The Assessment of Non-Technical Skills in ENT Surgery:

A Multidisciplinary Simulation Programme to improve Patient Safety.

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Declaration of originality:

I declare that the work within this thesis is my own and represents the findings of research undertaken during the study period at Imperial College. Work which is not my own is appropriately referenced.

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Thesis Abstract:

Surgical patients are at particular risk of harm, with 41% of all adverse events in hospital occurring in the operating theatre. Failures in Human factors are the leading cause. Despite recognition of the importance of human factors training to patient safety, there is a lack of theatre ENT crisis management simulation, and no formal assessment of the requisite skills.

Aims:

To Develop a psychometrically robust assessment tool for assessing Non-technical skills in the ENT theatre – to be termed ENT-NOTECHS. To Develop and validate an ENT themed multidisciplinary simulation programme for the assessment and feedback of non-technical skills.

Methods:

A multimodal method approach was used to create a novel behavioural marker tool to capture non-technical skills in the ENT theatre environment. Alongside this, a prospective, observational study involving a multidisciplinary team training day in ENT and airway themed crisis' in a high fidelity simulated theatre environment was designed. Teams undertook 6 high fidelity simulation scenarios and non-technical skills were assessed using the ENT-NOTECHS tool. The ENT-NOTECHS tool was assessed for its psychometric robustness; reliability and construct validity. Candidate feedback was obtained to determine overall effectiveness of training.

Results:

We successfully designed and delivered a novel multidisciplinary team ENT themed training day. Over 15 months, 74 trainees (surgeons, anaesthetists and nurses) participated in 6 MDT simulation days, totalling 54 hours of simulation training and 210 assessments. Excellent

Face and content validity was demonstrated. 100% of participants reported improved confidence in managing ENT crisis scenarios and demonstrated an improvement in non-technical skills (ENT-NOTECHS). The ENT-NOTECHS tool demonstrated excellent psychometric robustness. Good inter-rater reliability scores (cronbachs >0.7) were shown and the tool discriminated between novice and expert trainees ($p<0.001$).

Conclusion:

Multidisciplinary team training in ENT-themed crisis is feasible and well received training intervention. The simulated operating theatre serves as an excellent environment for the assessment and training of non-technical skills. ENT -NOTECHS is a novel assessment tool with evidence for reliability, content and construct validity in ENT teams.

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1 PATIENT SAFETY IN THE OPERATING THEATRE AND THE EVOLUTION OF SIMULATION IN SURGERY:

1.1 Patient Safety Overview

First, do no harm. Whilst these familiar words are embedded within the medical population from the earliest moment, the global concept of patient safety as a defined set of initiatives and ideas, is a relatively new one. It wasn't until the early 90's that the true extent of patient harm was highlighted, with an American study estimating that between 44,000 and 98,000 deaths per year were due to medical error(1). The Harvard Medical Study reported that 3.7 % of admissions suffered an adverse medical event, with a similar study in Australia reporting that adverse events occurred in 16.6% of admissions(2). Whilst there is significant variability in the exact number of adverse events reported, perhaps more importantly; in both studies over half of these adverse events were felt to be preventable(1, 2).

Over the years concern have been raised regarding the credibility of these sensational headline claims and figures, particularly the methodology and epidemiology in these landmark reports. A central reported error appears to be the lack of distinction between medical error occurring before death, and medical error directly leading to death. Nevertheless they have served to draw attention to the issues surrounding patient safety and the need to do better. Patient safety has been

defined as "*a health care discipline which has emerged from the evolving complexity in healthcare systems and the resulting rise of patient harm in healthcare facilities. It aims to prevent and reduce risks, errors and harm that occur to patients during provision of healthcare. A cornerstone of this discipline is continuous improvement based on learning from errors and adverse events"(3).*

This shocking realization spurred the Landmark report by The Institute of Medicine; "To Err Is Human" (4), and the UK equivalent report by Sir Liam Donaldson; "an organization with a memory"(5). Again, it was estimated that adverse events occur in approximately 10% of hospital admissions, half of which are considered preventable. These seminal reports have not only promoted patient safety, but have carefully examined the evidence surrounding adverse events and made key recommendations to help avoid such occurrences in the future such as staff training and incident reporting. A decade on, patient safety is now considered an integral part of healthcare system and at the forefront with policymakers, but despite this, patient harm remains a reality(6).

The 2016 report Patient Safety 2030 from The National Institute of Health Research (7) has taken the next step forward by highlighting the main perceived threats to patient safety over the next 15 years. It also highlights key areas of focus with which to enhance patient safety; continuing to build upon the existing systems based approach to patient safety and also calling for greater international collaboration. In

particular it highlighted the need to continue staff training, with specific emphasis placed on team based training with a content in human factors.

1.2 Improving patient safety; analysis of adverse events in healthcare

In order to reduce adverse events, we must first have an understanding of the root causes of error in the healthcare environment.

Traditionally, patient outcomes were thought to be a function of the patient's inherent risk factors combined with the expertise and knowledge of the individual medical practitioner. Adverse events were thought to occur due to either recklessness or incompetent actions of an individual, leading to fear and the cultivation of a blame culture(8). This "Person-centred approach" is now considered ill-suited to medicine(8). This can be considered due to two major factors; the first acknowledges that it is usually "good people working in bad environments" who commit errors(4), and the second states that errors are often recurrent; with similar circumstances producing similar results regardless of the individuals involved(8).

Over the last decade we have seen a significant shift in the conceptualization of adverse events. A more holistic "Systems based approach" to adverse events has now been adopted, whereby, the conditions in which a healthcare professional works are analysed and defences built in to avert errors and mitigate their effects(8). This approach essentially acknowledges that humans are fallible and prone to error, whilst arguing that errors are often due to multiple, intertwined systemic factors,

which an individual rarely has little influence on(8). Although relatively novel to healthcare, the systems approach has been used to good effect in high-reliability organisations such as the US Navy, aviation industry and nuclear power(8).

Once the causes of error within a system are understood, defences and safeguards for patient safety can be employed. The Swiss Cheese Model of system accidents described by Reason(8) states that errors can occur when weaknesses in the defences of the system occur. He likened the weakness of the defences to the holes in a slice of swish cheese. Whilst a hole (or weakness) in any one slice will not produce an adverse outcome, when the holes in the slices (or defences) align, the circumstances are set to allow error to occur and potential harm to come to the patient. Holes in the system defences can be due to “active failures” or “latent conditions”, with the majority of errors occurring due to a combination of the two(8). “Active failures” generally occur at the time of the incident and are usually committed by people on the front line in direct contact with the patient or system. “Latent conditions” are the inevitable flaws within the system, which are often implemented and designed at top layer management. They may not be apparent for sometime, but will ultimately be the background conditions which “allow” an adverse event to occur. Factors include; understaffing, poor or faulty equipment, and time pressure. When these factors are identified in advance, proactive risk management can be employed to avoid an adverse event. Several high profile studies have recommended the system approach to enhance patient safety(4, 5).

1.3 Patient safety in the operating theatre

The safety of the surgical patient in particular remains a concern. Studies have shown that surgical patients are most at risk of coming to harm in the hospital environment(9, 10), with 44% of adverse events occurring in the operating theatre(10). Once again, studies have shown that over half of these surgical adverse events were felt to be preventable(9). A study has shown that of all errors, 94.7% had no lasting effect on the patient, although almost 25% of patients required further therapeutic interventions to combat the effects of the error. However, the preventability of these incident has been estimated in the region of 50-70%(9).

1.3.1 The scale of adverse events in surgical specialties

Surgical specialties associated with the highest rates of adverse events include Cardiothoracic surgery and vascular surgery, with reported rates of 9.9% 9.2% respectively(11). The highest rate of error occurred in Triple A repairs (Abdominal aortic aneurysm repairs. AAA) and was as high as 18.9%(9)

The field of Otolaryngology and Head and Neck Surgery has traditionally been regarded as a "safe specialty", with lower reported incidence rates of 4.5%(11). However, this misconception may cause complacency. A report from the US in 2004 inferred that there might be potentially 2600 cases of major morbidity and 165

deaths due to adverse events within the specialty annually(12), and a review on Patient Safety in Otolaryngology concluded that whilst this specialty shares many common themes in patient safety with other surgical specialties, there are some specific high risk areas unique to ENT such as airway surgery and thyroid surgery(13). These included: (1) medication errors; in particular the use of adrenaline in the surgical field with 13% of medication errors being due to incorrect administration of adrenaline, and this accounted for a total of 5 mortalities. (2) 6% of all errors in ENT were due to wrong side surgery. In particular it was felt that the "accepted" lack of marking in ENT due to operations usually being performed bilaterally was a prime reason for this. (3) Diagnostic errors and delays in diagnosis were featured in this report, with diagnostic discrepancies in thyroid pathology being the most commonly reported error. (4) Lastly, the use of the laser for head and neck surgery was also associated with significant adverse events. The occurrence of airway fires, injury and superficial burns to mucosal surfaces, and near miss events with reported burning of endotracheal and tracheostomy tubes were highlighted.

Whilst some of these incidents may be due to technical errors, or hindered by the anatomy or pathophysiology of the organ in question, more can be done to reduce these errors and provide a safety net to ensure that human error can be eliminated as much as possible. The WHO timeout checklist has been instrumental in reducing wrong side surgery and never events, but a checklist can only function if it is undertaken well and there is institutional 'buy in" by all parties undertaking the checklist. A checklist fails to serve its purpose if it becomes a "tickbox" exercise. Learning points from adrenaline medication errors (as detailed above) again

highlight the importance of human error and perhaps the need to change established team behaviours. Traditionally topical adrenaline is not prescribed by the doctors and is simply provided on request by the nursing scrub team. Various strengths do exist and surgeons will often use what's given without checking strength as they are concentrating on operating.

More recently, The 4th National Audit Project (NAP4) by the Royal College of Anaesthetists, entitled Major Complications of Airway Management in the UK (14, 15) highlighted the incidence of serious airway complications occurring in the UK. Airway incidents for Head and Neck surgical patients featured heavily in the report, with 72 reported incidents involving an airway problem in a patient with acute or chronic disease process of the head and neck or trachea. Approximately 70% of these cases involved obstructive lesions within the airway. Outcomes for these patients, included death (n=13), an emergency surgical airway (n=50) and unplanned ITU admission(n=27). Haemorrhage into the airway was also reported following tonsillectomy and head and neck resections, and of the 10 reported events in children, half of these incidents involved children with ENT pathology (subglottic stenosis =2, aspiration following tonsillectomy = 2, and foreign body removal from the airway =1). The NAP4 report highlighted how these cases require careful assessment and communication between the anaesthetist and surgeon pre-operatively; with a need for meticulous prior planning and an ability to change those plans should difficulties arise. A breakdown anywhere in this process can lead to a high risk of adverse events with high stakes(14, 15). A key conclusion of the report

stated that many of the adverse incidents and deaths were likely to have been avoidable. Therefore, although Otolaryngology is considered a smaller surgical subspecialty, the very nature of our work and anatomical boundaries, mean that potential for harm is great and the impact of adverse incidents can have far reaching consequences.

1.3.2 Applying Human Factors engineering and the systems approach to the operating theatre:

As discussed earlier, the adoption of the systems approach to patient safety within healthcare, has set in motion a great deal of research looking into the various factors which can have an affect on that system within the operating theatre.

Human Factors engineering in healthcare can be defined as: "enhancing clinical performance through an understanding of the effects of teamwork, tasks, equipment, workspace, culture and organisation on human behaviour and abilities and application of that knowledge in clinical settings"(16, 17). It is now an established scientific discipline and creates common ground between humans and their working environments. A human factors approach can lead to a greater understanding to the contributors to incidents and errors, and its application can also allow us to mitigate risk and improve patient safety(16).

The operating theatre itself can be an incredibly complex system, with a huge interplay between the patient and his or hers inherent risk factors, the equipment and instrumentation, the team coordination and communication and the heavy

workloads, fatigue and stress. All of these factors make the operating theatre an intense environment prone to error and a target rich environment to apply the principles of human factors. Vincent et al(18) identified a number of independent external factors (i.e non-patient or operation related), including the non-technical skills of individuals, team performance as a whole, the operative environment (layout, distractions), and organizational factors (safety culture, financial constraints) which will all influence patient outcome. They surmised that while training and education in technical aspects of an operation may improve morbidity and mortality by a fraction, it is the cumulative effect of the "external" factors which may truly lead to high performance. An *"excellent team and a supportive environment will enable the surgeon to raise his or her game, with a considerable benefit to the patient*"(18). The importance of non-technical skills is a particularly critical component in the systems approach, as the human factors of healthcare professionals can often compensate for deficiencies in other parts of the system and ultimately stop harm coming to the patient. Both reports "To Err is Human"(4) and "An organization with a memory"(5), recommended this systems approach to healthcare in negating medical error and harm, and promoted a future vision of an open and blame free culture, with coordination of all "Adverse Events Databases" so that common factors and causes if adverse events could be identified and lessons learned.

2 NON-TECHNICAL SKILLS IN THE OPERATING THEATRE:

This chapter focuses on the concept of non-technical skills and their importance in patient safety. In particular we define the term non-technical skills, provide background to the origin of team training in these skills within other high risk industries and how this has translated to healthcare and importantly to the operating theatre. We describe how simulation has been central to safe medical training in the 21st century and how simulation in team training and non-technical skills is important.

2.1 Non-technical skills:

Non-technical skills or "Human factors" are the cognitive (decision making and situational awareness) and interpersonal skills (communication, teamwork and leadership) which underpin technical competence(19). Root cause analysis of adverse events in healthcare has shown that failures in non-technical skills are often the most common cause for adverse events rather than a lack of technical proficiency by the operating surgeon or team alone(20), and that up to 43% of errors made in surgery are attributable to poor communication(20). There is increasing evidence that an increased awareness of non-technical skills is important for the outcomes of surgical procedures(21, 22). They are now considered key to delivering safe surgical practice and improving patient safety, and an increasing amount of work has been undertaken to ensure these concepts are now embedded into the education and training of healthcare workers. It is important to highlight that whilst

the concept and term "non-technical skills" is relatively novel, the individual skills within this overarching term such as leadership, communication, and decision making etc, have always been identified as important traits to an individual's own performance. These so-called "soft skills" have traditionally been left to the individual to develop as part of their own professional growth. However, it is only now that healthcare is realizing that these skills can be taught, and that training in these skills, both on an individual level and team level, can lead to enhanced performance in the operating theatre, as it has done in other high risk industries.

2.2 Non-technical skills in high risk industries:

The aviation industry has been at the forefront of promoting and training non-technical skills and is now recognized for its excellent safety record. This improved safety record is largely attributed back to the inherent shift in understanding that human factors can contribute significantly to accidents. In the 1970's, data from aircraft accident investigations revealed that 70% of incidents were attributable to human error(23), and consequently training programmes to educate and train airline crew were developed with a grounding in non-technical skills and simulation. Crew Resource Management (CRM) training was born and subsequently developed to equip flight crew with the necessary skills, knowledge and training to enhance airline safety. The CRM training delivers basic knowledge in human error and explains how behavioural and cognitive skills can act as a tool of capturing error and preventing it from happening(23). The principles and ethos of CRM has since been adopted by other high risk industries such as nuclear power(24) and the offshore gas

industry(25), and has now spread to areas of medicine such as anaesthetics and surgery.

2.3 Non-technical skills training:

With an increasing emphasis on non-technical skills and patient safety within medicine, huge parallels have been drawn between the aviation industry and healthcare. The principles of CRM were first adopted by anaesthetists in the USA, leading to the development of Anaesthesia Crisis Resource Management (ACRM)(26), and similarly in the UK, the "Crisis Avoidance and Resource Management for Anaesthetists (CARMA)(27). Second generation courses have then been developed incorporating other specialties such as surgery, where the high stakes nature of crisis scenarios call for high standards of communication, leadership and teamworking(27).

2.3.1 Simulation in surgical training:

Simulation in surgery is one of the most common methods to train both technical and non-technical skills. Surgical training in the 21st century has undergone many changes, with pressures from the European Working Time Directive (EWTD)(28), patient care pathways and the reporting of surgical outcomes(29) all helping to shape the training of surgical trainees. Limited time in the operating theatre has been further compounded by the lack of trainee-trainer interaction given the ever increasing workload of consultant surgeons(28, 30). Ultimately time in the operating

theatre has reduced and it has therefore become even more important to develop novel-simulation based training in order to acquire the necessary skills and competencies, which would normally have been acquired in theatre. It is not surprising therefore that the Chief Medical Officers Annual report in 2008(31), entitled "Safer Medical Practice" highlighted the importance simulation had to play in delivering better training and patient care and the GMC has included simulation in the curriculum as a "highly recommended learning tool" for medical education.

Simulation has traditionally been used for training technical skills, and has various applications in otolaryngology, such as temporal bone(32) and the ovine model for endoscopic sinus surgery(33). More recently however, high fidelity operating theatre environments have been developed to train team skills; not only of the individual surgeon, but more importantly the multidisciplinary team(34-36).

2.3.2 Team simulation in the operating theatre:

As a high stakes, high-pressure profession, surgeons rely on experiential learning and require high levels of teamwork and leadership; particularly in a crisis situation. Despite the reducing opportunities to experience "rare" emergencies in real life, trainees are nevertheless expected to manage these effectively despite little or no experience. Simulation allows trainees to be exposed to a range of tasks outside the level of their competence and provides the platform in which these rare situations can be repeatedly reproduced with no risk to patient safety(37).

Traditionally healthcare professionals have trained separately despite working together on a daily basis. Crisis situations rely heavily on the ability of the healthcare team to perform well together in a stressful environment, and it is hardly surprising therefore that teamwork features heavily as a cause for error in the operating theatre(20).

There is significant evidence to support that multidisciplinary simulation improves theatre teamwork(34, 38-40), and importantly one study has shown that patients who are operated on by teams who regularly engage in teamwork behaviours are at a reduced risk of death or a major complication(21). Additionally, the recent report Patient Safety 2030(7) from the National institute of Heath Research, highlighted the need to continue with staff training with a particular emphasis on team based training with a content in Humans factors.

3 THE ASSESSMENT OF NON-TECHNICAL SKILLS IN SURGERY

The previous chapter introduced the importance of non-technical skills in surgery and the multidisciplinary team environment. This chapter will now go on to discuss the importance of assessment in these skills and the use of behavioural rating tools to accurately assess non-technical skills in the simulated or real environment. The main assessment tools currently being used within the literature will be presented together with a critical analysis of their psychometric robustness.

3.1 Methods of assessing non-technical skills:

Training and simulation in human factors has been developed within healthcare with the aim of improving the non-technical skills of healthcare professionals. However, in order improve something, you must be able to measure and assess what you are training. Additionally, assessment of non-technical skills is essential in order to provide feedback to those trainees undertaking the training and thereby identify any learning needs(19). It also helps to determine the effectiveness of training and objectively demonstrate that the training intervention has been beneficial(19).

Behavioural marker systems are a tool to capture and structure observations within the simulated setting or workplace and are a common method for assessment of human factors(41). They essentially “capture behaviours which contribute to

superior or substandard performance within a work environment"(41). The main non-technical skills are grouped into overarching categories, with each category having a number of exemplar behaviours attached to them to demonstrate good or bad behaviours. A rating scale is then used to either rate each behavioural item within the category, or give an overall rating for a category. This can then be used to provide structured feedback to the trainee or team. Behavioural markers are usually derived from triangulation of data from multiple sources which look at the performance in question. Examples include: interviews, observational studies, task analysis, expert focus groups and incident analysis to name a few. There are currently a number of behavioural markers within the literature which can either capture the behaviours of an individual(42-45) or a team(36).

3.1.1 Behavioural marker systems in surgery:

The first behavioural marker systems were adapted from existing aviation tools such as the aviation LOSA checklist (Line Operations Safety Audits)(46). Similarly, the Oxford -NOTECHS tool(45) and the revised NOTECHS tool for surgeons, anaesthetists and nursing staff(44), were adapted from the NOTECH aviation tool after pilot simulation sessions, task analysis and panel discussion with experts (consultant surgeons and human factor experts)(44). More recently we have seen the advent of behavioural marker tools for anaesthetists called ANTS (Anaesthetist's Non-Technical Skills)(43) and for surgeons called NOTSS(Non-Technical Skills for Surgeons)(42).

The increasing number of assessment tools is extremely encouraging but there are a number of issues surrounding assessment. Firstly, given the number of tools available, tool selection can be daunting and confusing. As mentioned above, some tools will capture the nontechnical skills of the individual whereas others capture the team as a whole. Rating scales on each of the tools are not standardized, with 4-point to 7 point likert scales across the board of tools. Consequently there is no "gold standard" and therefore performance cannot uniformly be compared and standardized. Importantly, assessment tools need to show psychometric robustness(41) and tools should be interrogated for this prior to deciding which tool is best to use. Lastly they are context specific and should be used in the environment in which they were intended for use(41).

