.uk

V.1
30/5/17

APPENDIX 13 – Stakeholder questionnaire

Lancaster University Medical School

Preparedness for Practice Questionnaire - Stakeholders

This questionnaire is asking you to report how prepared you feel the year 5 students at your trust are for practice as a doctor in a range of domains, taken directly from the GMC 'Outcomes for Graduates' and 'Tomorrow's Doctors' Its also asking about how simulation can contribute to preparedness Please answer the questions as honestly as you can, your answers to the questions are confidential. If you have concerns regarding a student this should be escalated appropriately within the university. By completing this questionnaire you are confirming that you have read the information provided to you (please see attached) and that you consent to the information from this questionnaire being analysed anonymously and published.

Q10 I supervise/am involved with medical students at

- O Lancaster Medical School (1)
- O Manchester Medical School (2)

Q2 At this moment in time, I feel the students are prepared enough to;

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Take a thorough medical history	O	O	O	O	O
Perform an appropriate physical examination	O	O	O	O	O
Select appropriate investigations	O	O	O	O	O
Answer patients questions and concerns	O	O	O	O	O
Respect and understand principles of patient centred care	O	O	O	O	O
Interpret results of basic diagnostic tests (e.g. Bloods, ECG, X-Rays	O	O	O	O	O
Formulate a differential diagnosis	O	O	O	O	O
Undertake a mental state examination	O	O	O	O	O
Deal with patients with dependence issues or self-harm	O	O	O	O	O
Assess patients capacity in line with GMC guidance	O	O	O	O	O
Formulate a diagnosis and management plan	O	O	O	O	O
Prescribe appropriate medications	O	O	O	O	O
Report an Adverse Drug Reaction	O	O	O	O	O
Plan a patients' discharge	O	O	O	O	O
Look after a patient at the end of their life	O	O	O	O	O
Break bad news to patient/family	O	O	O	O	O
Complete a discharge summary	O	O	O	O	O
Communicate with difficult/violent/angry patients and those with mental illness	O	O	O	O	O
Assess and recognise a medical emergency/deteriorating patient.	O	O	O	O	O
Perform basic and intermediate life support	O	O	O	O	O
Fill out a Death certificate and Cremation form	O	O	O	O	O
Adapt to changing circumstances and uncertainty	O	O	O	O	O
Manage time appropriately and prioritize tasks	O	O	O	O	O
Work independently and autonomously, taking responsibility for decisions	O	O	O	O	O
Teach colleagues and students	O	O	O	O	O
Work in a multidisciplinary team	O	O	O	O	O
Lead a team	O	O	O	O	O
Report a clinical error	O	O	O	O	O
Understand and practice concepts of infection control	O	O	O	O	O

V1
30/5/16

Q3 At this moment in time, I feel the students are prepared to undertake the following procedures

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
Temperature, Pulse, Respiration rate, Blood Pressure (1)	O	O	O	O	O
Venepuncture (2)	O	O	O	O	O
Cannulation (3)	O	O	O	O	O
Blood Cultures (4)	O	O	O	O	O
ECG (5)	O	O	O	O	O
Urine analysis including pregnancy testing (6)	O	O	O	O	O
Blood transfusions (7)	O	O	O	O	O
Intramuscular and subcutaneous injections (8)	O	O	O	O	O
Administer local anaesthetic (9)	O	O	O	O	O
Catheterisation (10)	O	O	O	O	O
Skin suturing (11)	O	O	O	O	O
Wound care (12)	O	O	O	O	O

Q4 Please select an answer to the following statements

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
"I feel the students are adequately prepared for their first job as a doctor" (1)	O	O	O	O	O

Q12 Many different factors contribute to preparedness. Please rate the following factors by how important you think they are in preparing medical students for practice as a doctor, with 1 being most important and 7 being least important

______ Curriculum Design (1)
______ Course style e.g. Problem based learning, Case Based learning, Traditional, Systems based (2)
______ Student Assistantship (3)
______ Shadowing (4)
______ Simulation (5)
______ Clinical Skills Training (6)
______ Other (please specify) (7)

Q13 How important do you think simulation is to prepare medical students for practice? Please explain you answer.

- O Extremely important (11)
- O Very important (12)
- O Moderately important (13)
- O Slightly important (14)
- O Not at all important (15)

Q14 Are you aware of the simulation courses for final year students that run in your trust? If so, please specify

- O Yes/No

Q15 Do you think the simulation courses provided locally are beneficial, specifically to prepare students for practice?

- O Yes/Maybe/No

Q16 Do you have any opinions on how the simulation may be improved?

Q7 What (if anything) could the medical school have done to better prepare the students for starting work as a Doctor?