3.1.2 Characteristics of a good behavioural marker system:

A team of international experts in human factors met in 2001 to discuss and agree on standards regarding the use of behavioural markers in healthcare(41). The characteristics of a good non-technical skills assessment tool are shown in the table below:

Table 3-1Characteristics of good non-technical skills assessment tool

Characteristics of a good non-technical skills assessment tool: (41).	
Validity	In relation to performance outcome
Reliability	Inter-rater reliability, internal consistency
Sensitivity	In relation to levels of performance
Transparency	The observed understand the performance criteria against which they are being rated. Availability of reliability and validity data
Usability	Easy to train, simple framework, easy to understand, domain appropriate language, sensitive to rater workload, easy to observe.
Can provide a focus for training goal and needs	
Baselines for performance criteria are used appropriately for experience level of ratee	
Minimal overlap between components	

Two of the most commonly used behavioural markers for rating surgeons (NOTTS and Revised NOTECHS) are analyzed and discussed in detail below.

3.1.3 NOTTS

Similar to ANTS, NOTTS was designed to rate the non-technical skills of the individual surgeon in the operating theatre. Reliability and sensitivity was tested in the

simulated operating theatre where videos of simulated scenarios were rated(47). After a brief training course of 2.5 hours, 44 recruited surgeons watched and rated the behaviours in 6 selected scenarios. These ratings were then compared to expert ratings and assessed for inter-rater reliability and internal consistency. Satisfactory Inter-rater reliability was achieved for "communication and teamwork" and "leadership". Accuracy against expert ratings was achieved in 60% and it was deemed that the scale was adequately reliable. Content validity was inferred through its inception: having been developed using task analysis, interviews, and literature reviews(42). Additionally, further studies compared scores between expert and novice raters, with only half of novice raters agreeing with the expert group(48).

3.1.4 Revised NOTECHS

Sevdalis et al revised the original NOTECHS tool from the aviation industry and made it applicable to the operating theatre(44). It was adapted so that the tool could be used to rate the various disciplines within the operating theatre individually: surgeons, anaesthetists, Nurses and Operating Department Practitioners (ODP's). Again, its content validity was inferred by its development by human factor experts. Reliability was tested by rating simulated operating room crisis scenarios. Cronbach alpha scores of >0.70 for all subscales/categories were achieved indicating satisfactory internal consistency(44). There was also good reliability in repeated administration of the tool (Cronbachs >0.85). Attempts at determining construct validity have also been undertaken, with Black et al(49) reporting that the tool was

able to differentiate between different grades of seniority, with significant differences seen in NOTECHS scores with ascending grade of surgeon.

Other assessment tools have been designed to rate non-technical skills in the operating theatre and table 3.2 (also see chapter 5) displays these together with an analysis of their psychometric robustness.

Table 3.2. Non-technical skills assessment tools within the operating theatre:

Assessment Tool	Population	Non-technical skills assessed	Validity	Reliability	Comments
Non Technical Skills of Surgeons (NOTSS)(42)	Surgeons	1. Situational Awareness 2. Decision Making 3. Communication and Teamwork 4. Leadership 4 point scale	**Content(50)**: NOTSS rating system "developed for surgeons, by surgeons" using task analysis, literature and interviews.	**Inter-rater reliability and internal consistency(47)**: with training, adequate levels of reliability found	Focuses on individual surgeon's nontechnical skills. A degree of training is recommended prior to use for novice raters.

Revised NOTECHS (49)	Surgeons Anaesthetitsts Nurses ODP's	1. Communication and interaction 2. Vigilance and situational awareness 3. Team skills 4. Leadership and management skills 5. Decision making – surgical crisis. 6 point scale	**Content:** developed and revised for use in theatre teams by human factors experts and pilot studies involving surgical teams. **Construct(49):** significant difference in NOTECH scores seen with increasing seniority (junior vs senior vs consultant)	**Internal consistency(44):** Good reliability cronbachs alpha (i)across all raters (ii) between trainers and trainee raters, (iii) across all subspecialties. **Inter-rater reliability(49)**: High (alpha =0.82)	Focuses on individual non-technical skills performance for all subteam members in the operating theatre. Can be used to rate skills by both experts and novice raters. No training needed.

Oxford NOTECHS (I and II)(35)	Surgeons Anaesthetists Nurses	1. Communication and interaction 2. Situational awareness 3. Teamwork and cooperation 4. Leadership and management 5. Decision making 4 point scale later revised to 8 point scale	**Construct(35, 45):** improved scores after teamwork training, inverse scores between teamwork and surgical error, improved attitudes to teamwork after training	**Inter-rater reliability(35, 45):** good reliability scores across raters.	Focuses on individual non-technical skills performance for all subteam members in the operating theatre. Used expert raters with prior experience

Anaesthetists Non-technical skills (ANTS)(43)	Anaesthetists	1. Task Management 2. Team working 3. Situation Awareness 4. Decision making 4 point scale	**Content:** developed using task analysis, interviews, observations and literature review(43, 51, 52). Completeness and observability studies	**Internal consistency:** good ratings. (43) **Inter-rater reliability**: reasonable level of agreement but better if expert raters.(43)	Focuses on individual anaesthetists non-technical skills. A degree of training is recommended prior to use for novice raters.
Scrub Practitioners' intraoperative non-technical skills (SPLINTS)(53)	Nurses	1. Situation Awareness 2. Communication and teamwork 3. Task Management 4 point scale	**Content:** developed using task analysis, literature reviews and interviews. Completeness and observability studies	Within group reliability: acceptable levels Internal consistency: good internal consistency(54) - Absolute mean difference was M < 0.2 of a scale point	Focuses on the scrub nurse in charge, does not assess all nurses present (i.e runners etc).

				for all three categories.	
Observational Teamwork Assessment for Surgery. (OTAS)(55)	Operating theatre teams	1. Communication 2. Leadership 3. Coooperation and Back-up behavior 4. Coordination 5. Team monitoring and Situational Awareness 7 point scale	**Content:** observational studies confirmed high OTAS exemplar behaviours with a high observer agreement(55). **Construct:** assessed by consistency in the scoring by expert versus novice-expert raters produced significantly more consistent scoring than novices(36).	**Inter-rater reliability:** overall adequate agreement with regards to teamwork (r>0.05) except communication (0.35)(38, 56)	Focuses mainly on teamwork related behaviours. Captures performance on individuals subteams, together with a global marker of overall team performance. Training needed to rate teams.

3.1.5 Summary of Non-technical skills assessment tools:

Multiple validities have been established for the NOTSS assessment tool and overall this is a good psychometrically robust tool on which there has been a huge amount of research and time spent to show construct and reliability(47, 48). It has been developed by surgeons for surgeons, ensuring good face validity(42), and unsurprisingly much of the work has been undertaken within general surgery. It assesses the individual surgeon and not the wider operating team, and assessment takes place during the interoperative phase only. Additionally, a high level of training is required in order to obtain accurate results and it is intended that people using this tool attend 2 days of structured training prior to its use(47) ; most likely as a result of the huge scope for interpretation of behaviours, and less step by step guidance on how to rate each behaviour. Crucially it lacks any assessment of pre-operative planning and communication between surgeon and anaesthetist, which is crucial within an ENT theatre environment due to the shared airway. The 4 point likert scale has also come under scrutiny, with other raters feeling this was restrictive and did not allow for differentiation between being very good and good, or acceptable and poor(35). There are just three elements of behaviour in each category of teamwork, leadership, decision-making and communication. And whilst NOTSS provides examples of good and bad behaviour to rate individuals, there is a huge amount of interpretation and subjectiveness (hence the need for structured training in its use). If this is being used as a real time intra-operative assessment then trainers may find this lack of structure hard to rate and therefore not

engage in it fully. It has been suggested anecdotally by surgeons within our institution that NOTSS serves a good framework for feedback rather than assessment.

On this note, the Revised NOTECHS assessment tool is certainly more prescriptive in the behaviours it assesses for, with the rater being asked to rate more behavioural elements in a more structured manner. The behavioural elements being rated also lend themselves to the whole patient journey within the operating room, with specific elements for pre-op communication (between surgeon and anaesthetist), intraoperative phase between all theatre team members (specifically elements for communication between scrub and assistant), and post operative, with specific behavioural elements relating to team debrief. This tool also achieves high levels of psychometric robustness, with various studies determining adequate construct and content validity(49) and reliability(44). Whilst it assesses the individual surgeon, there are also versions of the tool for the wider operating team; anaesthetists, scrub nurses and ODPS; all of which have been subjected to the same psychometric testing. This can allow for simultaneous assessment of all multidisciplinary members within the same scenario and may allow researchers to fairly compare ratings for theatre team members rather than making assumptions that concurrent validity exists between the various different tools which have been developed for the wider team members.

The Oxford NOTECHS(I and II)(35, 45) has followed a similar theme in ensuring that all members of the team are assessed, although this is encompassed on the one tool as opposed to 3 separate version for each subspecialty. Interestingly the

research team here felt that the 4 point likert scale to rate behaviours was limited and required a larger scale (1 to 8, rather than 1 to 4), to allow for greater discrimination between levels of performance within the normal range(35).

The OTAS (Observational Teamwork Assessment for Surgery) tool is also a tool developed for capturing teamwork in the operating theatre. It too has undergone testing to determine reliability(56), and content and construct validity(36). Construct of the tool however was assessed using data from just 12 elective operating cases and was undertaken by showing a significant difference in novice/expert ratings compared to expert/expert ratings. Experts had a significant background in human factors and psychology, compared to a novice rater. This indicated that significant training was required in order to produce reliable repeatable results. It is a data-rich tool, but equally resource-intensive, which may ultimately limit its clinical applicability in real-life.

From an Airway perspective the ANTS system has many attractive elements which may be relevant to an ENT theatre environment, but of course lacks the surgical angle and necessary communications and interactions with the scrub team and/or assistant. By its own definition, this is a tool developed by Anaesthetists to assess anaesthetic non-technical skills, and whilst there is great overlap in skills it lacks the face validity for a surgical trainee.

Consequently, it can be concluded that there is no one tool which is classed as gold standard to assess non-technical skills in the operating room. The numerous developments and reiterations of specialty specific tools further enforces this point, and that there is no “one size fits all”. Each surgical specialty has areas of

uniqueness which surgeons feel may form the cornerstone of safety within that specialty. With this in mind, we can conclude that whilst the tools currently available all have pros and cons, Otolaryngology is a surgical specialty which demands its own dedicated tool, especially if we are aiming to use this tool as an assessment and as a precursor to improving patient safety within that specialty.

3.1.6 Assessing Non-technical skills in Otolaryngology:

Most of the literature regarding non-technical skills in surgery has been undertaken in general surgery; not surprisingly as this is the largest surgical specialty. Consequently the work which was performed to develop and validate the Non-Technical Skills for Surgeons (NOTSS) behavioural assessment tool was undertaken in this specialty(42, 47, 48). Behavioural rating tools are context specific and it is therefore important to use a tool which is applicable to the situation or environment in which it is intended(57). Research into the training and assessment of non-technical skills has been undertaken in other specialties and attempts made to develop specialty specific assessment tools(58, 59). Various examples exist in the literature where a validated tool has been adapted for a particular specialty, such as ENDO-OTAS for endovascular surgeons(60), and T-NOTECHS for trauma team resuscitation(61). Otolaryngology as a specialty is different to other surgical disciplines and it is therefore worth considering the following factors when considering assessment of non-technical skills in the ENT theatre environment:

As ENT surgeons, we work closely with the airway alongside the anaesthetic team, often sharing control of the airway simultaneously. Never is communication and situational awareness more relevant in the operating theatre, with mutual trust and a shared understanding of the goals and plan being a necessity.

ENT can produce a high turnover of cases and therefore increases the potential for errors. In order for the operating list to run smoothly and on time increased situational awareness and communication between all team members in the operating room is imperative.

Local anaesthetic cases can be common, and therefore a special attention to verbal communication must be appreciated since the patient is aware of the activities and environment around them

Some of the equipment used in ENT is heavily specialised and may require assembling in a correct manner by the scrub team. A stringent check of equipment by the ENT surgeon can be crucial to ensuring a smooth, complication free operation. More importantly some of our most challenging emergency cases rely on specialised equipment (eg bronchoscope for removal of foreign body from an airway in a child) which quite often may not have been used by either the surgeon or the scrub team for years.

Many ENT units in the country may operate a solely day-case service. Consequently interaction between doctor and patient is inevitably lessened and aspects may be overlooked pre-operatively which could have an influence on the course of the

surgery (eg failure to take a comprehensive medical history or the patient has forgot to tell the surgeon they are on warfarin.)

An ENT operating list can cover a vast age range from neonates to the elderly. Whilst elderly patients may have multiple co-morbidities making surgery more risky, elderly patients and neonates are also considered more high risk cases due to their limited capacity for cardiovascular reserve if complications ensure (ie. a "small" bleed may have significant impact on extremes of age as opposed to a fit healthy young adult).

Many ENT procedures require additional adjuncts which need to be communicated between surgeon and anaesthetists. Examples include throat packing, nasal preparation with Moffats solution, anaesthetic to the vocal cords and use of Jet ventilation or microlaryngoscopy tube.

The disparity between the available training and assessment tools within Otolaryngology and other specialities has previously been highlighted, and to a certain extent this difference can be expected due to the relatively smaller specialty size. However it is equally important to ensure that ENT trainees needs are met and the tools and assessments available to them fairly reflect their speciality and the skills they are expected to acquire over the course of their training. Evan Propst et al(62) highlighted a deficiency in the Objective Structured Assessment of Technical Skills (OSATS) for Otolaryngology, with just 11 out of 114 core competency procedures having a dedicated assessment tool. They set about developing a

dedicated assessment tool for paediatric tracheostomy, and by establishing a consensus with international paediatric otolaryngology experts, this ensured that the tool was applicable across a range of training programs(62). The selected core procedure of paediatric tracheostomy was especially important as this is a crucial, possibly life-saving skill, which is often performed in stressful situations, and highlights the importance of paired technical and non-technical skills to achieve overall competency.

The importance of training non-technical skills alongside technical skills in otolaryngology has been realized but despite this, the literature is scarce and training haphazard(63). Attempts have been made to reach a consensus on what aspects of technical and non-technical skills should be taught and incorporated within a curriculum or training program(64), The concept of an ENT bootcamp, especially for junior trainees starting out in ENT has been a very popular training intervention both in Northern America(64) and the United Kingdom(65, 66). Clinical trainers and educators have made recommendations for intensive training in key competencies to be provided at the beginning of residency/specialty training with simulation providing a vital role in teaching skills and behaviours that will lead to safe patient care(67). Malloy et al(64) undertook a review of Otolaryngology bootcamps with the United States to determine a consensus on the current landscape of bootcamps, a structured and standardized curriculum and financial and resource implications. Teamwork/human factor scenarios undertaken by the various bootcamps were analysed, and the following scenarios proved the most common;

(1) angioedema, (2) neck haematoma, (3) Foreign body (paediatric) and (4) airway fire. Trainees were able to use individual skills taught throughout the bootcamps in other stations (flexible nasendoscopy, surgical airway, build a bronchoscopy) together with coordinating a team, communicating with the wider team and performing under pressure. The paper recommended that effective training bootcamps should incorporate a core set of 4 to 6 individual skills (decided regionally), and 1 to 3 team scenarios to ensure all residents have the opportunity to develop the same set of core skills. A systematic review on non-technical skills assessment in ENT has also been undertaken to further explore the published literature on this topic and provide guidance on further direction of work in this area(63). Only three papers were included in the review highlighting the paucity of literature on non-technical skills assessment in ENT(68-70). In these papers, attempts were made to assess ENT trainees using the NOTSS and ANTS behavioural assessment tools. It was determined that trainees had good situational awareness skills, with leadership marginally better than decision making and communication. Interestingly the inclusion of the anaesthetic ANTS assessment tool to assess surgical ENT trainees highlights the intra-operative airway considerations which need to form part of a competent ENT trainee's non-technical skills. The importance of this should be emphasized in any tool developed to specifically assess non-technical skills in the ENT theatre environment.

With these considerations in mind, we wanted to further examine and assess the degree of non-technical skills training in ENT: determine what training was being

undertaken and whether any attempts have been made to assess those skills in more detail. The next chapter and systematic review sets out to answer these questions.

4 HUMAN FACTORS TRAINING IN OTOLARYNGOLOGY: A SYSTEMATIC REVIEW OF THE LITERATURE:

This chapter aims to summarise the extent of human factors training in ENT within the literature. A systematic review is undertaken to explore the training, how this is being delivered and how ENT professionals are evaluating the training they are delivering in non-technical skills. A brief introduction to the review is presented below, together with aims, methods and results. The findings of the review are discussed and how this has helped to shape the research presented in this thesis. The chapter concludes with the subsequent overall aims of this thesis.

4.1 Background:

The importance of non-technical skills for improving patient safety within the operating theatre has been increasingly recognized over the last few decades, with poor communication contributing in over 40% of errors made in surgery(20). Evidence also suggests that quality of theatre team non-technical skills correlate with the number of technical errors in the operating theatre(71), and it is breakdown in these cognitive and interpersonal skills which remain the cause of errors in the operating room worldwide.

There has been a dramatic increase in the amount of research undertaken into non-technical skills in surgery, but this has largely occurred in general surgery as a result of the NOTSS skills taxonomy and revised NOTECHS development(38, 42, 44, 48, 72).

The importance of non-technical skills within otolaryngology should not be underestimated. A review on Patient Safety within Otolaryngology reported that not only did the specialty share common safety concerns with other surgical specialties, but there were additional risks unique to the ENT operating room such as airway and thyroid surgery(13). The incidence of serious airway complications occurring in the UK was highlighted by The 4th National Audit Project by the Royal College of Anaesthetists(14, 15). Airway incidents for head and neck surgical patients featured highly, and the report recommended greater collaboration in team training between anaesthetists and otolaryngologists in particular. Despite this, it would seem that comparatively little research has been undertaken in otolaryngology. A synthesis of the existing literature on non-technical skills training in ENT could help to better understand what training is being undertaken and possibly help to determine future research.

4.2 Aims:

The aim of this systematic review was to synthesize the existing literature on nontechnical skills training in ENT. Specifically the primary aim was to determine what training is being undertaken in otolaryngology where the emphasis is placed on

team training or non-technical skills. A secondary aim was to identify what assessment tools were being used to assess participants non-technical skills and thirdly to determine how training programs in nontechnical skills in the ENT environment are validated i.e . How is training effectiveness being assessed?

4.3 Methods:

4.3.1 Databases searched and search strategy:

Databases searched included MEDLINE, EMBASE and PsychINFO.

MeSH terms were identified to ensure the search was comprehensive. The following search strategy is outlined in Box 1:

Box 1: search stragetgy

	Search Terms:
A = Non-technical skills	NOTSS OR nontechnical skill$ OR non-technical skill$ OR human factors$ OR situational awareness OR communicat* OR communication OR decision making OR crisis resource management OR leadership OR teamwork OR briefing OR self confidence
B = ENT	Otolaryngology OR Otolaryngol* OR ENT OR ear, nose and throat

C = **Training**	Training OR simulation OR education OR in-situ OR insitu OR learning

Search Limits:

- Language: English
- Subjects: Humans
- Year of publication: 1980 – current (25/06/2019 – date search last performed)

After combining categories A, B, C with the Boolean term "AND", the limits stated above were applied, and duplicates removed. The last search was conducted on 25th June 2019.

4.3.2 Inclusion and exclusion criteria:

Search result citations were reviewed to identify relevant studies based on predefined inclusion and exclusion criteria. This was as follows:

Inclusion criteria:

- Empirical study, eg observational, cohort, published in peer reviewed journals
- Main focus of the study is Non-technical skills training or involves aspects of non-technical skills training alongside more technical training.
- Contains a simulation or training component

- Subjects: includes ENT trainees
- Simulation/training can include adult and/or paediatric ENT.

Exclusion criteria:

- Commentary or review of literature (although reference lists were checked)
- Abstracts with no clear method or data regarding assessment or evaluation of training.
- Descriptive or survey studies.

Data was extracted from the included articles. Relevant data gathered included:

- Author, title and study design
- Setting
- Scenario/ subject of training or simulation
- Sample size
- Candidate specialty
- Non-technical skills assessed or focused on
- Assessment tools:
    - How the training was evaluated by the participants
    - How the participants non-technical skills were assessed
- Key findings/Results

All titles and abstracts were searched by myself to identify the studies which were relevant to the review. A second reviewer (a medical student with an interest in human factors) independently screened all abstracts and a consensus reached.

4.4 Results:

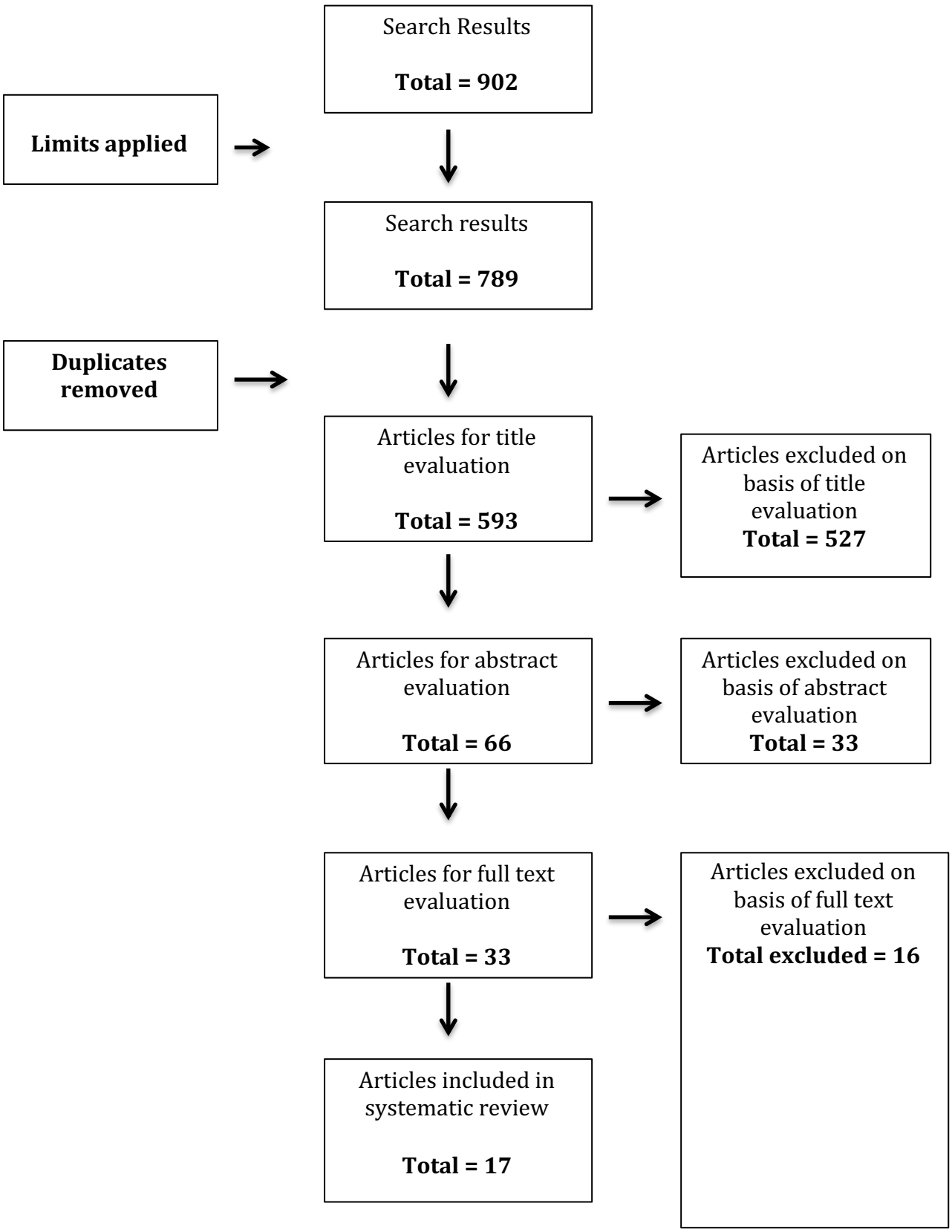
4.4.1 Selected articles:

The following flow diagram illustrates the results of the literature search:

A total of 17 articles were included in the final review and a flow diagram of search results is illustrated in figure 4.1.

Figure 4-1 PRISMA Flow diagram showing search results

Figure 4.1: Prisma flow diagram showing process flow of articles:



The search yielded 902 citations, of which 789 were eligible after limits were applied. Duplicate removal reduced this figure to 593, and these articles were then subjected to title evaluation. 66 articles were then determined appropriate for abstract examination. 33 abstracts were excluded which left a further 33 articles which were retrieved for full text analysis. Of these 33 articles, 17 articles were deemed eligible for systematic review.

Table 4.1 shows the main characteristics of the 17 included studies in the review.

4.4.2 Study setting and content:

Most studies used a simulated setting, with just four studies using an in-situ location to host the simulation training(73-76). In situ simulation locations included the Operating room(73), emergency department(74), interventional radiology(74), the intensive care unit(73) and post anaesthetic care unit(75).

A number of studies report a Bootcamp style training day(68, 77-79), where high fidelity team simulations only form a small part of a larger training day. Often, the high fidelity team training is given alongside lectures and specific skill stations such as epistaxis management or a cricothyroidotomy skills stations. Trainees are then immersed in a team crisis scenario and encouraged to use these technical skills in

conjunction with managing and leading a team, with particular emphasis on these non-technical skills in the team debrief. Similarly, high fidelity crisis simulation has also been a popular addition to airway skills courses(74, 75, 80-82), and ENT trainees have undertaken training alongside anaesthetic trainees.

The simulations in the reported studies encompassed both adult and paediatric ENT emergencies. Studies detailing Paediatric ENT emergencies were included in this review of scenarios as Paediatric Foreign body airway removal is a key core competency for CCT along with experience managing paediatric emergencies (tonsil bleed for example). Additionally, the ENT on-call out of hours service provides cover for both adult and Paediatric emergencies. Trainees are also exposed to paediatric operating within most otolaryngology rotations. Lastly, the extensive work done by Malloy et al(64) to standardize and reach a consensus on the teaching content within the national ENT bootcamps also highlighted that Paediatric foreign body removal was one of the most common skills ENT trainers included in bootcamp training, indicating the high level of importance placed om this skill. 7 studies in this review included paediatric airway foreign body removal as one of the simulation scenarios(68, 73, 75, 80, 81, 83, 84). The remaining studies in this review all included acute airway scenarios; these included post tonsillectomy bleeds, post thyroidectomy bleeds, neck trauma and stridor. (see Table 4.1 for details).

4.4.3 Study participants:

Although all studies included in this review performed team training, the vast majority of the training did not address multidisciplinary group simulation. 5 out of the 17 studies performed truly multidisciplinary team simulations; with all members in the scenario blind to the crisis or case presented to them(73-76, 85). The remaining studies, undertook team training with just the ENT trainee as the main subject, with other team roles (i.e nursing team, anaesthetist) being acted by confederates who knew the scenario and could therefore help "steer" the scenario.

4.4.4 Assessment of trainees:

Only one study by Wu et al attempted to formally assess the nontechnical skills of the participants(68). This study used a generic behavioural marker system for surgeons in the operating theatre (NOTSS)(42). One study by Amin(82) did undertake faculty assessment of the trainees using a developed assessment tool covering the 4 domains of Preparation, Clinical reasoning, knowledge and technical skill. Although there was no specific assessment of non-technical skills, certain aspects of this tool did comment upon situational awareness ("provides assessment of the situational issues" and "considers anaesthetic issues related to airway scenario"), and decision-making ("adjusts plan with changes in clinical condition or failure of initial plan"). There was no data regarding the reliability or validity of this

tool, and was reported as a simple yes/no checkbox assessment. i.e did the participant demonstrate the required skill or not. In addition to this, two studies(74, 82) undertook pre and post knowledge tests regarding airway management skills.

4.4.5 How was the training assessed?:

According to Kirkpatricks training evaluation, an educational training course may be assessed on 4 levels: reaction, learning, behaviour and organizational impact(86).

All studies evaluated their training programs at a reactionary level, by collecting participants perception and evaluation of the training. In general, all studies reported that participants assessed the training favourably. Attempts were made to evaluate the training at the learning level by all studies. Four out of ten studies reported that participants self -reported confidence levels increased following the course(74, 77, 79, 82). Questionnaires and post course evaluations reported a perceived increase in non-technical skills by the participants; either through improved understanding of team processes, or agreeing that the course had enhanced their non-technical skills. Amin et al(82) and Tsai et al(74) formally undertook pre and post course assessments, with both studies reporting that trainees improved their knowledge and skills following the training day.

With regards to Organizational impact, one study attempted to address this, by looking at airway related mortality data(85). Metha et al(85) reported a reduction in airway related mortality during the 2 year time period the course was running compared to the same period prior to the commencement of the course

Table 4-1 Characteristics of studies reporting Non-technical skills training in Otolaryngology

Author	Year	Study design and setting	Scenario/teaching material	Number	Specialties	Non-technical skills	Non-technical skills assessment	Results:
Zirkle et al(87)	2005	Prospective observational study simulated setting (ICU or OR)	complex airway emergency scenarios	17	ENT Trainees	1. Leadership 2. Crisis management 3. Teamwork 4. Communication	*structured debrief* - No formal assessment 5-point likert scale Post course questionnaire/ evaluation	Participants assessed the training favourably Evaluation: overall program, 5.0 (SD, 0.00); course goals, 4.79 (SD, 0.43); realism, 4.36 (SD, 0.63); value of lecture, 4.71 (SD, 0.47); and quality of debriefings, 4.92 (SD, 0.28)
Deutsch et al(83)	2008	Prospective observational study simulated setting (OR)	airway foreign body aspiration and ingestion	8	ENT Trainees	1. Teamwork 2. Communication 3. Leadership 4. situational awareness	Residents coached to achieve "competence" 5 point likert scale post course evaluation	participant evaluations generally positive The mean ratings were highest for training cognitive and psychomotor endoscopy skills (4.89) and team process(4.78)
Deutsch et	2009	Prospective	multimodality course to	2007 - 16	ENT Trainees	1. Teamwork	5 point likert scale post	Lecture and high fidelity

al(84)		observational study simulated setting (OR)	develop airway endoscopy skills high fidelity sim for paediatric airway foreign body aspiration	2008 - 20		2. Communication 3. Leadership	course evaluation	manikins were evaluated as best for teaching team process.
Volk et al(73)	2011	Prospective observational study In situ simulated (ICU or OR)	airway and anaesthetic themed scenarios inc paediatric foreign body	59	ENT trainees Anaesthetic trainees Nurses	1. Communication 2. Team working 3. Leadership 4. Decision making	*Structured debrief* -no formal assessment. *25 point post course questionnaire* (organisation, realism, debriefing, future practice)	Participants assessed the training favourably > 90% of participants either agreed or agreed strongly that the training was advantageous to their learning.
Malekzadeh et al(79)	2011	Prospective observational study simulated setting (boot camp, simulated Patient room in ED)	Airway scenarios (cant intubate cant ventilate vs post thyroidectomy bleed)	27	ENT Trainees	1. Leadership 2. Team working	Structured debrief -no formal assessment pre and post course questionnaires on confidence and knowledge	Participants assessed the training favourably improved confidence levels ($p<0.05$) across all skill domains. Strongest gains in managing complex airway scenarios ($P<0.001$)
Amin et al(82)	2013	Prospective cohort study simulated setting (simulated room used to simulated various settings ED, OR)	clinical airway emergency scenarios	12	ENT Trainees	1. Teamwork 2. Communication 3. Leadership	Structured debrief 5 point likert post course evaluation Self assessment of competency and confidence pre and post course Multiple choice test on airway skills pre and post course	All respondents felt the course was effective Significant increase in participants' self-perceived ability to carry out critical airway-related skills was observed. Statistically significant increase in multiple choice scores post course

							faculty assessment of performance (preparation, clinical reasoning, knowledge and technical skill)	Faculty assessment yielded a cumulative score of 80% and 91% pre- and postcourse, respectively (P =0.002)
Chin et al(78)	2014	Prospective observational study simulated setting (bootcamp, simulated patient rooms)	BOOTCAMP. airway emergency scenarios (pneumothorax, post thyroidectomy bleed and facial trauma requiring surgical airway)	28	ENT Trainees	1. Teamwork 2. Communication 3. Leadership	*structured debrief* - No formal assessment 5 point likert scale Post bootcamp evaluation Pre and post experience and confidence questionnaire (but no results reported in article)	Klob Learning style inventory - active experimentation (acting, initiating, and deciding) were more common usefulness of Team scenarios rated 4.5/5 (between very good and outstanding)
Metha et al(85)	2015	Prospective cohort study simulated setting (anaesthetic room used to simulated various settings eg ED or ICU/ward)	difficult airway scenarios	78	ENT Trainees (18) Anaesthetic trainees (28) Nurses (19) ODP's (13)	1. Teamwork 2. Communication 3. Leadership 4. situational awareness	*structured debrief* - No formal assessment 6 point likert scale post course evaluation	Delegates gave an average score of 5.6 to the course improving clinical knowledge, teamwork, leadership and non-technical skills. Audit of Trust airway mortality reduced from 3 deaths in the prior 2 years, to 0 deaths during the course running.
Chin et al(77)	2016	Prospective	BOOTCAMP.	22	ENT Trainees	1. Teamwork	*structured debrief* - No	improved confidence levels

		observational study simulated setting (boot camp, simulated patient rooms)	airway emergency scenarios (post thyroidectomy bleed and facial trauma requiring surgical airway)			2. Communication 3. Leadership	formal assessment 5 point likert scale Post bootcamp evaluation pre and post course questionnaires on confidence and practical experience	in managing 6/9 tasks. significantly improved confidence in handling Otolaryngology - Head and neck surgery calls ($p<0.05$) evaluation: communication and teamwork skills scored less favourably. (? Related to small number of tasks dedicated to this)
Tsai et al(74)	2016	prospective cohort study in situ sim (ED or interventional radiology)	difficult airway scenarios (all scenarios involving the Emergency Airway Response Team; EART)	178	ENT trainees Anaesthetics Trauma Surgery emergency medicine Nurses Respiratory medicine	1. Teamwork 2. Communication 3. Leadership 4. situational awareness	structured debrief - No formal assessment. 5 point likert scale pre and post questionnaire re confidence and EART protocols and knowledge	significant improvement in self-rated team participation and confidence and objective knowledge regarding EART after undergoing simulation.
Hogg et al(88)	2019	prospective observational study simulated setting	emergency airway scenarios (penetrating neck injury, airway fire, post T's bleed, post thyroidectomy airway compromise)	62	ENT Trainees Advanced nurse practitioners core surgical trainees	1. Leadership 2. crisis management 3. Teamwork 4. Communication	structured debrief - No formal assessment. 10 point scale pre and post course confidence in managing airway emergency	participants assessed the training favourably. significant increase in confidence managing emergency airway and head and neck emergency.
Leeper et al(80)	2018	Prospective cohort study lectures, skills stations, high fidelity sim in afternoon	difficult airway management: airway trauma, Paeds ICU airway scenario, general medical ward	499 (since 2008) 128 (since 2014 when	ENT trainees Anaesthetists critical care medicine emergency	1. Leadership 2. Teamwork 3. Communication 4. decision making	structured debrief - no formal assessment of non-technical skills. 5 point likert scale post	qualitative evaluation by participants suggested major value from the high fidelity scenarios, and teamwork practice.

		simulated setting	airway scenario.	course evaluation started)	medicine other (nursing, respiratory therapy, paramedic)		course questionnaire	
Nguyen et al(76)	2019	prospective observational study. High fidelity Simulation performed as part of a larger airway curriculum. in situ setting (operating room, emergency room, post anaesthetic care unit)	airway crisis scenarios	31	ENT trainees multidisciplinary confederates present. (Nurses and resp therapists)	1. Teamwork 2. communication 3. Leadership 4. crisis management	structured debrief - no formal assessment. Self assessment questionnaire on self perceived improvement in knowledge, skills and non-technical skills. 5 point likert scale, feedback survey	participants assessed the training favorably. Significant self reported increase in non-technical CRM skills post course. Senior residents placed increased value on the crisis scenario compared to junior.
Wu et al(68)	2019	Prospective cohort study simulated setting as part of a bootcamp	emergency scenarios (post thyroidectomy haematoma, facial trauma, neck stabbing, foreign body aspiration)	15	ENT trainees	1. Teamwork 2. communication 3. Leadership 4. situational awareness decision making	Non-Technical Skills for Surgeons (NOTSS)	residents scored highest in situational awareness and lowest in leadership domains there was good consistency and reliability between raters using NOTSS.
Sommerfeld et al(81)	2019	Prospective cohort study simulated setting as part of simulation symposium.	emergency airway scenarios (laryngeal trauma, paediatric stridor, foreign body aspiration	19	ENT trainees multidisciplinary confederates present	1. Teamwork 2. communication 3. decision making	structured debrief - No formal assessment 5 point likert scale pre and post session questionnaire. Structured interviews 1:1 pre and post course questionnaires on confidence and practical experience	participants assessed the training favorably. Participants reported significant increases in comfort managing airway problems, knowledge of CRM and team training post course.
Lind et al(75)	2018	Prospective cohort study	Paediatric airway emergency	39	ENT trainees (10) Paeds medicine	1. teamwork 2. communication	structured debrief - No formal assessment	participants felt significantly more

		lectures, skills stations, high fidelity sim in afternoon insitu setting (ER, radiology, PICU and operating room)	airway foreign body and blunt trauma		(3) PICU (10) Paeds surgery (4) anaesthetics (12) other confederates playing nurses etc	3. Leadership	self reported efficacy and confidence in technical and non-technical skills pre and post course and 6 months	confident in all non-technical skills post course 6 months post - 90% reported greater confidence dealing with real clinical airway emergencies and 100% felt more confident communicating during these crisis events.
Bouhabel et al(89)	2017	Prospective cohort study simulated setting subgroup analysis of workshop run by Nygen et al.	acute airway scenarios	19	Ent trainees	CRM principles 1. Teamwork 2. Communication 3. Leadership 4. situational awareness	novel error detection model: residents asked to identify and describe errors seen in a pre-recorded video of CRM scenario.	increased error detection: 80 before course 99 after course. Individual participants identified a mean of 2.6 new CRM errors yearly. Improved use of CRM terminology after course; 37% used CRM terminology before workshop, compared to 95% after.

4.5 Discussion:

This is a systematic review looking into the extent of non-technical skills training in ENT. Whilst a subsequent systematic review has also been performed looking into non-technical skills in ENT, the paper examined the research undertaken to date on the assessment of these skills with just 3 studies identified in the literature. They excluded a huge number of articles as there was insufficient detail about any assessment tool used. They failed to include any paper detailing bootcamps and the effort invested by the UK, US and Canada to incorporate these skills into critical training and a formal curriculum. However, as evidenced by our review here, we have shown that training and observation of non-technical skills in otolaryngology is being undertaken and is more widespread than what is currently reported. The recent recommendations at the highest level that non-technical skills training is as important as technical training, is starting to peter through, with efforts being made to incorporate these skills on core training bootcamps and ensuring they form part of an established curriculum. However, true team training, with all operating room personnel and assessment of these team skills is very scarce. True multidisciplinary team training, was reported in just 5 studies, with ENT trainees undertaking crisis scenarios in conjunction with anaesthetic trainees and scrub team members(73-76, 85). This is particularly worrying for our specialty, given the complex interactions which take place in high stress events such as airway emergencies. The NAP4 audit(14, 15) in particular called for combined ENT and anaesthetic training to help prevent the high morbidity and mortality previously seen in these circumstances.

Although individual specialties can practice skills and competencies associated with airway management, nothing prepares you for the very real, high stress encounter when multiple teams come together under tough circumstances and are expected to work seamlessly. Training together for such emergencies seems the most logical and useful training solution and yet centres are either not undertaking team training at all or are failing to share and report the extent of their work if they are doing so.

A Key finding in this review is the reported use of bootcamps to train non-technical skills. A large number of the studies included (and indeed excluded – due to insufficient information on the non-technical skills training) have documented the design, implementation and effectiveness of these training bootcamps as a means of teaching and training core competencies to junior ENT trainees. Crucially however, training in non-technical skills is conducted as a small addition to a larger training day that focuses primarily on technical skills and knowledge. Trainees are then emersed in one team scenario where the technical skills learnt on the day can be incorporated together with managing a wider team in a stressful situation. Given that the training emphasis and majority of the day is on other technical skills, the fear therefore is that the importance of these non-technical skills may be overlooked by the participating trainees. Reassuringly the feedback from participating trainees regarding the benefits of non-technical skills training has been excellent, and all studies reported that the trainees found these sessions very beneficial. This is also in line with the recent recommendations from Patient Safety 2030(7), where it was

reported that the training intervention which had the most impact on NHS staff was simulation team-based training with an emphasis on non-technical skills.