APPENDIX 14 – Interview schedule

Interview schedule student phase

Lancaster University
Medical School

Focus Group/Interview topic guide – student participants

Ground rules;

Thankyou for coming

We want you to do the talking; everyone to participate

No right or wrong answers; I want to learn from your experiences

What is said in this room stays here

Tape recording; once transcribed anonymously will be stored securely and deleted once thesis handed in. Transcription will be kept on secure, encrypted online storage (Lancaster Box) and deleted after 10 years

However- If anyone says anything that makes me think that they or others are at risk of harm- including previously undisclosed patient safety incidents I will need to break confidentiality; if this happens I will tell that person.

Topics;

Opinions on simulation course;

Was it worthwhile?

What things that worked/didn't work

What was the best/most useful part?

Has it impacted feelings of preparedness? How? Why?

Anything that could be improved? Do you think once is enough?

Preparedness

How prepared do students feel for starting work?

What are the reasons for this?

Anything particularly worrisome?

What is the single thing that they are most worried about?

How do they plan on addressing this? How could the medical school address this?

How accurate do they think their self reflection of preparedness is? What do they think their supervisors would say/think?

What role has simulation had in their feelings of preparedness?

Did they have enough exposure to simulation for it to impact preparedness? Would more or less sessions have been better?

Do they think simulation alone has increased preparedness or is it a combination of other methods? What methods? What is the single most useful educational method to prepare them for practice?

Feelings of stress or anxiety? Reasons for this and how they will address?

Anything that medical school could have offered to improve preparedness?

V.2
30/5/17

Interview schedule doctor phase

Interview Schedule

Ground rules;

Thank you for coming

I want you to do the talking

No right or wrong answers; I want to learn from your experiences

What is said in this room stays here

Tape recording; once transcribed anonymously will be stored securely and deleted once thesis handed in. Transcription will be kept on secure, encrypted online storage (Lancaster Box) and deleted after 10 years

However- If you say anything that makes me think that you or others are at risk of harm-including previously undisclosed patient safety incidents I will need to break confidentiality; if this happens I will tell you.

Topics;

Preparedness/Coping with Foundation training

How has the first few months of foundation year been?

Stressful? Enjoyable? Give examples?

How has this made them feel about their ongoing careers as doctors?

Any patient safety incidents involved in or reported? Tell me about them and how it made you feel?

Things that found most/least difficult or things that felt most prepared for?

How often do you stay late to finish jobs/care for patients?

How often do you get your allocated breaks? If you don't; why?

Have you had any prescribing incidents or difficulties?

How supported do you feel in your role? Has this impacted your ability to do your job?

Did you feel adequately prepared for being 'on call' and holding a bleep? Do you think you could have done with more experience of this whilst an undergraduate?

Looking back on medical school now that they are doctors;

How well did your medical school training prepare you for foundation training? Anything in particular looking back that was especially good?

Anything looking back that was not useful?

Did simulation help prepare you? In what way? Anything else you can specifically pinpoint that help prepare you?

Did they have enough exposure to simulation for it to impact preparedness? Would more or less sessions have been better?

Lancaster University Medical School

Interview schedule for stakeholders

Ground rules;

Thank you for coming/participating

No right or wrong answers; I want to learn from your experience, what is said in this room stays here

Tape recording; once transcribed anonymously will be stored securely and deleted once thesis handed in. Transcription will be kept on secure, encrypted online storage (Lancaster Box) and deleted after 10 years. However- If a interviewee says anything that makes me think that they or others are at risk of harm- I will need to break confidentiality; if this happens I will tell that person.

Preparedness

How prepared do supervisors/stakeholders feel the students are for starting work?

What are the reasons for this?

Anything particularly concerning?

What is the single thing that they are most worried about students facing?

How could the medical schools address this?

How accurate do they think the students self-reflection of preparedness is? How does this compare to the supervisors view?

What role do they think simulation has in student's feelings of preparedness?

Do the students have enough exposure to simulation for it to impact preparedness? Would more or less sessions be better?

Do they think simulation alone has increased preparedness or is it a combination of other methods? What methods? What is the single most useful educational method to prepare them for practice?

Anything that medical school could have offered to improve preparedness?

Opinions on simulation;

In general

Is it worthwhile?

What things work/don't work?

Anything that could be improved? Do you think once is enough?

Opinion on simulation course within hospital (ward/bleep)

What is good/bad about it?

How does it impact preparedness?

Do you think there are differences between students who do bleep-style simulation vs. ward-based simulation?

Enough to do it just once or more than once? Suggestions for improvement?