A common theme is the high value of the debriefing session, with just 2 of the 10 studies not reporting a formalized debrief(83, 87). The literature on non-technical skills training has emphasized the importance of the debrief, and it is often the most valuable part of the training session. It allows trainees to reflect on their performance and receive constructive feedback, which has been shown to result in increased levels of retention(90). Crucially, it allows each specialty to have a discussion with one another and allow each team to appreciate the concerns and expectations of the other team members in a controlled stress free environment, leading to greater understanding in the real world.

All studies included in this review are of low level evidence and are mainly in the form of training programme descriptions, or case series. No randomized control trials or cohort studies were found. Very few studies made an attempt to assess trainees, and remarkably only one study used a validated tool to do so(68). Assessment of non-technical skills is critical to improving patient safety(27). It allows structured and specific feedback to trainees and identifies any training needs or areas of weakness for an individual or group. It also allows us to objectively and fairly measure the progress of a team or individual and observe the effect that training

might have(27). For this reason, if we are to improve non-technical skills, and thereby patient safety, a psychometrically robust assessment must be in place.

Despite the low numbers of reported centres training non-technical skills, this review does demonstrate that non-technical skill training in ENT is feasible and well received by the trainees.

4.6 Conclusion:

Although ENT as a specialty has been relatively late to incorporate non-technical skills into training, there has been an increase in reported training interventions in recent years. Dedicated simulated environments or in-situ simulation has been shown to be feasible and valuable to trainees. Multidisciplinary team training has been shown to be effective in surgery and it is hoped that team training will lead to an improvement in patient safety. More structured and formal training in non-technical skills should therefore be incorporated into ENT training programs. Additionally, psychometrically robust assessment of non-technical skills is crucial. Future work should focus on developing MDT simulation with an emphasis on assessment of essential human factors using a tool which is specific to ENT and reflects the core skills expected from a trainee in that specialty.

4.7 Introduction conclusions:

Patient safety and training programmes to improve patient outcomes are hugely important in today's NHS. Otolaryngology and Head and Neck surgery is a unique specialty where complex anatomy and airway pathology means that leadership, communication and intricate team-working skills with our anaesthetic and nursing colleagues are essential to minimize adverse events and complications. Crucially the NAP 4 audit highlighted ENT as a specialty where team training with anaesthetists is fundamental to avoid catastrophic airway complications. Despite this, our systematic review has identified both a lack of multidisciplinary non-technical skills training in ENT teams and an absence of assessment of these skills.

Clearly there is a lack of ENT themed multidisciplinary theatre simulation and no psychometrically robust tool dedicated to an ENT operating theatre to assess the requisite skills. With this in mind, the overarching aims of this body of work are as follows:

4.8 PRIMARY AIMS AND HYPOTHESIS:

HYPOTHESIS:

"High fidelity Multidisciplinary team simulation training in ENT crisis scenarios leads to improved confidence in team and leadership skills in the operating theatre, with demonstratable improvement in these skills when assessed using an appropriate behavioural tool."

AIMS:

1) ***To develop a novel non-technical skills assessment tool to be used by ENT theatre teams:***

Specifically:

i) To modify a previous well validated non-technical skills assessment tool and make this applicable to ENT surgery teams.

ii) To assess the psychometric robustness of ENT-NOTECHS. Specifically; to assess content validity, construct validity and reliability.

2) ***To develop and validate an ENT themed multidisciplinary simulation programme for the assessment and feedback of Non-technical skills.***

Specifically this training day programme will have 2 functions:

i) To improve awareness of non-technical skills, particularly in the stressful emergency crisis environment, with the aim of improving non-technical skills.

ii) This training day will be used to test the psychometric robustness of the newly developed ENT-NOTCHS tool.

4.8.1 SECONDARY AIMS:

- ***Evaluate the effectiveness of the training day and its impact upon the participating trainees (surgical, anaesthetic and nursing).***

5 DEVELOPMENT OF A NOVEL NON-TECHNICAL SKILLS ASSESSMENT TOOL TO BE USED BY ENT THEATRE TEAMS: TO BE TERMED "ENT –NOTECHS"

5.1 Background:

Non-technical skills and behaviours within the operating theatre are increasingly important to achieve safer surgery(21). The ability to robustly assess these skills is a pre-requisite to implementing training programmes to hone and improve these skills in the work place environment(27).

Indeed, the assessment of non-technical skills can achieve several aims:

1) To provide robust feedback to trainees and teams regarding their skills. 2) To identify learning needs of individuals or teams, 3) To determine whether a training intervention has been effective, and 4) To evaluate level of performance and competency, with the overall hope this will improve safety within surgery.

Consequently, several tools have been developed to capture team skills in a variety of situations, including the operating theatre(35, 43, 44, 50) (For an in depth analysis see Chapter 3). The most common method of examining such skills is with a

behavioural marker system, allowing explicit behaviours and skills to be rated. A variety of methods have been employed in the past to develop behavioural rating tools. Whilst some tools have been adapted by the surgical profession from the Crew Resource Management (CRM) and NOTECHS tool originally used in the aviation industry(44), others have reverted back to first principles to identify the relevant nontechnical skills for their chosen specialty(42). Following discussion with my research team, it was felt that the former method would be most appropriate in the context of the ENT theatre environment. Whilst there are key perceived differences when working within an ENT/airway themed theatre, the core exemplary behaviours of communication, situational awareness, teamwork and leadership are commonly shared and hence it was felt unnecessary to completely reinvent the wheel. With this in mind, we aimed to produce a novel assessment tool to assess non-technical skills in the ENT environment where specific behaviours and practices unique to ENT and airway training can be assessed in depth but whilst still based upon the psychometric grounding already established by existing tools.

5.2 Aims:

To produce a provisional ENT-specific non-technical skills assessment tool based on a current psychometrically robust tool within the existing literature

The development of the assessment tool was divided into 3 phases, each with specific aims. These specific aims were:

Phase 1:

To identify a suitable psychometrically robust behavioural tool within the existing literature to assess non-technical skills in the operating theatre. This would serve as a basis on which to base our own ENT specific tool.

Phase 2:

To modify the selected tool in order to make this applicable to ENT. This was undertaken by performing thorough field observations within the ENT operating theatre, and then conducting a focus group meeting with subject matter experts.

Phase 3:

To assess the content validity of the developed ENT-NOTECHS tool.

5.3 Methods:

5.3.1 Phase 1 methods:

"To identify a suitable psychometrically robust behavioural tool within the existing literature to assess non-technical skills in the operating theatre."

The literature was examined to identify existing observational tools being used to assess non-technical skills within the operating theatre environment. Online sources including Pubmed, Medline and EMBASE were consulted to identify the main behavioural assessment tools. The resulting identified tools were then examined for their psychometric robustness and the most appropriate tool on which to base our ENT tool was selected. Rating scales used within the published tools were also examined.

5.3.2 Phase 2 methods:

"To modify the selected assessment tool to form ENT-NOTECHS".

A multi-method approach was employed to modify the selected tool. There were 3 steps to this phase:

Step 1:

Review and modification of the tool elements.

The chosen assessment tool was examined in detail to identify any behavioural elements within it which were not considered applicable to ENT. These were then removed from the tool. The tool structure was also rearranged to make it more applicable to an ENT theatre environment and mindset. For example: it was felt that the element "outlines strategy and institutes a plan i.e asks for suction etc", should be moved from "Crisis Management" category to "Situational awareness". This was due to the fact that ENT surgeons will commonly anticipate such needs as part of a "routine" operation, just by the nature of the work we are undertaking i.e operating on the airway, where we have to be prepared for all eventualities. In order to avoid a crisis in the first place, these elements should be routine practice by all ENT trainees and therefore not part of "crisis management".

Step 2:

Field observations of behaviours in an ENT theatre environment;

This was undertaken to ensure that the skills and behaviours in the assessment tool were observable and sufficiently common to warrant inclusion within the adapted tool and hereby contribute to the tool having content validity within the ENT theatre. Basic ENT operations were observed and theatre team behaviours were

recorded. This was undertaken at St Mary's Hospital, Paddington over the course of 1 week, encompassing both adult and paediatric theatre sessions.

Consent to observe the operating list was gained from both the operating consultant and nurse in charge of theatre. Ethical consideration was given to the field observations: this was classed as a quality improvement project and data was completely anonymized. The observations were all carried out by the lead investigator (JCM). The unmodified selected tool was used in each case as a checklist to record whether individual behavioural elements of the tool either "occurred" or "did not occur". Additionally, extensive field notes were also made on each case, documenting observed behaviours and communications felt to be important to the overall success or potential errors in the ENT case.

Step 3:

Focus group with subject matter experts:

A focus group with subject matter experts was conducted. One consultant surgeon (20+ years experience post CCT), two consultant anaesthetists (10+ years experience post CCT) and 2 senior scrub sisters (10+ years experience) were consulted to identify behaviours unique to the ENT theatre environment, in conjunction with the results of the field observations. Both consultant anaesthetists had an interest in human factors and are faculty for various difficult airway courses for anaesthetists, of which human factors also features.

The results of the 3 steps above were used to revise the assessment tool and construct a novel "ENT-NOTECHS" assessment tool.

5.3.3 Phase 3 methods:

"To assess the content validity of the developed ENT-NOTECHS tool."

For the tool to be content valid, the behavioural elements of the tool should be observable within the environment in which it is intended to be used; i.e the ENT operating theatre. Observability of these behavioural elements has previously been addressed (See phase 2 methods, step 2). Additionally, the developed ENT-NOTECHS tool was given to 6 assessors (2 ENT consultants, 2 anaesthetic consultants, and 2 senior theatre sisters) for quantitative content validation. Participants were asked to rate the relevance of each item (1 = not relevant, 2= somewhat relevant, 3 = quite relevant, 4 = highly relevant) with regards to nontechnical skills within the ENT operating theatre. Consequently an Item-Content validity index (I-CVI) was computed for each behavioural element of the tool. A I-CVI criterion of >0.78 (by 6 or more assessors) was deemed acceptable to be included in the tool(91). Elements scoring lower than this were then discussed with subject matter experts in more detail to determine whether they would be included in the final tool.

Finally, subject matter experts were given a questionnaire to evaluate the content and structure, feasibility and usability of the ENT NOTECHS tool.

5.4 Results:

5.4.1 Phase 1 results:

"To identify a suitable psychometrically robust behavioural tool within the existing literature to assess non-technical skills in the operating theatre."

A Review of the literature found 6 tools in common circulation for assessing Non-technical skills in the operating theatre. These included:

NOTSS, ANT, SPLINTS, Revised NOTECHS, Oxford NOTECHS (I and II), and OTAS. Tools were assessed for their psychometric robustness, study population and nontechnical skills assessed (i.e leadership, teamwork etc). Comments were also made based on usability etc. Table 5.1 demonstrates the main non-technical skills assessment tools within the published literature and analysis of psychometric robustness:

Table 5-1 Characteristics and psychometric robustness of behavioral markers in the operating theatre

Assessment Tool	Population	Non-technical skills assessed	Validity	Reliability	Comments
Non Technical Skills of Surgeons (NOTSS)(42)	Surgeons	5. Situational Awareness 6. Decision Making 7. Communication and Teamwork 8. Leadership 4 point scale	**Content(50)**: NOTSS rating system "developed for surgeons, by surgeons" using task analysis, literature and interviews.	**Inter-rater reliability and internal consistency(47)**: with training, adequate levels of reliability found	Focuses on individual surgeon's nontechnical skills. A degree of training is recommended prior to use for novice raters.
Revised NOTECHS (49)	Surgeons Anaesthetitsts	6. Communication and interaction 7. Vigilance and	**Content:** developed and revised for use in theatre teams by human factors	**Internal consistency(44):**	Focuses on individual non-technical skills performance for all

	Nurses ODP's	situational awareness 8. Team skills 9. Leadership and management skills 10. Decision making – surgical crisis. 6 point scale	experts and pilot studies involving surgical teams. **Construct(49):** significant difference in NOTECH scores seen with increasing seniority (junior vs senior vs consultant)	Good reliability cronbachs alpha (i)across all raters (ii) between trainers and trainee raters, (iii) across all subspecialties. **Inter-rater reliability(49)**: High (alpha =0.82)	subteam members in the operating theatre. Can be used to rate skills by both experts and novice raters. No training needed.
Oxford NOTECHS (I and II)(35)	Surgeons Anaesthetists Nurses	6. Communication and interaction 7. Situational awareness	**Construct(35, 45):** improved scores after teamwork training, inverse scores between teamwork and surgical	**Inter-rater reliability(35, 45):** good reliability scores across raters.	Focuses on individual non-technical skills performance for all subteam members in the operating theatre.

		8. Teamwork and cooperation 9. Leadership and management 10. Decision making 4 point scale later revised to 8 point scale	error, improved attitudes to teamwork after training		Used expert raters with prior experience
Anaesthetists Non-technical skills (ANTS)(43)	Anaesthetists	5. Task Management 6. Team working 7. Situation Awareness 8. Decision making	**Content:** developed using task analysis, interviews, observations and literature	**Internal consistency:** good ratings. (43) **Inter-rater reliability**: reasonable level of	Focuses on individual anaesthetists non-technical skills. A degree of training is

		4 point scale	review(43, 51, 52). Completeness and observability studies	agreement but better if expert raters.(43)	recommended prior to use for novice raters.
Scrub Practitioners' intraoperative non-technical skills (SPLINTS)(53)	Nurses	4. Situation Awareness 5. Communication and teamwork 6. Task Management 4 point scale	**Content:** developed using task analysis, literature reviews and interviews. Completeness and observability studies	Within group reliability: acceptable levels Internal consistency: good internal consistency(54) - Absolute mean difference was M < 0.2 of a scale point for all three categories.	Focuses on the scrub nurse in charge, does not assess all nurses present (i.e runners etc).
Observational Teamwork Assessment for Surgery. (OTAS)(55)	Operating theatre teams	6. Communication 7. Leadership 8. Coooperation and	**Content:** observational studies confirmed high OTAS exemplar	**Inter-rater reliability:** overall adequate agreement with regards	Focuses mainly on teamwork related behaviours. Captures

		Back-up behavior 9. Coordination 10. Team monitoring and Situational Awareness 7 point scale	behaviours with a high observer agreement(55). **Construct:** assessed by consistency in the scoring by expert versus novice-expert raters produced significantly more consistent scoring than novices(36).	to teamwork (r>0.05) except communication (0.35)(38)	performance on individuals subteams, together with a global marker of overall team performance. Training needed to rate teams.

On review of the table and following discussion with the project supervisor (NST), the Revised NOTECHS tool was chosen as the basis for our revised ENT version.

This was chosen for the following reasons:

i) Highly valid and Reliable: Revised NOTECHS has been tested for content and construct validity, together with internal consistency reliability and inter-rater reliability.

ii) Non-technical skills of individual operating team members can be assessed using the same assessment tool (with slight adaptations to reflect the differing specialty roles).

iii) The content and rating structure of Revised NOTECHS appeared more structured and offered more direction to the evaluator/rater than other behavioural markers. NOTSS appears to provide more of a framework on which discussion over the 4 category behaviours can be based rather than as a formative assessment of specific skills. It was also felt that to "rate" the behaviours of individuals in a time pressured environment (either in situ or in a simulated environment) without a structured assessment

criteria on which to base behaviours on, would lead to a degree of subjectiveness and be less informative in its feedback.

iv) Does not require extensive training prior to use. We ideally wanted a tool which was easy to rate, and specifically defined the key behavioural elements. We felt that a tool which required too much prior training to use might limit its uptake and acceptability to trainers.

Many of the existing tools require assessors to attend a training course prior to using the tool and many tools only demonstrated inter-rater reliability after a specified period of training. We wanted to create and use a tool which could be "picked off the shelf" and be transparent in its rating of skills and behaviours.

5.4.2 Phase 2 results:

"To modify of the selected assessment tool to form ENT-NOTECHS".

Firstly the selected NOTECHs tool was reviewed in detail; both in terms of structure and content.

The following modifications were made to the existing tool:

5.4.2.1 Modifications:

Rating scale.

The original rating scale for Revised NOTECHS was based on a 6-point likert scale (1= not done, up to 6 = Done very well). Following discussion with the project supervisor we felt it counter-intuitive to give a score of 1 for "Not done". Consequently, this was adapted so that "Not done" scored 0. The resulting rating scale was therefore: 0 = Not done, 1 = done very poor, 2 = Done poor, 3 = Satisfactory, 4 = Done well, 5 = Done very well.

"Communication and interaction" category:

ENT operations are often single operator, and therefore do not involve an assistant. Having the elements *" instructions to assistant clear and polite"* and *"waited for acknowledgement from the assistant"* as permanent elements of the tool seemed pointless as this would invariably score "not applicable". Given that communication between ENT surgeons and Anaesthetists is key, especially given the shared airway in many operations, we elected to substitute these elements for:

"*informs anaesthetist that he or she is starting operation"* and

"waits for acknowledgement from the anaesthetist".

"Situational Awareness" category:

We agreed that all original behavioural elements described within this category were highly applicable to ENT. Additionally, the behavioural element "*anticipates potential problems and shows evidence of contingency plan (i.e equipment on standby)"* was added to this category. Demonstrating the situational awareness that a relatively routine intubation may indeed not be so straight forward (particularly when operating on a patient with airway pathology) is a key critical skill for both the ENT trainee and wider team, and planning in advance for rare problems is critical to avoiding a crisis and ensuing a smooth case.

Cooperation and Teamwork category –

No changes on initial review.

Leadership and management skills category –

The behavioural element "*debriefing the team*" was removed. Whilst this is a key skill for those individuals leading a team, we wanted our ENT tool to represent the intraoperative interaction occurring between team members DURING the case. Team debriefs commonly occur at the end of the list or the end of the case, it was therefore felt that this was an unnecessary element to this category.

"Decision making – surgical crisis" category:

ENT surgery commonly calls for a shared airway with the anaesthetist and can often involve complex airway pathology. It is therefore imperative that the ENT trainee is able to recognize potential problems BEFORE they arise and have the necessary equipment on hand to use at a seconds notice in order to avoid a stable situation becoming a crisis. For this reason, we felt the element "*Anticipates potential problems and prepares a contingency plan*" should not be included in this category but instead be moved to the "Situational awareness" category (also see discussion above regarding this decision). The remaining behavioural elements in this category were felt to be highly appropriate to any potential crisis situation in an ENT environment.

5.4.2.2 Field Observations and notes:

Secondly, in order to assist with the modification of revised NOTECHS, field observations within a routine ENT theatre list were undertaken.

A total of 10 ENT cases (16 hours) were observed over a 1 week time period. Cases observed included elective and semi-emergency cases. Typical procedures included

tonsillectomy, microlaryngoscopy, MLB's for foreign body inhalation, functional endoscopic sinus surgery, rhinoplasty and thyroid surgery.

Table 5-2 Frequency of occurrence of behavioural elements from the original NOTECHS tool for each case

Communication and interaction	Instructions to assistant clear and polite	X	X	X	X	X	X	X	✓	✓	X
	waits for acknowledgement from assistant	X	X	X	X	X	X	X	X	X	X
	instructions to scrub nurse clear and polite	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	waits for acknowledgement from scrub nurse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vigilance and situational awareness	monitors patient parameters throughout procedure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	awareness of anaesthetist	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	actively initiates communication with anaesthetist during crisis	✓	✓	✓	✓	X	✓	✓	X	✓	✓
Team Skills	Maintains positive rapport with whole team	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Open to the opinions from other team members	✓	✓	✓	✓	✓	X	✓	✓	✓	✓

	Acknowledges contribution made by other team members	X	X	X	✓	X	X	X	X	X	X
	Supportive of other team members	✓	✓	✓	✓	✓	X	✓	✓	X	✓
	Conflict handling: concentrates on what is right rather than who is right.	✓	✓	✓	✓	✓	✓	✓	X	✓	✓
Leadership and Management Skills	Adherence to best practice during procedure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Time management – eg. Appropriate time allocation without being too slow or rushing team	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Resource utilization – i.e appropriate task load	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Debriefing the team – i.e provides details and feedback to the entire team about the procedure	x	x	x	✓	x	x	x	✓	x	✓
	Authority and assertiveness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Decision making – surgical crisis	Prompt identification of the problem	✓	X	✓	✓	X	✓	✓	X	✓	✓
	Informed team members – promptly, clearly and to all team members	✓	X	✓	✓	X	✓	✓	X	✓	✓
	Outlines strategy/institutes plan – i.e ask scrub nurse for suction, instruments, suture material.	✓	X	✓	✓	X	✓	✓	X	✓	✓
	Anticipates potential problems and prepares a contingency plan – eg. Asks anaesthetist to order blood, calls for help	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Option generation – takes the help of the team.	✓	X	✓	✓	✓	X	X	X	✓	✓

Field observation notes results:

Communication and interaction:

Communication was an important feature in all cases, with interactions noted between the operating surgeon and scrub nurse. Field observations further highlighted that the majority of ENT procedures are single operator, and hence communication with "assistant" was not as applicable to ENT surgery when compared to a general surgical environment. However, communication between operating surgeon and anaesthetist was hugely important in all cases observed and was a key feature of interactions within the ENT theatre environment.

Vigilence/Situational awareness:

Situational awareness was a key behavioural element picked up in almost all cases observed. Enquiry from the surgeon to the anaesthetist regarding key patient parameters were observed in all cases. Examples included:

"what is the blood pressure? We are closing now and want to check haemostasis" and "what is the blood pressure? Can we please bring it back up now?" – thyroidectomy surgery

"what are the saturations? Let me know if you need to ventilate" and "this (foreign body) is going to be difficult to remove; shall I come out, re-oxygenate and then have an attempt once the child is optimized?" - Paediatric microlaryngobronchoscopy (MLB).

Team skills:

Members of the observed theatre teams clearly had good working relationships with one another, and worked closely together both as a unified team, but also within their own subteams. Nursing staff worked well together, with both runners and the scrubbed assisting nurse constantly communicating to ensure equipment such as swabs and adrenaline were on hand when more was required. Conversations were frequently undertaken between the operating surgeon and nursing teams regarding suture material and potential additional equipment. Occasionally, junior scrub nurses were involved, and both surgeons and circulating nurses were supportive of new colleagues learning the instruments and providing coaching/teaching if the scrubbed nurse was unsure what was being asked for. Examples of this included:

Operating surgeon: "can you pass me the Dennis Brown forceps please"

Scrub nurse: "which ones are those? I'm sorry I don't know the names yet"

Operating surgeon: “it’s this one here; (picking up the correct instrument) it’s what we hold the tonsil with – a Dennis Brown forcep.”

Additionally, conflict handling was also an important feature. Issues with broken suction and incorrect number of suction devices available were dealt with in a calm yet urgent manner.

Leadership and Management:

The leadership role changed frequently within the operating theatre environment, especially when the responsibility of controlling the airway changed between the anaesthetist and surgeon. Authority and assertiveness was important in this situation, and observed in all cases; whether it was controlling the airway, or explaining to the team that a difficult part of the operation was coming up and therefore people needed to concentrate/turn off music. The Team debrief however was an element that was not observed in each case, but rather at the end of the entire operating list. This was also a task that tended to be led by the sister in charge of theatre or consultant and not a key behaviour of the ENT operating trainee surgeon; they took a more passive, receptive role. Maintaining standards/adherence to best practice within the theatre was also evident throughout the field observations. This was displayed in multiple actions ranging from correct scrubbing and gowning procedures, to ensuring a sterile field was kept over the patient. Any

faulty equipment would be flagged correctly to the nurse in charge and the correct procedures followed.

Decision making – Surgical Crisis:

The cases observed in this field observation study were largely routine elective cases. Despite that however, behavioural elements listed in the Revised NOTECHS tool were observed in routine straight forward cases. In particular the element "anticipates potential problems and prepares a contingency plan" seemed to be a routine part of the ENT theatre setup and practice. This was commonly performed alongside the WHO and team brief and at the very start of the operation. This was felt to be due to the nature of the ENT caseload; often control of the airway would be handed to the ENT surgeon, and consequently the ENT surgeon has to therefore anticipate what might be needed if there is difficulty getting an airway; devices and equipment such as suction, tracheal dilators, or a Microlaryngoscopy tube, often need to be requested prior to the commencement of the operation to prevent a "stable" situation turning into a crisis.

5.4.2.3 Results of Focus Group with subject matter experts:

The results of the field observations were discussed with subject matter experts (2 consultant surgeons(with paediatric and adult experience), 2 consultant anaesthetists, 2 senior sisters), and asked to identify any additional important behaviours or routines which they felt were unique to an ENT theatre environment.

An area that everyone felt very strongly about was the need for "Pre-operative checks and communication". Often the type of airway or airway tube required for an ENT operation will vary greatly depending on the procedure and sometimes surgeon preference. Examples include:

- South-facing ray tube – for tonsillectomy. This ensures the Boyle davis gag can be inserted correctly and does not obscure the operating field.
- For an Microlaryngoscopy and bronchoscopy (MLB), the surgeon may have a preference for an LMA, which is then exchanged in theatre for trans-laryngeal jetting. Alternatively, an Microlaryngoscopy (ML) tube may be requested instead.
- For nasal surgery a throat pack may need to be inserted to protect the airway from blood.

A plan regarding the type of anaesthetic and method of intubation is an integral part of safe surgery, and should be a collaboration between the anaesthetist and surgeon.

- Prior planning and communication between the anaesthetist and surgeon is paramount for a difficult airway intubation. Conversations must be had regarding the expertise of the anaesthetist and surgeon, and an appropriate plan A, plan B and possible plan C must be in place prior to putting the patient to sleep.
- For a Paediatric MLB, ideally the operating surgeon would like the child to be self-ventilating for a meaningful and true assessment of the child's airway. Additionally, factors such as adding a drying agent and anaesthetizing the larynx with a metered dose of lignocaine must be discussed as a team.
- In surgery requiring a nerve monitor (thyroid surgery, mastoid surgery, parotidectomy etc), it is important to ensure the anaesthetist does not use a long acting muscle-relaxant.

In addition, certain medications may be requested by the surgeon prior to the operation which aid surgery:

- Nasal surgery often requires nasal preparation in the form of Moffatts solution or co-phenylcaine to decongest the nose and lead to less intraoperative bleeding.
- Paediatric MLB may require a drying agent and local anaesthetic application to the vocal cords.

The original Revised NOTECHS did not include a team brief or WHO completion as a key element: subject matter experts felt strongly that this was an important aspect in the patient safety ethos within the ENT theatre environment and should therefore be included in the final ENT-NOTECHS tool.

Additionally it was felt that when developing a rating tool, it is often difficult to separate the non-technical skills completely from the technical aspects: we must appreciate that the outcome of a case is dependent on a fusion of the two; therefore in the final version of the ENT-NOTECHS, we also included space for technical assessment (which changed from case to case depending on operation being performed). The technical rating tool was based on the ISCP curriculum PBA's (procedure-based assessments) for each particular operation and therefore in keeping with existing assessment standards currently in practice. The technical rating half of the tool was not assessed for content or construct validity as part of this research and was beyond the scope of this body of work. Addition of this section was intended to act as an aid to assessors debriefing; to emphasize that the technical and non-technical aspects can be debriefed alongside each other and should in theory complement each other.

Ensuring this tool complimented existing work-based assessments for ENT trainees was important. For this reason, a Global Summary level 0-4 was also included, again to complement the ISCP assessments and provide a common understanding of competency level.

5.4.3 Phase 3 results:

5.4.3.1 Content validity of tool:

A summary of the I-CVI results for each behavioural elements is shown in table 5.3.

Table 5-3 Item content validity index results for the ENT-NOTECHS tool:

Category	Element	I-CVI
Pre-op Checks	gathers relevant information/ investigations and informs colleagues appropriately	1.0
	liaises with anaesthetic team regarding anaesthetic plan for patient	1.0
	if appropriate; specifically discusses contingency plan/Plan B with anaesthetist if airway concerns likely	1.0
	gives effective briefing to team members	1.0
	makes any relevant equipment checks	1.0
	ensures WHO completed (consent and side of surgery checked) and any issues addressed	1.0
Communication and Interaction	waits for acknowledgement from assistant	0
	informs anaesthetist that he/she is starting operation	0.83
	waits for acknowledgement from anaesthetist	0.66
	instructions to scrub nurse/ assistant clear and polite	1.0
	waits for acknowledgement from scrub nurse/ assistant.	0.66
Leadership and Management	debriefing the team - provides feedback to whole team	0.33
	clearly follows theatre protocol and adheres to "best practise" during procedure. Eg no corner cutting	1.0
	resource utilisation - appropriate task load distribution and	0.66

	delegation of responsibilities	
	Time management - appropriate time allocation; not too slow but does not rush team members	1.0
	authority and assertiveness	1.0
	remains calm under pressure	1.0
Teamwork	maintains positive rapport with all team members	0.83
	open to opinions of other team members	0.83
	supportive of other team members	1.0
	conflict handling - concentrates on what is right rather than who is right.	1.0
Situational Awareness	monitors patient parameters throughout procedure	1.0
	awareness of anaesthetist	1.0
	actively initiates communication with anaesthetist during crisis	1.0
	anticipates potential problems and shows evidence of contingency plan (ie equipment on standby)	1.0
Decision Making and Crisis Management	promptly identifies problem	1.0
	clearly informs team of change in situation i.e emergency	1.0
	outlines strategy and institutes a plan ie asks for suction, appropriate drug, airway equipment, glidoscope etc	1.0
	asks for opinion of other colleagues / team opinion	0.66

All Elements scoring an I-CVI value lower than the pre-determined acceptable level of 0.78 were discussed amongst the subject matter experts in more detail. 23 out of a total 29 elements (79.3%) reached and exceeded the pre-determined I-CVI value of >0.78 indicating that these elements were deemed particularly important to non-technical skills within the ENT operating theatre and were therefore automatically retained for inclusion in the final ENT-NOTECHS tool. 6 out the 29 elements (20.7%) scored below the predetermined I-CVI level.

These 6 elements were discussed in detail. 2 elements scored particularly low I-CVI values (highlighted in red) and were eliminated from the tool ("waits for acknowledgement from assistant" and "debriefing the team - provides feedback to whole team"). Following discussion with subject matter experts, and review of observability of these elements within the ENT operating theatre (see earlier field observation results) a consensus agreed that the remaining 4 elements were sufficiently important to retain within the tool.

5.4.4 ENT NOTECHS tool:

Based on the results above, the **ENT NOTECHS** tool was developed. Minor alternations were made to tailor the assessment tool for anaesthetists and scrub nurses. These can be found in the appendix.

Figure 5-1The developed ENT-NOTECHS tool:

ENT and Anaesthetic MDT theatre simulation - Surgeon

Trainee name:	Speciality and Grade:
Scenario:	Date:

Rating	n/a	0	1	2	3	4	5
	Not applicable	Not done	Done very poor	Done poor	Satisfactory	Done well	Done very well
ISCP rating:		Development required (D)			Satisfactory (S)		

TECHNICAL ASSESSMENT (GLOBAL):	n/a	0	1	2	3	4	5
Knows steps of operation and follows agreed logical sequence.							
Consistently handles tissues with minimal damage							
Uses instruments appropriately and safely							
Familiar with instruments and names							
Proceeds at appropriate pace with economy of movement							
Planned course of operation with effortless flow							
TECHNICAL ASSESSMENT (TASK SPECIFIC):							
Safe and diligent use of the laser							
Ensures adequate protection to teeth and gums from scope							
Inserts appropriate scope to visualize pathology and secures suspension device safely							
Demonstrates competency at efficient cutting technique with laser including economy of movement and avoidance of scatter/ eschar etc.							

CATEGORY	ELEMENT	n/a	0	1	2	3	4	5
PRE-OP CHECKS	gathers relevant information/ investigations and informs colleagues appropriately							
	liaises with anaesthetic team regarding anaesthetic plan for patient							
	if appropriate; specifically discusses contingency plan/Plan B with anaesthetist if airway concerns likely							
	gives effective briefing to team members							
	makes any relevant equipment checks							
	ensures WHO completed (consent and side of surgery checked) and any issues addressed							
	informs anaeasthetist that he/she is starting operation							

COMMUNICTION AND INTERACTION	waits for acknowledgement from anaesthetist							
	instructions to scrub nurse/ assistant clear and polite							
	waits for acknowledgement from scrub nurse/ assistant.							
LEADERSHIP AND MANAGEMENT	clearly follows theatre protocol and adheres to "best practise" during procedure. Eg no corner cutting							
	resource utilisation - appropriate task load distribution and delegation of responsibilities							
	Time management - appropriate time allocation; not too slow but does not rush team members							
	authority and assertiveness							
	remains calm under pressure							
TEAMWORK	maintains positive rapport with all team members							
	open to opinions of other team members							
	supportive of other team members							
	conflict handling - concentrates on what is right rather than who is right.							
SITUATIONAL AWARENESS	monitors patient parameters throughout procedure							
	awareness of anaesthetist							
	actively initiates communication with anaesthetist during crisis							
	anticipates potential problems and shows evidence of contingency plan (ie equipment on standby)							
DESCISION MAKING AND CRISIS MANAGEMENT	promptly identifies problem							
	clearly informs team of change in situation i.e emergency							
	outlines strategy and institutes a plan ie asks for suction, appropriate drug, airway equipment, glidoscope etc							
	asks for opinion of other colleagues / team opinion							

GLOBAL SUMMARY		**TICK**
LEVEL 0	Insufficient evidence	
LEVEL 1	Unable to perform procedure	
LEVEL 2	Abe to perform the procedure with supervision	
LEVEL 3	Able to perform the procedure with minimal supervision (needs occasional help)	
LEVEL 4	Competent to perform the procedure without supervision (could deal with any complications)	

COMMENTS:

SIGN OFF:	
CONSULTANT NAME:	
SIGNATURE	
DATE:	

5.5 Discussion:

We have developed a novel non-technical skills assessment tool for use in the ENT theatre environment: termed ENT-NOTECHS. This tool has been developed using a variety of methods and subjected to content validity testing. It is hoped that this tool can be used to help rate individual's non-technical skills, with a view to providing accurate assessment and recorded progress, and also providing a framework by which to give constructive feedback to the ENT trainee and wider team members.

Firstly, the revised NOTECHS tool was selected from the existing tools in the literature and adapted to produce a novel ENT NOTECHs tool. There are multiple instances in the literature where other groups have adapted validated tools and modified them to suit their specialty, such as Endo-OTAS for endovascular teamworking (60) and T-NOTECHS for Trauma resuscitation teams(92). The various steps and methods we employed to develop ENT-NOTECHS has been shown to be an accepted and established method for designing a specialty specific tool (60). Real time field observations of the ENT operating theatre were carried out, along with a review and focus group with consultant and senior nursing subject matter experts, and then subjected to content validity testing.

The original revised NOTECHS tool from Imperial College was deemed an excellent base on which to base our adapted ENT tool due to excellent existing psychometric

robustness and ease of use. We wanted to create a tool which would be easy to use, need very little training and have very clear behavioural elements that could be deemed as a basic competency. How well these behavioural elements were undertaken were the basis on which marks were allocated to trainees on a likert scale, with a "satisfactory" level assigned to 3, and 5 "done very well". We felt that having a tool with set behavioural elements would negate the degree of subjectiveness seen with other behavioural tools and would be less daunting than faced with a long list of hundreds of exemplar behaviours.

The real time field observations demonstrated that the majority (20 out of 22) of the behavioural elements within the tool were largely applicable to the ENT operating theatre and occurred with enough frequency to be included within the final tool.

The behavioural elements of Communication, Situational awareness and Decision making were skills frequently observed in the ENT operating theatre and in this regard, is very similar to other surgical specialty theatres. However, it was noted that there was a large degree of decision making, and contingency planning prior to the operation starting, with a large chunk of vital communication between surgeon and anaesthetist occurring at the very start of the theatre brief and operation and this therefore prompted a consideration of where in the tool certain behavioural elements were best placed to reflect the activity and processes within the ENT operating theatre.

Only a few elements of this original tool were felt to be inappropriate and were therefore discussed with subject matter experts for potential removal. The real time observations highlighted a key difference between ENT and general surgery; an assistant is largely needed/present for general surgical cases, whereas our real time observations highlighted that the vast majority of cases were single surgeon, with very little room to pass the role of lead surgeon back and forth between assistants.

Overall these results were very reassuring as it confirmed that the selected Revised NOTECHS was applicable to ENT and therefore a good choice of tool on which to develop an ENT-themed tool.

The most striking addition to the tool stemmed from a combination of observational notes and the expert focus group, with a unanimous decision that "pre-operative planning and checks" were a major patient safety issue and should be included in any tool aimed at improving patient safety within the ENT operating theatre. Therefore our ENT-NOTECHS has a new behavioural category called "Pre-operative planning and checks" which has a further 6 behavioural elements. Whilst some of the skills/elements within this new tool category could be placed within other tool categories (i.e within situational awareness or crisis management), it was felt that due to the way in which an ENT operating theatre functions, including these elements within their own category to coincide with when they occur in clinical practice (i.e beginning of tool, beginning of operation) was important and would aid easier rating of the trainees. Additionally, a major difference between ENT and other surgical specialties' is the close proximity of operating to (or indeed within) the

airway. Consequently, the non-technical skills of communication and situational awareness between anaesthetist and surgeon are extremely important and key to improving patient safety. The NAP4 audit called for exactly this in its recommendations and therefore it was imperative that any tool dedicated to ENT non-technical skills should place an emphasis on this. Since this is now a new tool category it will be vitally important to ensure that the internal consistency of the tool is upheld and maintained, and this will be addressed in a future chapter of this thesis.

Prior to the final version of ENT-NOTECHS, content validity of the tool was assessed by 6 subject matter experts. 6 out of the 29 behavioural elements did not score above the predetermined I-CVI value of > 0.78. These elements were not dismissed automatically but instead discussed in detail with the subject matter experts. Because a behavioural element did not occur in field observations, or was not regarded by a single subject matter expert as important, does not automatically mean that they are not important to the skills in question. Indeed, sometimes this may highlight areas which could be improved in the operating theatre in real life, and perhaps more of an emphasis should be placed on these elements in training to modify the attitudes of tomorrows consultants. Consequently only 2 behavioural elements were removed. The elements “waits for acknowledgement from assistant” and “debriefing the team - provides feedback to whole team” were removed. It was felt that the first element was not necessary within the ENT theatre environment as procedures were commonly single operator and therefore no need for an assistant.

Secondly, the decision to remove "debriefing the team – provides feedback to the team" was a decision which was not taken lightly. It was observed from the real time observations that the team debrief was not performed in all cases immediately after the operation, and rather was done collectively at the end of the day. In addition, it was often the consultant surgeon who led the debrief and not necessarily the operating surgeon (who the tool is intended to assess). Since the tool was designed to assess the non-technical skills of the team members during the planning and intraoperative phase of the ENT case, including this element within the tool would lead to repeatedly low scores in this one area. We do acknowledge that the decision to remove the debrief may be controversial and we fully realize the importance of a debrief to the theatre and the overall team attitudes.

Whilst evaluation of the tool was not explicitly assessed at this stage in development, it is worth noting that subsequent evaluation by consultant (anaesthetic and ENT) and senior nursing assessors was hugely positive, suggesting that this tool is relevant and helpful to assess trainee's non-technical skills (This is discussed in detail in Chapter 7).

Limitations of this study would include that we aimed to design a tool purely for the feedback of non-technical skills WITHIN a surgical case. In hindsight, considerations could therefore have been given to developing an additional category of the tool called "Post -operative Procedures", of which an element on "team debrief" would

be an important inclusion. A further limitation could also be directed to our decision to remove "communicates and waits from acknowledgement from assistant". There will undoubtedly be a few cases where an assistant is needed and furthermore where a trainee is being trained by a more senior colleague. However, it is hoped that good communication scores with anaesthetists and scrub team members will equate to good overall communication in general and therefore this may count as a proxy to good communication with an assistant if applicable. Since the majority of ENT operating is single surgeon we are happy however that the tool accurately reflects the majority of cases undertaken. Additionally, the real time observations were only undertaken in one trust over a period of one week. Whilst we were happy that the cases observed during that time were reflective of the average cases seen and undertaken by ENT trainee surgeons, we acknowledge that other institutions may have different operative protocols and possibly different team members. Ideally field observations should have been gathered from various trusts, in order to develop a tool which we could say is 100% applicable to all ENT theatre environments, trainees and theatre personnel. Our subject matter experts were all senior colleagues from within Imperial NHS Trust. Whilst they have over 40 years of experience between them, extending our subject matter experts to other NHS Trusts within the country would also add to the generalizability of the tool and ensure that it is truly reflective of the non-technical skills deemed necessary by an ENT theatre team.