V1
30/5/17

APPENDIX 15 – NVIVO Codebook

Nodes	
Expanding on learning by doing	Expression of the need for more experiential learning in relation to improving preparation e.g. increased assistantship/shadowing, more direct patient care, simulation - From 'how to improve preparation' and 'other methods of preparing for practice' 'reasons for poor preparation'
Active roles in patient care	References from learning from having an active role in patient care or a desire for more active roles in patient care
areas students unprepared for that increased experiential learning will solve	Areas participants feel students aren't prepared for that an increase in experiential learning - assistantship or simulation may solve e.g. prioritisation, dealing with sick patients
Assistantship	Reference to learning from the experiential nature of the assistantship or a desire for increased assistantship type roles/placement
importance of doctors on ward	References to importance of doctors on the ward including students in the team and facilitating learning on placement and assistantship, specifically allowing involvement in patient management and practice being the FY1
Over protected	reference to students or junior doctors being 'sheltered' or under exposed to clinical situations due to concerns about patient safety etc
Practice being an FY1	References to the want for more FY1 type experiences including assistantship/ward placement but also references to how having realistic FY1 scenarios was beneficial for preparing participants i.e. in the bleep and ward sim. Also references to wanting teaching on "how to be an FY1"
Simulation	References to learning by the experiential nature of simulation, or the desire for more simulation for experiential learning
Learning by doing	Participants talking about how they learn and the importance of deliberate practice and/or learning by doing/by experiences, including discussion of how they learn, benefits of shadowing/assistantship/simulation, how is simulation effective
Active roles in patient care	Reference to learning from having active roles in patient care
Assistantship	Reference to learning through the assistantship
Deliberate Practice	Reference of learning with deliberate practice e.g. repetition of tasks
How is simulation effective	What components does the participant think are the most important or that contribute the most to simulations efficacy e.g. scenarios, debrief, repetition, fidelity
Simulation	Reference to learning through simulation
Drawbacks of simulation	Problems with learning by simulation or areas that participants felt should not be taught by simulation
Thoughts on local simulation course - negative	What participants think makes the local simulation courses not effective or suggestions for improvements e.g. more realistic scenarios, fidelity, number of times it should be done
Bleep sim	
Other sim	
Ward sim	
Simulations effects on preparedness	Did simulation make the students feel more or less prepared?

30/01/2019

Thoughts on local simulation course - positive	What participants think makes the local simulation courses effective e.g. realistic scenarios, fidelity, range of scenarios, how the course is set up and run
Bleep sim	
Other sim	
Ward Sim	
Other - not used yet for focused coding	
Personal experience	Mention examples of personal experience; either for participant when they were more junior or their personal experience of juniors and medical students
Self-assessment and reflection	How accurate are students at assessing their own preparedness? Compared with their supervisor or stakeholder opinion?
Stakeholder	Opinions of stakeholders; How good are students at self-reflection/self-assessment?
Student	Opinions of student; how good are they at self-reflection/self-assessment?
Simulation	
Individual vs group learning	do the participants think that simulation is most effective as a group or individually or a mixture of both
Prepared but still scared	The concept of students feeling overall prepared but still scared/concerned about certain aspects of the job e.g. responsibility, making mistakes, dealing with acute patients etc Students may feel prepared but still scared, but also scared but prepared.. some things you cannot fully prepare for due to the inability to be fully independent as an undergrad
as prepared as I can be	students acknowledgment that there are some things that you can never fully prepare for as a student no matter how much simulation/assistantship
Unprepared for in retrospect	Areas that, looking back, FY1 participants felt they were unprepared for when they started work
Experience of FY1	FY1 participants experiences of foundation training, positive and negative, interactions with medical students and other colleagues
Problems encountered	Including clinical incidents or incident forms completed, any issues they had with tasks e.g. prescribing, managing on calls etc
Students well prepared for	Areas where the participant feels students are prepared for e.g. communication skills, history taking etc
Transition to professional practice	General thoughts on the transition
areas of stress and anxiety	Specific things or areas which are causing stress/anxiety regarding the transition to professional practice
Specific examples of stressful situations	Examples of times/issues that caused stress in foundation training
Concerns	Areas students (or stakeholders) were concerned about facing as a doctor or areas that doctors were concerned about during their FY1
Concerns that can be prepared for	Areas that participants feel concerned about that can be prepared for e.g. clinical skills, prescribing etc

Concerns that cannot be fully prepared for	Things that students/supervisors are concerned about graduates facing that cannot fully be prepared for (generally because undergraduates cannot be independent) as an undergraduate e.g. making mistakes, responsibility, NTS
Learning on the job	Reference to skills that participants think you can only learn/develop when you are doing the job e.g. prioritisation
Impact on patients	Ways in which students preparedness or lack of may influence patient care and safety. Also ways in which organisational or the way in which students are trained my impact patient care
Importance of support	Importance of providing support to new FY1s e.g. senior staffing, cancelling elective work etc or references to concerns about being supported or not over the transition,
prioritisation and time management	Foundation doctors experiences of time management and prioritisation, including times they have to stay late or miss lunch due to workload
What does preparedness mean	What does preparedness mean to the participant; how does competence and confidence interact, can we achieve 100% competence?
What makes a good doctor	Components that the participant thinks makes a good doctor e.g. good listener, awareness of own limitations, confidence, competence