It is hoped that this tool can be used in a number of ways to assess non-technical skills and hereby contribute to increased patient safety. Firstly, it can act as an assessment tool of individual trainees, and with repeated training in non-technical skills, can be used to demonstrate progression of skills and competency. Secondly, it can be used as a framework on which to base feedback regarding team and leadership performance. Behavioural elements within the tool can serve as indicators of good team performance and behaviour, and therefore be used to guide best practice behaviour within the operating theatre. Existing recognized safety features such as the WHO checklist are incorporated into this tool, reinforcing the importance of these safety checklists and the team behaviours involved in safe surgical practice. ENT-NOTECHS can also be used as a tool for self-reflection, allowing trainees to see areas where perhaps their non-technical skills can be honed and improved.

Triangulation of data from a variety of methods was used to ensure that the developed tool was highly applicable to ENT whilst being grounded in the basic principles and concepts of an already developed psychometrically robust behavioural tool. The next step is to ensure thorough evaluation of the tool in order to determine construct validity and reliability. Future chapters (chapter 7) will focus on this challenge.

5.6 Conclusion:

ENT-NOTECHs is a novel assessment tool consisting of 6 behavioural categories, with 28 specific key behavioural elements considered to be an appropriate set of skills and behaviours for ENT trainees, anaesthetists and nursing staff. We have demonstrated evidence of content validity and relevance to the ENT operating theatre team. Content validity is only one desirable characteristic for a non-technical skills assessment tool and therefore future work in this thesis will concentrate on determining further validity and reliability. In time we are hopeful that this tool could be used for objective assessment of non-technical skills in ENT and provide a valuable framework to guide and train the ENT theatre team.

6 TO DEVELOP AND VALIDATE AN ENT THEMED MULTIDISCIPLINARY SIMULATION PROGRAMME FOR THE ASSESSMENT AND FEEDBACK OF NON-TECHNICAL SKILLS, AND TO DETERMINE THE PSYCHOMETRIC ROBUSTNESS OF THE ENT-NOTECHS TOOL.

6.1 Background:

Simulation based training now forms an essential part of modern medical education(93, 94). With the spotlight firmly on patient safety and the factors which contribute to safe medical practice, we now acknowledge that nontechnical skills such as team work, communication, leadership and situational awareness are increasingly important to surgical outcomes(95). Whilst traditional simulation based training has focused on technical proficiency, training of tomorrows surgeons in these human factors is becoming particularly important.

The operating room is the area with the highest number of medical errors due to various contributing factors(50). Examples include: time pressure, the presence of multidisciplinary groups, and a definite steep hierarchy. Indeed the very nature of surgery itself means that is a high stakes, high-pressure profession, relying on

experiential learning and requiring high levels of teamwork and leadership. Surgical crisis events, although rare, do unfortunately occur. Due to the paucity of these events, trainees have little or no experience, and despite the need for high team performance, the intense pressure of the situation usually leads to reduced team functioning. Simulation, particularly team simulation with surgical crisis scenarios, allows trainees to gain the necessary experience and provides an educational platform on which these rare situations can be reproduced in a risk-free environment.

Despite recognition that Human factors are an important contributor to patient safety, our systematic review into non-technical skills in ENT training found very few studies which had a main focus of non-technical skills within the literature, and even fewer reporting multidisciplinary simulation. We therefore aimed to produce a multidisciplinary team training day in ENT emergencies, with a particular emphasis on non-technical skills.

As previously reported, the ability to measure and assess non-technical skills is a vital part to improving these skills and thereby improving patient safety(27). The ENT NOTECHS tool was specifically developed to assess these skills within the ENT operating theatre. A vital part of the research concerning this tool is to ensure that it is psychometrically robust. Content validity has previously been addressed. This

training day was therefore also designed to help evaluate the ENT NOTECHS assessment tool, focusing on reliability, internal consistency and construct validity.

6.2 Aims:

Specifically the Primary aims were:

- To design and implement an ENT themed multidisciplinary team training day that would improve awareness of non-technical skills, particularly in the stressful emergency crisis environment, with the aim of improving those skills. To determine face and content validity for the training day and the simulation scenarios.

- To test the psychometric robustness and acceptability of the developed ENT-NOTECHS tool.

  Specifically to determine:

  1. internal consistency of the ENT-NOTECHS tool
  2. inter-rater reliability for the ENT-NOTECHS tool
  3. construct validity of the ENT-NOTECHS tool
  4. feasibility and acceptability of the tool.

Secondary aims were:

- To evaluate the effectiveness of the training day using Kirkpatricks model of evaluation on the following levels:
    - Participants Reaction to the training
    - Participants Learning from the training
    - Skill/Behaviour acquired from the training
    - Organisational impact as a result of the training.

6.3 Methods:

A multidisciplinary team simulation training day was developed in conjunction with expert faculty from ENT surgery (2 consultant surgeons with 20+ years experience each), Anaesthetics (2 consultants with 10 + years experience each), senior nursing staff (senior sisters in the ENT theatre with 10+ years experience each), an aviation pilot with a special interest in human factors (currently working at the Air Accidents Investigation Bureau (AAIB)) and myself (senior ENT trainee). The following section provides a detailed description of the training day and the rationale underpinning the key aspects.

Participants attended a one-day training programme encompassing ENT and Anaesthetic themed crisis' within a high fidelity operating theatre environment.

6.3.1 Ethical consideration:

The HRA decision tool regarding research ethics was consulted(96). The tool did not class this work as research, and the simulations were deemed as a service evaluation / quality improvement project. No patients were involved in the study. No NHS resources were used. Simulation was performed using mannikins or dead animal tissue in a non-clinical environment. There are no restrictions to using dead animal tissue in the UK and all tissue was handled in accordance with the human tissue act. The Paterson skills centre is compliant with UK health and safety regulations. All participants attended outside of their working commitments and all data was anonymized.

6.3.2 Setting:

The training programme was held at The Paterson building; Simulation suite, St Marys Hospital. A high fidelity ENT theatre was recreated complete with working anaesthetic machine, operating table, microscope and essential theatre instruments and supplies. Accompanying audiovisual was linked to a control room and seminar room where the faculty and remaining trainees could view the participating candidates (see figure 6.1 for simulation setup and audiovisual to seminar room).

Figure 6-1Simulation set up and audiovisual feed

6.3.3 Participants:

The training was targeted primarily at trainee ENT surgeons, anaesthetists and operating theatre nurses. Simulation training amongst North Thames ENT trainees is mandatory for training grades ST3-ST5 and all trainees within the region were scheduled to attend one training day each. Senior ENT trainees were also invited to attend, with places allocated on a first come first served basis. Recruitment of anaesthetic trainees was via advertisement in a group email sent from the Anaesthetic TPD for North Thames, and again places were offered on a first come first served basis. (see appendix for MDT airway simulation recruitment advert for anaesthetists). Operating team nursing staff were also recruited to attend with the help of senior nursing staff. Due to minimal nursing study leave, nursing attendees were selected to attend by Senior sisters from the ENT theatres at Charing Cross Hospital and St Marys Hospital, rotating nursing staff to attend the training days whilst still managing to fully staff ENT operating theatres on site.

6.3.4 Assessors/Faculty:

The assessors consisted of two consultant surgeons, two consultant anaesthetists and two senior operating theatre nurses. Additional core faculty included the research simulation fellow (myself – trainee surgeon), junior simulation fellow (trainee surgeon) and the simulation officer for Imperial College. Additional consultant faculty from both ENT and Anaesthetics were also present at each simulation training day depending on personal availability/commitments and contributed to the team debrief and discussion.

6.3.5 Training day content:

The training day programme was split into introductory course lectures and video, simulation suite orientation and then 6 team simulations scenarios with full debriefs following each scenario. A full timetable of the course can be found in the Appendix.

Introductory lectures covered the theoretical background to non-technical skills and human factors when applied to healthcare. The lectures were delivered by myself, with contributions from an aviation pilot with background in human factors and accident investigation. Prior to the training day creation I dedicated time and

resources to educate myself in human factors in healthcare, with attendance at an imperial College safety in surgery symposium day, regularly meetings with the Professor Nick Sevdalis and Dr Louise Hull who were instrumental in designing and validating the OTAS tool. I attended a training day to use the OTAS tool and also a local imperial college training day for simulation debriefing. Lectures on this training day covered a brief background in the origins of human factors training in aviation and other high risk industries was given, together with the systems approach to safety in the surgical workplace. Definitions of non-technical skills and background relating to their relationship with adverse events in the operating theatre was also covered. We introduced the concepts of assessment in simulation and non-technical skills, and the implications for improving skills and ultimately patient safety. The ENT-NOTECHS tool was introduced to candidates and explained that whilst trainees would be "assessed" using the tool, this would be for validation purposes of the tool. The theory section of the day was closed by playing a reconstructed video of the Eileen Bromiley case – "Just a routine operation"(97), which served to highlight the importance of human factors in patient safety. Eileen Bromiley was a landmark case and has become the focus for human factors in surgical safety after a routine operation for sinus surgery resulted in catastrophic brain injury following unexpected complications securing her airway. Her husband Martin Bromiley, a former pilot in the aviation industry, was instrumental in drawing comparisons with the aviation industry to understand the exact errors which occurred and the role human factors has to play in surgical safety,

Candidates were given a full orientation and introduction to the high fidelity simulation suite and equipment by the lead simulation technician.

Following on from this, candidates undertook 6 team simulations, and the ENT-NOTECHS tool was used to assess candidates. Teams, comprising of one surgeon, one anaesthetist and one scrub nurse, participated in one scenario each, followed by a structured debrief of the scenario by senior nurses and consultant faculty from ENT and Anaesthesia. The debrief also featured feedback from observing trainees, and candidates were given the opportunity to ask questions and learn from the experience. The team was supplemented during the scenario by the addition of an OPD and circulating nurse, both of whom knew the scenario and could therefore act as "plants" and facilitate the candidates if needed to help "drive" the scenario.

6.3.6 Simulation scenarios:

Simulation scenarios were developed based on real life faculty experiences and literature review. Expert faculty brainstorming of scenarios was initially undertaken; common ENT emergencies were identified and/or real life experiences of faculty were discussed for learning points and key competencies. Scenarios were further scrutinised and cross-referenced with commonly occurring scenarios from the systematic review of the literature into non-technical skills training in ENT (See Chapter 4). The following scenarios were finalised for inclusion in the ENT MDT training programme:

- Bleeding into the airway following vocal cord biopsy
- Airway fire
- tonsillectomy bleed
- Foreign body in airway
- Drug error
- Anaphylaxis
- Supraglottitis requiring definitive airway

Scenarios were formalized using the pre-developed “Imperial scenario Template” (see figure 6.2) Scenarios were meticulously scripted out, with a vignette describing the initial simulation scenario to the participants. Patient parameters such as saturations and heart rate were scripted as start points, but due to the fluid nature of the scenarios, these were changed as the scenario went along depending on the actions of the participating team.

Please see Appendix for further example records of scripts for simulation scenarios

Figure 6-2 Simulation vignette for MDT simulation training day. Scenario: Airway Fire.

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>Candidates:
ENT SpR
Nurse/ Scrub
Anaesthetic SpR</td><td>confederate OPD</td><td><u>Mannequin setup:</u></td></tr>
<tr><td colspan="2">Candidate briefing: 40 yr old lady listed for ML and laser to Right vocal cord lesion. (lesion on right vocal cord for excision biopsy with laser.) PMH: T1DM, HTN. NKDA. good exercise tolerance and previous uneventful anaesthetic for a right ORIF.

Pt is to be anaesthetised. Currently bag and mask by OPD. Commence procedure with the WHO form and proceed as appropriate.</td><td><u>Initial Parameters</u>

A – ET tube in situ
B – sats 100%
C – HR 90, BP 100/60
D – anaesthetised
E –</td></tr>
<tr><td colspan="2">Scenario progression: ISSUE1: Discussion re method of ventilation (jetting preferred by ENT: no laser proof ML tubes)
• WHO checklist completed - uneventful
• LMA inserted and jetting to be commenced.
• operation commences
• Laser to be used: ensure staff wearing glasses and laser safety protocol used. ISSUE 2: confederate OPD not wearing glasses (initially refuses – says “ill be ok”)
• 1 minute into procedure – ISSUE 3 - SMOKE from airway.
• AIRWAY FIRE suspected.
• Water from Nurses (syringe available)
• ENT and Anaesthetist to respond appropriately: anaesthetist to stop Oxygen, ENT to stop Laser
• Procedure abandoned
• formal intubation – ISSUE 4: Airway swelling (tongue to be inflated by confederate, unable to visualize cords), fibreoptic performed. Tracheostomy on standby. DETERIORTATING SATS while trying to establish airway. Tracheostomy may be discussed as a preferred airway
• plan for ITU post op.</td><td><u>Deteriorating Parameters</u>
A –
B – reducing sats, high pressures.
C – tachcardia, hypotension</td></tr>
</table>

Key confounders: No Laser proof ML tubes available (confederate OPD to announce) surgeon to ensure laser glasses for everyone - initially glasses not on display and confederate OPD initially refusing to wear Airway swelling and difficult intubation	**Imaging available**
Key expected outcomes: Ventilation method to be discussed between A and ENT • laser safety protocol followed • awareness that fire has started and actions taken (stop lasering, remove/stop oxygen) • secure airway following airway swelling • plan to take pt to ITU post op.	**Information**
Technical Skills	
• Laser safety • ML and laser of VC lesion • intubation	
Non-technical Skills	
• Team work with nursing staff, anaesthetic, ICU • Handover/Communication of situation • Situational Awareness • Decision Making	
Technical Skills	
• airway fire - KEY actions. (preparation key).	
Non-Technical Skills	
• Team work with nursing staff, anaesthetic, ICU • Handover/Communication of situation • Situational Awareness • Decision Making	

Briefing:	Key tasks:
confederate OPD	To let team know NO laser proof ML tubes available. (prompt discussion re airway for procedure if not done so by the team.). Not initially wearing laser glasses and insist you will be ok without. Eventually concede if ENT SpR insists.
Briefing:	Key tasks:

6.3.7 Equipment:

A state of the art Laederal SimMan 2 was used – fully capable of interacting with the trainees. From the control room the simMan's airway could be manipulated to mimic various conditions, including; cant intubate cant ventilate, inflated swollen tongue, fixed flexed neck, and limited mouth opening. For the cases requiring microlaryngoscopy, the Laryngotech model(98) was used along side the SimMan. The Laryngotech head was placed on the operating table with the SimMan body in place covered by drapes. Laryngotech is a fully validated model used to simulate microlaryngoscopy, with various silicone inserts designed to imitate various airway pathologies (vocal cord tumours, vocal cord polyps)(98). In those scenarios, where the candidate might perform a tracheostomy, a pigs larynx with porcine skin was realistically strapped to the neck of the model.

Candidates were briefed to approach the scenarios as they would a routine operating list, conducting a team brief and WHO checklist. To ensure fidelity, candidates were dressed in theatre scrubs and theatre hats, with operating gowns and sterile gloves at their disposal. All equipment and facilities usually available during a theatre list were available to the trainees with the exception of bipolar or monopolar diathermy. Microscopes, High Definition camera stack systems and CO2 laser was also available.

6.3.8 Assessment and data collection

ENT NOTECHS:

During each scenario, candidates from all three specialties were assessed using the novel ENT-NOTECHS tool to assess non-technical skills in an ENT environment. Throughout the simulation trainees were observed from the control room by faculty and via audio-visual projection to the seminar room for the non-participating candidates to observe. Senior faculty (2 surgeons, 2 Anaesthetists and 2 senior nurses) used the ENT-NOTECHS tool to assess their specialty trainee.

ENT-NOTECHS scores were used to calculate internal consistency, inter-rater reliability and construct validity of the assessment tool.

6.3.8.1 Reliability:

Internal consistency

Internal consistency of the tool was determined by calculating a cronbachs alpha internal consistency correlation coefficient for each behavioural domain of the ENT-NOTECHS tool. Cronbachs alpha range typically between 0 and 1, with a value of >0.7 generally considered acceptable.

Inter-rater reliability

Each candidate was assessed by 2 senior faculty assessors from the same specialty as themselves (i.e surgeons assessed by consultant surgeons, anaesthetists assessed by consultant anaesthetists etc). Inter-rater reliability was determined by calculating an intra-class correlation coefficient. Again, a value of >0.7 is generally considered adequate for acceptable inter-rater reliability.

6.3.8.2 Construct:

Construct validation is a process by which new tools are submitted in order to determine if they are sensitive enough to detect difference between novice and experts. Construct validity can be assessed in a number of ways:

1. *Does the ENT-NOTECHS tool distinguish between novice and experts?*

Candidate's performance during the simulations were scored using the ENT-NOTECHS tool. Candidates scores were grouped into 4 distinct groups: Junior (ST3-ST4), Intermediate (ST5-ST6), Senior (ST7-ST8) and Consultant, and mean scores for each group were compared to determine if there was a statistically significant difference.

The validity testing of the assessment tool was also repeated by measuring the correlation between grade of seniority and ENT-NOTECH score. Correlation was measured by using spearman rank correlation coefficient (r)

2. *Does training in non-technical skills improve participants ENT-NOTECH scores?*

   Following the first "pilot" simulation training day, the format of the simulation day was changed slightly to allow for further data collection to contribute to the construct of the tool; we wanted to show whether participating in training in non-technical skills would increase trainees ENT-NOTECH scores. During the pilot, 6 trainees from each specialty attended the training day. This was reduced to 3 trainees from each specialty (surgical and anaesthetic), hereby allowing for trainees to participate in one simulation each, observe others undergoing the simulation and discussion, and then repeat a further simulation each later in the day. This allowed us to gather PRE and POST training ENT NOTECH scores for trainees.

6.3.8.3 Face and content validity of the ENT training day:

Face and content validity of the training day was assessed by completing the post course evaluation questionnaire using a 5 point likert scale (Table 6.1). Evaluation forms were completed by participants and expert faculty.

Table 6.1 post course evaluation form assessing face and content validity:

Face Validity:	Strongly Disagree	Disagree	neutral	Agree	Strongly Agree
The scenarios in the simulations were realistic	1	2	3	4	5
The simulated environment was as realistic as a real operating theatre	1	2	3	4	5
The team interaction during the scenarios was realistic	1	2	3	4	5
The model was a realistic representation of the real procedure	1	2	3	4	5
The simulation replicated the likely level of stress amongst team members	1	2	3	4	5
Content Validity:					
The simulated procedure is a good method to train technical skills	1	2	3	4	5
The simulated scenario is a good method to train team skills and leadership	1	2	3	4	5
Participation helped me to improve my technical skills	1	2	3	4	5
Participation helped me to improve my teamwork and leadership skills	1	2	3	4	5

Scenario Simulation is useful to help increase confidence in managing real life crisis scenarios.	1	2	3	4	5

6.3.8.4 Feasibility and Acceptability of ENT-NOTECHS tool:

Senior faculty were given a post course feedback 17 item questionnaire (using a 5 point likert scale) pertaining to the feasibility and acceptability of the ENT-NOTECHS tool.

Table 6.2 shows the post course feedback questionnaire for faculty on the use of ENT-NOTECHS:

Table 6.2 faculty feedback questionnaire pertaining to the use of ENT-NOTECHS:

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
This tool provides a common language to discuss non-technical skills with trainees	1	2	3	4	5
It was easy to rate cognitive skills (situation awareness, decision-making)	1	2	3	4	5
It was easy to rate interpersonal skills (communication, teamwork, leadership)	1	2	3	4	5
It was easy to rate technical skills	1	2	3	4	5
This tool provided a good assessment framework	1	2	3	4	5
This tool provided a good feedback framework	1	2	3	4	5

This tool is a valuable adjunct to tools that assess surgical skills (WBA's: eg PBA/ DOPS)	1	2	3	4	5
This tool addresses all aspects of non-technical skills in the theatre environment	1	2	3	4	5
This tool provides useful feedback for the trainee	1	2	3	4	5
This tool is applicable to real life cases	1	2	3	4	5
This is a useful tool to provide feedback to trainees regarding non-technical skills	1	2	3	4	5
This tool could be used in the operating theatre	1	2	3	4	5
This tool is not too time consuming	1	2	3	4	5
This tool takes up too much time	1	2	3	4	5
Routine use of this tool will enhance safety in the operating theatre	1	2	3	4	5
I would recommend the use of this tool in training theatre teams	1	2	3	4	5
Overall tool satisfaction	1	2	3	4	5

6.3.8.5 Effectiveness of the training day:

In order to evaluate the effectiveness of the training day, a multi-level evaluation of training was conducted.

Kirkpatrick's method of evaluation of the most robust and widely used method to determine effectiveness of training(86). This method of evaluation looks at 4 main areas:

Level 1: Reaction. This level of evaluation refers to how participants react to the training, and the degree to which they found the training favourable.

Level 2: Learning. This level of evaluation refers to the degree to which participants acquire the intended skill, knowledge or attitudes set out by the training programme.

Level 3: Skill/Behaviour. This level of evaluation refers to the degree to which participants behaviour changed as a result of the training day.

Level 4: Results/Organisational impact: This level of evaluation refers to the effect the training programme has had at an organizational level.

A detailed description of the measures used to evaluate each level is given below:

Level 1: Reaction.

Reaction is typically assessed using a closed question questionnaire with a likert scale along with open questions for freetext.

A 13 statement questionnaire was devised to assess participants reaction to the training day and was administered directly after the training day had ended.

Level 2: Learning.

To assess participants degree of learning of the attitudes and skills engendered within the training day, trainees were asked to complete an "Attitudes and confidence" questionnaire. To assess changes in attitude to nontechnical skills and teamwork the questionnaire was administered pre and post training day.

Level 3: Skill.

In order to assess how participants skills/behaviours changed as result of the training day, trainees were assessed using the ENT NOTECHS tool in an initial training simulation in the morning, and then again in the afternoon after viewing multiple simulations and formal debriefs regarding non-technical skills in the operating theatre. Pre and post training ENT-NOTECHS scores were compared.

Level 4: Organisational impact/Results:

It is widely accepted that measuring this level of evaluation is the most difficult due to time and cost constraints. An overarching aim of the training day was improve trainees nontechnical skills within the operating theatre when participants return to their day to day jobs and operating teams. Therefore, a surrogate marker for this level of outcome was used by asking faculty if they would recommend the ENT-NOTECHS to train teams in the operating theatre. Additionally, trainees were given a follow up questionnaire (table 6.3) 6 months post training enquiring about their use of non-technical skills in the workplace since the course and asking for examples were this has proved beneficial.

Table 6-3 Six month post course questionnaire

	Strongly Disagree	Disagree	neutral	Agree	Strongly Agree
On reflection, I found the MDT simulation training day useful	1	2	3	4	5
Participation in the training day has improved my confidence managing crisis scenarios in the last 6 months.	1	2	3	4	5
Participation in the training day has improved my non-technical skills in the operating theatre over the last 6 months	1	2	3	4	5
I would benefit from repeating the simulation training again	1	2	3	4	5
Comments:					
Are there any real life instances in the last 6 months where the non-technical skills learnt from the training day were useful? Please give details:					

6.3.9 Statistical analysis:

All data was analysed using SPSS V 22 (IBM, New York, USA).

6.3.9.1 Statistical analysis: Reliability of the ENT-NOTECHS tool:

Internal consistency of the ENT-NOTECHs tool was assessed by calculating a cronbachs alpha internal consistency correlation coefficient for each behavioural domain of the tool. A value of >0.7 is generally considered acceptable.

inter-rater reliability in ENT-NOTECHS was assessed by using the intra-class correlation coefficient (ICC). A value if > o.7 is generally considered adequate.

6.3.9.2 Statistical analysis: Construct Validity of the ENT-NOTECHS tool:

To determine if ENT-NOTECHs scores correlated with seniority/grade in training, candidate scores were grouped into 4 distinct groups; Junior (St3-St4), Intermediate (St5-St6), senior (St7-St8) and consultant. Mean scores were calculated for each group. A one-way anova test was applied with a Newman-Keuls multiple comparison test. Individual ENT-NOTECHS scores were also correlated with seniority: correlation was measured using spearman rank correlation coefficient (r). As an additional measure, construct validity can be determined by looking at pre and post training Ent-NOTECH scores. Median ENT NOTECHS scores pre and post training were compared and analysed using a Wilcoxin Signed Rank Test.

6.3.9.3 Statistical analysis: Usability and feasibility of the ENT-NOTECHs tool:

Non-parametric statistics were used, including median and quartiles to describe the data. The percentage of participants who agreed or strongly agreed with each

statement was also reported. Medians scores for the subspecialty groups (surgeons vs anaesthetics vs nursing) were compared. Kruskal Wallis test with a Dunns post test was applied to determine significance

6.3.9.4 Statistical analysis: Face and content validity:

Non-parametric statistics were used, including median and quartiles to describe the data. The percentage of participants who agreed or strongly agreed with each statement was also reported. A Power calculation confirmed that 14 subjects in each group (expert vs novice) would be required to identify a median difference of 1 on a 5-point likert scale with a 90% confidence interval of $p<0.05$.

6.3.9.5 Statistical analysis: Effectiveness of the training day:

Descriptive non-parametric statistics were used to describe data pertaining to participants response to "reaction, learning, skill and organisational impact". Median and quartiles scores were used to describe the data. The percentage of participants who agreed or strongly agreed with each statement was also reported

Median pre and post training scores for attitudes and confidence were compared using a paired Wilcoxin Signed Rank test.

6.4 Results:

6.4.1 Demographics:

A total of 74 trainees participated in the MDT simulation training days. A total of 6 simulation training days were undertaken over a 15 month period. In total, 54 hours of simulation was undertaken, and 210 assessments using the ENT-NOTECHS were recorded. The following table (table 6.4) shows the breakdown of training level of the participants.

Table 6.4 grade and specialty of training day participants.

Specialty	**Grade**	**Number**
Anaesthetists	ST3	5
	ST4	5
	ST5	2
	ST6	7
	ST7	2
	Consultant	4

Surgeons	ST3	7
	ST4	7
	ST5	4
	ST8	3
	Consultant	4
Nursing	Band 5	11
	Band 6	10
	Band 7	2
	Band 8	1
Total		**74**

34 males and 40 females participated in the MDT training day, with an mean age of 36.8 years (range 28-55 years). Of the 74 participants, 73 participants completed the post course evaluation and attitudes questionnaire. One Anaesthetic trainee unfortunately had to leave the simulation early to attend an airway emergency

hence course evaluation data was not collected for her. Of the 73 remaining trainees, 47 had previous simulation experience, and 26 did not. Of the 26 participants who did not have any prior simulation experience, 19 of these were nursing staff.

6.4.2 Evaluation of the training day

Level 1: reaction:

Participants reaction to the training day was positive, with a median score of ≥4 for 13/13 statements relating to course content, delivery and satisfaction. Table 6.5 reports the median scores for each evaluation statement.

Table 6-5 Simulation training day evaluation showing median scores, range and percentage agreement to each statement

ITEM	STATEMENT	MEDIAN SCORE	RANGE	% agreement (rating ≥4)
1	The simulation today addressed my learning needs	**5**	2-5	97
2	The scenarios in the simulations were realistic	**5**	4-5	100
3	The simulated environment was as realistic as a real operating theatre	**4**	3-5	89
4	The team interaction during the scenarios was realistic	**4**	4-5	100

5	The model was a realistic representation of the real procedure	**4**	2-5	85
6	I behaved in the same way i do in the workplace	**4**	2-5	84
7	My performance was similar to that in the workplace	**4**	2-5	82
8	The simulation replicated the likely level of stress amongst team members	**4**	2-5	88
9	The simulated procedure is a good method to train technical skills	**5**	3-5	85
10	The simulated scenario is a good method to train team skills and leadership	**5**	4-5	100
11	Participation helped me to improve my technical skills	**4**	2-5	81
12	Participation helped me to improve my teamwork and leadership skills	**5**	3-5	99
13	Scenario Simulation is useful to help increase confidence in managing real life crisis scenarios.	**5**	4-5	100

Initial reactions were excellent with trainees agreeing that the training was beneficial and a good method to train teamwork and leadership skills.

In particular 97% of trainees felt that that the training day addressed their learning needs, and participation in the simulation helped to improve nontechnical skills (99% agreement). Consequently, 100% of trainees agreed that their confidence in managing crisis scenarios had increased as a result of the training day.

Free text area was also available for comments regarding the strengths and weaknesses of the course. A representative selection of these comments are provided in the following table 6.6.

Table 6-6 Selection of free text feedback from trainees on simulation training day:

	Free text comments:
What will you take away from todays simulation?	*"Very good at helping with clinical decision making and brings to life some of the airway emergencies we only usually read about/hear about from colleagues. I think this should form an essential part of immediate/higher training."* *"thinking of other options for managing the airway. The importance of teamworking, good communication and pre-planning."* *"The importance of anticipating and thinking ahead"*
Improvements/ recommendations	*Over 2 days? A lot of information in one go* *Nothing!* *More haptic feedback on simulator – had to ask if breath sounds heard*

Level 2: Learning:

The effect of the training day on attitudes and confidence levels in participants non-technical skills was evaluated by comparing pre and post course attitude questionnaires. The post course questionnaire was administered immediately after the training day programme had finished.

The Pre course median score was 3.82 (IQR 3.56-4.00), whilst the post course median score from participants was 4.41 (IQR 4.21-4.59). There was a significant difference between the pre and post course ratings by participants for attitudes and confidence in non-technical skills. The following table (table 6.7) and graph (figure 6.3) demonstrate the results:

Table 6-7 Pre and post course median scores for attitudes and confidence in no-technical skills.

	Median	IQR	Min	Max	Wilcoxon signed rank test
Pre course score	3.82	3.56-4.00	3.12	4.88	P<0.0001
Post course score	4.41	4.21-4.59	3.59	5.00	

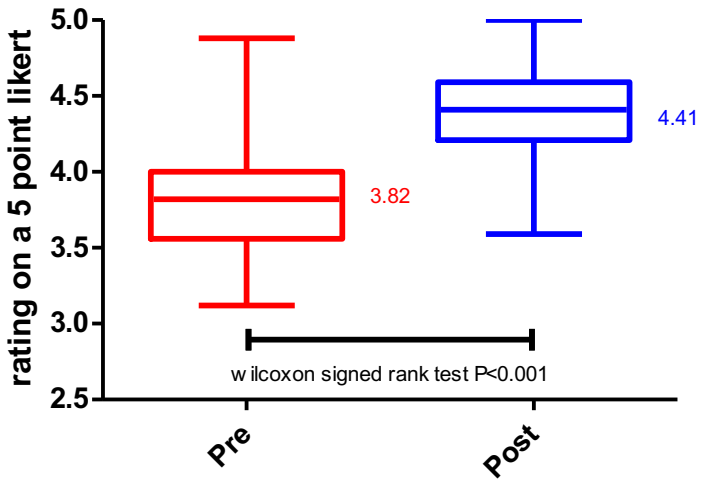


Figure 6-3 Graph showing median scores for candidates attitudes and confidence pre and post non-technical skills training. The middle thick horizontal line denotes the median. Boxes represent the interquartile range and whiskers represent the minimum and maximum

Level 3: Skill.

In order to assess how participants skills/behaviours changed as result of the training day, trainees were assessed using the ENT NOTECHS tool in an initial training simulation in the morning, and then again in the afternoon after viewing multiple simulations and formal debriefs regarding non-technical skills in the operating theatre. Pre and post training ENT-NOTECHS scores were compared.

A total of 20 candidates underwent Pre and Post training simulations. This comprised of 7 ST3 trainees, 6 ST4 trainees, 2 ST5 trainees, 2 ST6 trainees, 1 ST7 trainee and 2 consultants. ENT NOTECHs scores for candidates were compared using

wilcoxon signed rank test. This showed a statistically significant improvement between the first (pre) and second (post) simulation sessions (figure 6.4).

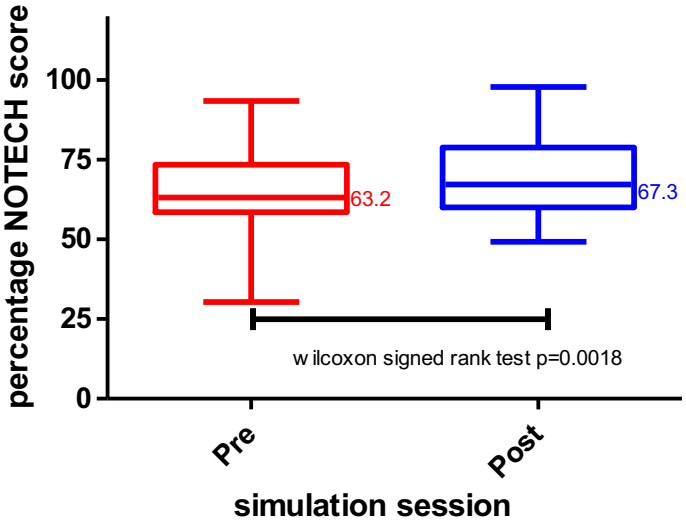


Figure 6-4 Graph showing ENT NOTECH scores for candidates pre and post non-technical skills training. The middle thick horizontal line denotes the median. Boxes represent the interquartile range and whiskers represent the minimum and maximum ENT NOTECH scores

Level 4: Organisational impact:

In order to assess the impact of the training day at an organizational level faculty reported 100% agreement that they would recommend the use of the ENT-NOTECHS tool to train teams in the operating theatre. 6 month post course questionnaires were unfortunately only completed by the surgical trainees despite reaching out to all delegates. 84% (21/25) of ENT trainees completed and returned the 6 month post course questionnaire. 100% reported confidence managing crisis's in real life since the training and there was 100% agreement that participation in the course

had increased their non-technical skills in the operating theatre in the six months since the course (table 6.8)

Table 6-8 Six month post course questionnaire results:

ITEM	STATEMENT	MEDIAN SCORE	RANGE	% agreement (rating ≥4)
1	On reflection, I found the MDT simulation training day useful	**5**	(4-5)	100
2	Participation in the training day has improved my confidence managing crisis scenarios in the last 6 months.	**5**	(4-5)	100
3	Participation in the training day has improved my non-technical skills in the operating theatre over the last 6 months	**5**	(3-5)	81
4	I would benefit from repeating the simulation training again	**4**	(3-5)	62

6.4.3 Face and content validity results:

Face and content validity of the training day was assessed by completing the post course evaluation questionnaire. 73 participants completed the questionnaire, along with a further 3 consultant faculty experts, making 76 respondents in total. 62 of these were trainees (St3-St8, and Band 5-6) and 14 were deemed experts (11 consultants and 3 senior nurses).

There was no statistically significant difference between the expert and trainee ratings for face or content validity of the MDT simulation training days.

The simulation training day achieved a median face validity of 4 from both experts and intermediate trainees, with agreement from trainee and experts raters of 93% and 89% respectively. (figure 6.5 and table 6.9).

The median content validity score was 5 for trainees and 4.5 for experts with a 93% and 91% agreement respectively. (figure 6.6 and table 6.9).

A breakdown of trainee and expert ratings for individual items can be seen in table 6.7.

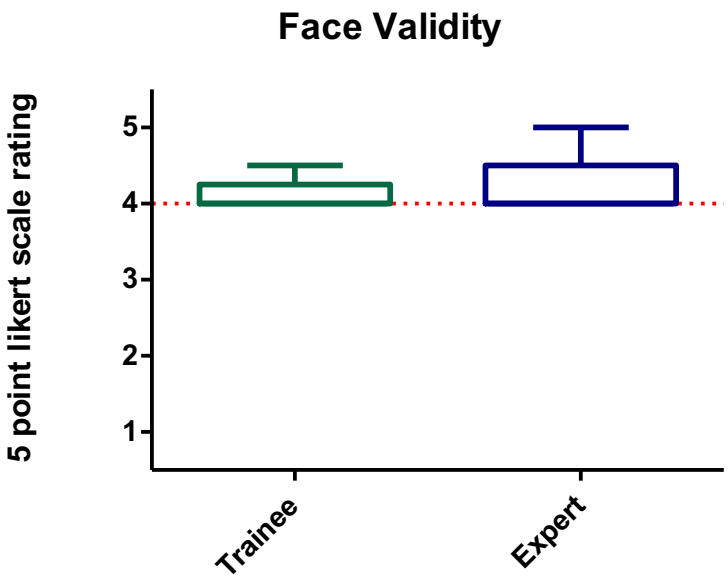


Figure 6-5 Face validity for the simulation training day as rated by trainee and experts. The middle thick horizontal line denotes the median. Boxes represent the interquartile range and whiskers represent the minimum and maximum ratings.

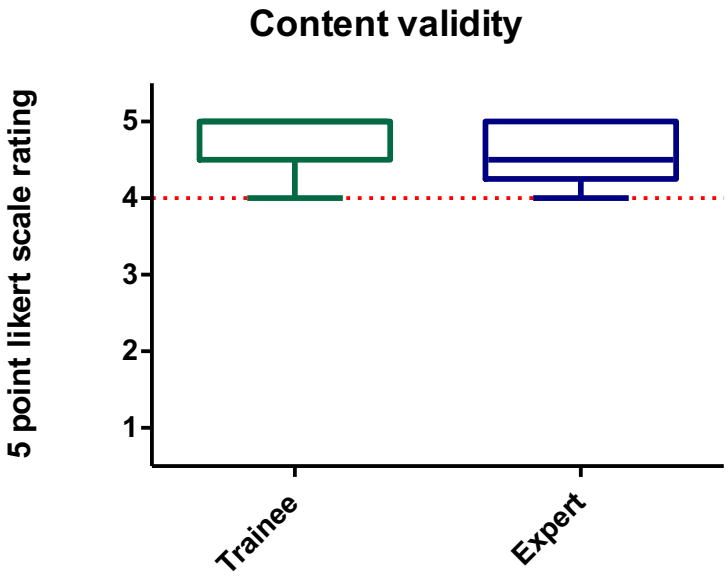


Figure 6-6 Content Validity for the simulation training day as rated by trainee and expert raters. The middle thick horizontal line denotes the median. Boxes represent the interquartile range and whiskers represent the minimum and maximum ratings

Table 6-9 Face and content validity results for trainee and expert raters of the simulation training day:

DOMAIN	ITEM	LEVEL	MEDIAN	IQR	%AGREE OR STRONGLY AGREE	P-VALUE MW-U
FACE VALIDITY	Scenarios	Trainee	4.5	(4-5)	100	0.341
		Expert	5	(4-5)	100	
	Environment	Trainee	4	(4-4)	89	0.715
		Expert	4	(4-4.25)	93	
	Team interaction	Trainee	4	(4-5)	100	0.398
		Expert	4	(4-5)	100	

	Model	Trainee	4	(4-4)	87	0.156
		Expert	4	(3-4)	64	
	Stress	Trainee	4	(4-5)	90	0.099
		Expert	4	(4-4)	86	
	TOTAL Face Validity	**Trainee**	**4**	**(4-4.25)**	**93%**	**1.000**
		Expert	**4**	**(4-4.5)**	**89%**	
CONTENT VALIDITY	Technical skills training	Trainee	5	(4-5)	87	0.829
		Expert	4.5	(4-5)	86	
	Nontechnical skills training	Trainee	5	(4-5)	100	0.979
		Expert	5	(4-5)	100	
	Improved technical skills	Trainee	4	(4-5)	82	0.126
		Expert	4	(3-4.25)	71	
	Improved non-technical skills	Trainee	5	(4-5	98	0.240
		Expert	4.5	(4-5)	100	
	Crisis management	Trainee	5	(4-5)	100	0.322
		Expert	5	(4-5)	100	
	TOTAL Content Validity	**Trainee**	**5**	**(4.5-5)**	**93%**	**0.408**
		Expert	**4.5**	**(4.25-5)**	**91%**	

IQR – interquartile range. MWU – Mann Whitney u

6.4.4 ENT-NOTECHS Reliability Results:

(i) Internal consistency of tool:

Cronbachs alpha internal consistency coefficients were calculated for each individual behavioural category of the ENT-NOTECHS tool. An alpha coefficient of >0.7 is generally considered adequate.

The table below (Table 6.10) shows data collapsed across all professional subspecialties. Calculated cronbach alpha scores were all within the acceptable range suggesting good reliability of the tool.

Table 6.10 internal consistency of ENT-NOTECHs tool:

	No. of assessments	Cronbachs alpha
Pre op checks	210	0.830
Communication and Interaction	210	0.925
Leadership and Management	210	0.858
Teamwork	210	0.861
Situational Awareness	210	0.797
Decision Making and Crisis Management	210	0.875

We also carried out a reliability analysis by professional subgroup to see if there were differences in scale use between specialties (table 6.11). Differences were found between the use of scales for the anaesthetic group within the "situational awareness" and "decision making and crisis management" categories. Further analysis demonstrated that removal of the behavioural item *"anticipates potential problems and shows evidence of contingency plan"* in the "situational awareness" category together with *"asks for opinion of other colleagues"* in the "decision making/crisis management category" would result in an improved cronbachs of 0.702 and 0.727 respectively, reaching an acceptable level of reliability.

Table 6.11 Internal consistency of ENT-NOTECHS by subspecialty:

Category	**Surgeons**	**Anaesthetists**	**Nurses**
Pre op checks	0.847	0.733	0.894
Communication and Interaction	0.940	0.796	0.950
Leadership and Management	0.939	0.846	0.737
Teamwork	0.821	0.812	0.936
Situational Awareness	0.906	0.622	0.728
Decision Making and Crisis Management	0.931	0.665	0.861

(ii) Inter-rater reliability:

Overall excellent inter-rater reliability scores were calculated for each of the participating specialties. These were as follows

(intraclass correlation coefficient (Cronbach) >0.7 considered adequate.)

Overall: Surgeons: 0.923

Anaesthetics: 0.834

Nursing staff: 0.852

Data can be collapsed to look at the correlation coefficient (Cronbach) for the different categories within the ENT-NOTECHS tool for each of the specialties (Table 6.12)

Table 6.12 Table showing the inter-rater reliability (correlation cronbach alpha scores) for each of the categories of the tool per specialty.

ENT-NOTECH TOOL Category	Cronbachs Surgeons	Cronbachs Anaesthetist	Cronbachs Nursing
Pre op checks	0.945	0.796	0.849
Communication and interaction	0.959	0.825	0.639
Leadership and Management	0.892	0.758	0.786
Teamwork	0.91	0.885	0.934
Situational awareness	0.902	0.827	0.771
Decision making and crisis management	0.901	0.872	0.858

All categories within the ENT-NOTECH tool achieved acceptable levels of inter-rater reliability for surgeons and anaesthetists. Nurses also achieved an excellent level of inter-rater reliability apart from the "communication and interaction" category.

Data was also collapsed to look at the correlation coefficient (Cronbach) for the different simulation scenarios to ensure that inter-rater reliability for each scenario was also acceptable. A range of scenarios were undertaken during the simulation day, and it was therefore important to determine that NOTECHS scores were reliable regardless of the simulation scenario being undertaken.

Table 6.13 inter-rater reliability results for ENT-NOTECHS per specialty for each simulation scenario.

Simulation Scenario	Cronbachs Surgeons	Cronbachs Anaesthetist	Cronbachs Nursing
ML Bleeding	0.9	0.854	0.868
ML foreign Body	0.907	0.828	0.875
Drug Error	0.934	0.784	0.827
airway tire/tonsil	0.956	0.802	0.876
supraglottitis	0.918	0.874	0.773
anaphylaxis	0.929	0.85	0.857

All scenarios across all specialties achieved an acceptable inter-rater reliability with cronbachs alpha of >0.7.

6.4.5 ENT-NOTECHS Validity results:

Average ENT-NOTECH scores were calculated for 4 distinct groups: Junior (ST3-ST4), Intermediate (ST5-ST6), Senior (ST7-ST8) and Consultant. (Figure 6.7)

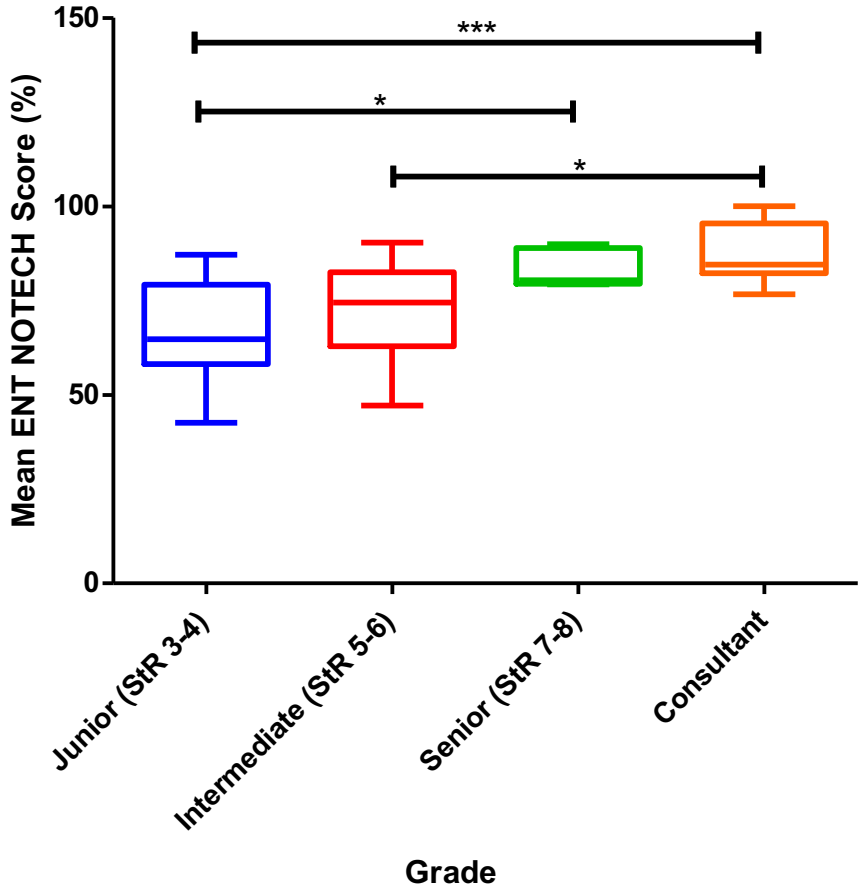


*Figure 6.7 NOTECH scores for junior, intermediate, senior and consultant groups. The mean scores are shown within each box, with maximum and minimum scores represented by the whiskers. A one way Anova test was applied with a newman-keuls multiple comparison post. KEY: * p<0.05, ** p<0.01 *** P<0.001.*

A general upward trend in mean ENT-NOTECHS scores with increasing seniority was demonstrated. A statistical difference in ENT-NOTECHS scores was seen between the junior and consultant groups (P<0.001), between the junior and senior groups (P<0.05) and between the intermediate and consultant groups (P<0.05). There was no statistical difference between senior trainees and consultants.

In addition, further analysis was undertaken to look at general trend in ENT-NOTECH scores with increasing seniority at an aggregate level (figure 6.8).

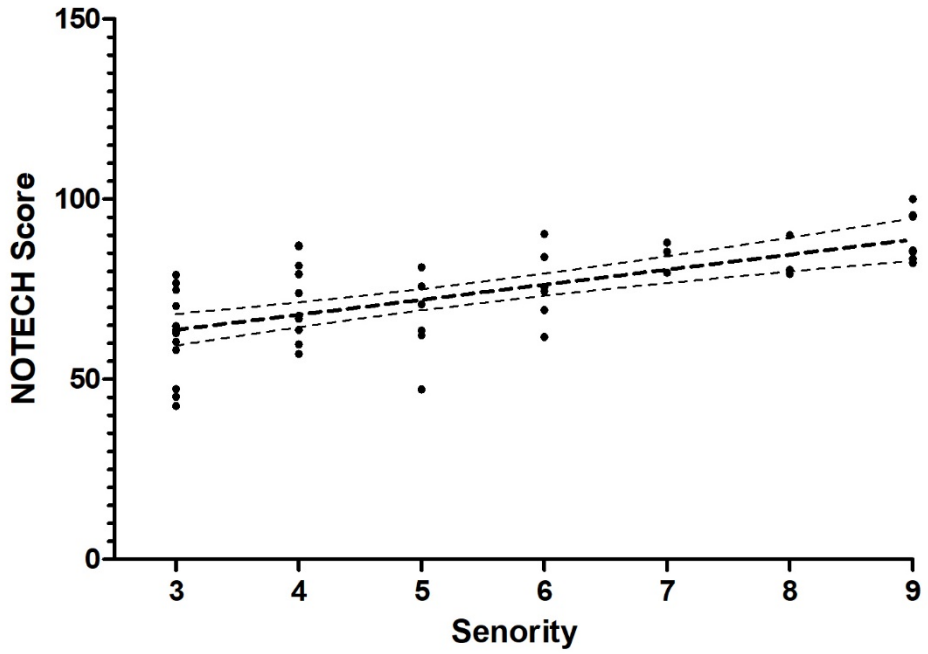


Figure 6.8 scatterplot of ENT-NOTECHS scores compared to grade of seniority. Bold interrupted line represents trend in correlation and fine interrupted line represents 95% confidence interval.

A positive correlation of ENT-NOTECHS scores with increasing training level was seen (r 0.6656) which was statistically significant (P<0.001).

Validity was further examined by determining candidate ENT-NOTECHS scores before and after simulation training.

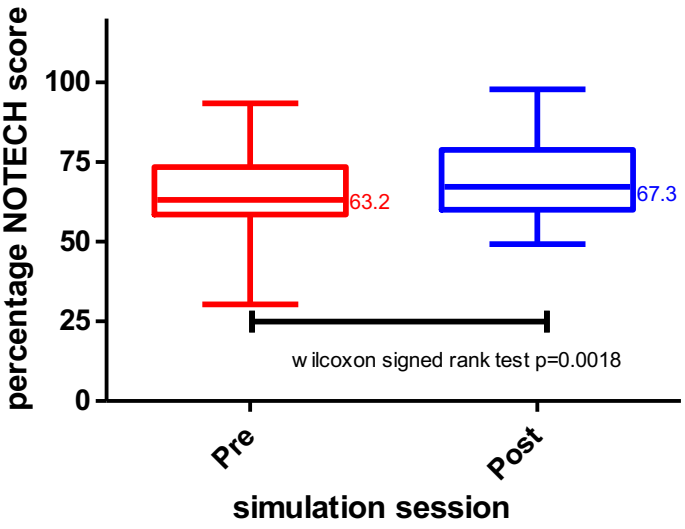


Figure 6.9 median ENT-NOTECHS scores for candidates Pre and Post training (n=20 (10 surgeons, 10 anaesthetists)). Box represents interquartile range and bars represents range.

The paired data for the participants who undertook the simulation scenarios twice (pre and post training in non-technical skills) was analysed using a wilcoxin signed rank test. This showed a statistically significant improvement (p=00018) between ENT-NOTECH scores between the first and second simulations.

6.4.6 ENT-NOTECHS tool usability and feasibility results:

21 faculty members gave feedback on the ENT-NOTECH tool regarding its usability and feasibility. A breakdown of faculty specialty can be seen in the table 6.14.

Table 6.14 faculty by specialty.

Faculty	**number**
Surgeon	10
Anesthetist:	6
Nursing	4
Pilot	1

Feedback was very positive. ENT-NOTECHS achieved a median rating of 5 for overall satisfaction of the tool with 100% agreement from all expert faculty raters. 100% of faculty agreed that they would recommend the use of this tool in training theatre teams (median 5, range 4-5), and that it provided a common language to discuss non-technical skills with trainees (median 5, range 4-5, 100% agreement). Faculty felt that interpersonal skills were easier to rate compared to cognitive skills (100 percent agreement and 86% agreement respectively), with a significant difference in ease of rating found between anaesthetists and nurses (median 3.5 and 5 respectively, p=0.0111). The lowest feedback scores were given for the ability to rate technical skills. There was only a 57% agreement (median 4, range 2-5) from faculty that it was easy to rate technical skills, with nurses scoring this significantly easier to rate than surgeons (P=0.0118).

A breakdown of faculty ratings for individual items can be seen in table 6.15.

Table 6.15 Usability and feasibility of the ENT-NOTECHS tool. Median and Percentage agreement (% rating 4 or 5). Kruskal Wallis test with a Dunns' post test to determine significance between median group ratings.

(NB. Overall median ratings also include ratings for pilot (n=1)).

	Specialty	Median	Range	% agree or strongly agree	P value
Q1: This tool provides a common language to discuss non-technical skills with trainees	Surgeon	4.5		100	
	Anaesthetist	4.5		100	
	Nurse	5		100	
	OVERALL	**5**	**4-5**	**100%**	**0.2503**
Q2: It was easy to rate cognitive skills (situation awareness, decision-making)	Surgeon	4		100	N vs A
	Anaesthetist	3.5		50	
	Nurse	5		100	
	OVERALL	**4**	**3-5**	**86%**	**0.0111***
Q3: It was easy to rate interpersonal skills (communication, teamwork, leadership)	Surgeon	4		100	
	Anaesthetist	4.5		100	S vs N
	Nurse	5		100	
	OVERALL	**4**	**4-5**	**100%**	**0.0087****
Q4: It was easy to rate technical skills	Surgeon	3		40	
	Anaesthetist	3.5		50	S vs N
	Nurse	5		100	
	OVERALL	**4**	**2-5**	**57%**	**0.0118***
Q5: This tool provided a good assessment framework	Surgeon	4		100	
	Anaesthetist	4		83	
	Nurse	5		100	
	OVERALL	**4**	**3-5**	**95%**	**0.1943**
Q6: This tool provided a good feedback framework	Surgeon	4		90	
	Anaesthetist	4.5		100	

	Nurse	5		100	
	OVERALL	**4**	**3-5**	**95%**	**0.1296**
Q7: This tool is a valuable adjunct to tools that assess surgical skills (WBA's: eg PBA	Surgeon	4		90	
	Anaesthetist	4		67	
	Nurse	5		100	
	OVERALL	**4**	**3-5**	**86%**	**0.3067**
Q8: This tool addresses all aspects of non-technical skills in the theatre environment	Surgeon	4		90	
	Anaesthetist	4		83	
	Nurse	5		100	
	OVERALL	**4**	**3-5**	**90%**	**0.1121**
Q9: This tool provides useful feedback for the trainee	Surgeon	4		100	
	Anaesthetist	5		100	
	Nurse	5		100	
	OVERALL	**5**	**4-5**	**100%**	**0.4084**
Q10: This tool is applicable to real life cases	Surgeon	4.5		100	
	Anaesthetist	4		100	
	Nurse	5		100	
	OVERALL	**4**	**4-5**	**100**	**0.4531**
Q11: This is a useful tool to provide feedback to trainees regarding non-technical skills	Surgeon	4.5		100	
	Anaesthetist	5		100	
	Nurse	5		100	
	OVERALL	**5**	**4-5**	**100%**	**0.6513**
Q12: This tool could be used in the operating theatre	Surgeon	5		90	
	Anaesthetist	4.5		100	
	Nurse	5		100	
	OVERALL	**5**	**2-5**	**95%**	**0.7590**
Q13: This tool is not too time consuming	Surgeon	4		90	
	Anaesthetist	3.5		50	
	Nurse	5		100	N vs A
	OVERALL	**4**	**3-5**	**81%**	**0.0173 ***

Q14: This tool takes up too much time	Surgeon	2		0	
	Anaesthetist	2.5		0	
	Nurse	1.5		0	
	OVERALL	**2**	**1-3**	**0%**	**0.3161**
Q15: Routine use of this tool will enhance safety in the operating theatre	Surgeon	4		100	
	Anaesthetist	4.5		100	
	Nurse	4.5		100	
	OVERALL	**4**	**4-5**	**100%**	**0.1919**
Q16: I would recommend the use of this tool in training theatre teams	Surgeon	4.5		100	
	Anaesthetist	5		100	
	Nurse	5		100	
	OVERALL	**5**	**4-5**	**100%**	**0.6513**
Q17: Overall tool satisfaction	Surgeon	4		100	
	Anaesthetist	5		100	
	Nurse	5		100	
	OVERALL	**5**	**4-5**	**100%**	**0.4084**

6.5 Discussion:

Effective teamwork is essential to improving safety of patients in the operating theatre. Despite recognition from numerous high profile publications(5, 31) and audits(15), a review of the literature has highlighted a paucity of multidisciplinary team training within the ENT operating theatre(63). A key aim of this thesis was to develop a training day to teach and train non-technical skills to ENT trainees and the wider team by undertaking high fidelity MDT simulation. We aimed to increase awareness and understanding of these key skills, provide constructive debrief feedback on team interactions and use the simulated scenarios to validate the ENT-NOTECHS tool and provide initial assessment of these skills.

Simulation provides an excellent opportunity to practise team training in stressful crisis scenarios, where mistakes and possibly new ways of working can be undertaken in a safe and reproducible environment with no risk to patients. The team scenarios were chosen based on real life experiences, and designed to encompass key competencies required by an ENT trainee. Particular emphasis was placed on airway scenarios; not only to ensure that anaesthetic colleagues were equally challenged during these scenarios but also to provide a sufficiently stressful situation which requires a co-ordinated team effort involving multiple healthcare professionals. As evidenced by the NAP4 audit, failures in airway management often result from poor team communication and situational awareness. Therefore

simulations can act as a “team dress rehearsal”, to highlight the importance of these skills and how each team member may be able to contribute when faced with a real life scenario.

Whilst team training has been recommended, it is also vitally important to show that the training we are providing is effective and received favourably by the participants. This chapter has aimed to address this need.

6.5.1 Effectiveness of the training day:

Initial reaction:

Participants initial reaction to the training was very positive, with excellent feedback for course content, delivery and overall satisfaction. 100% of trainees agreed that the simulations were an effective method to train and teach team skills and leadership. The free text area on the evaluation form allowed for more in depth nuanced comments, identifying many strengths of the training day programme and suggestions for improvement. In particular, most trainees attending commented that the simulation day was excellent, especially as it allowed trainees to experience situations which are very rarely encountered and indeed dreaded by trainees due to the fear of the unknown and stress of the situation. Allowing them to experience situations within the safety of simulation serves as an aide memoir for any future encounters; therefore, hopefully improving outcomes.

Learning:

The training day was effective in increasing trainee's confidence to manage crisis scenarios within the operating theatre. Post course feedback from candidates showed a 100% agreement that the training day had increased their confidence to manage a crisis scenario in the operating theatre, and this was also reflected in the overall significant increase in candidates assigned scores for confidence and attitudes towards non-technical skills within the operating theatre post course. Simulation debrief has previously been shown to be one of the most valuable parts of human factors training. Trainees were able to observe all simulations (6 per simulation training day) with the use of excellent audio-visual facilities and thereby contribute to the team debrief for each scenario. Trainees were encouraged to give honest feedback to one another within the safety of the debrief room. Consequently, candidates were able to acquire an increased understanding of the complex dynamics within the operating theatre and how improved non-technical skills can be a key factor in patient safety. Going forward it would be interesting to see if this attitude change is a sustained and real change and not just a reactionary result of the training. Whilst reactionary responses can be very valuable, in order to instigate real change within institutions (i.e to ensure that they assign value to the importance of non-technical skills and its training), this ethos and attitude needs to be long term. Conducting regular MDT simulation training days throughout the year so that teams get repeated exposure to this may be one solution.

Skill:

The training programme was successful in increasing candidate's teamwork, leadership and communication skills. As a result of attending the training day, ENT-NOTECHS scores significantly improved between first and second simulations for individual participants. As explained above, candidates not only experienced the simulation themselves, but were privy to the discussion and debrief for all simulations throughout the day. Whilst the introductory lectures serve to set the tone of the day by highlighting the different aspects of non-technical skills, it is most definitely the learning opportunity afforded by observing other teams in action which help to reinforce the significance of good teamworking and leadership. This further highlights the importance of having a dedicated tool to capture non-technical skills within the ENT operating theatre environment. In order to improve something we must first understand it. Measuring a skill allows us to identify areas for improvement and to also track progress.

Organizational impact:

As a surrogate marker for organizational impact, expert raters were asked regarding their intention to use ENT-NOTECHS in the real life operating theatre to assess their trainees. This does unfortunately lead to potential bias and a trainer's initial positive intention may not translate to actual results.

Surgical trainees were contacted 6 months post simulation and asked if the simulation training day had influenced their practice in the last 6 months. There was

100% agreement that the day was useful and helped to improve confidence managing a real life crisis. Unfortunately despite our best efforts, we were only able to get 6 month responses from ENT trainees, with an 84% response rate (21/25 trainees). This was largely due to failure to obtain permanent contact details at the initial training programme. Trainees moved on to other trusts and a large number of the emails to anaesthetic trainees failed to deliver as some professional email addresses were no longer in use. As a trainee myself I was able to reliably contact the ENT trainees and so this was not a problem for the surgical cohort. This was a lesson learned and in future it may be worth asking for a personal or permanent email.

6.5.2 Face and content validity of the training day:

Obtaining an adequate Face validity of the training day was vitally important, to ensure that candidates were appropriately emersed in the scenario and the stress of the situation. Crisis situations within the operating theatre call for exemplary nontechnical skills, and indeed it is in these situations that those skills are tested the most. We therefore wanted to create a high-fidelity operating theatre environment and scenarios which were as realistic as possible in the hope that participants would behave in a similar fashion to the real life operating theatre.

Excellent face and content validity ratings were obtained from expert and trainee groups for the MDT simulation training day, with both groups rating the training day

above the general level of acceptance of 4 out of 5 on a 5 point likert scale. In particular, candidates had a 100% agreement that the scenarios undertaken throughout the day were credible and the team interaction during these simulated scenarios was realistic (100% agreement). The lowest % agreement among trainees and experts related to the realism of the technical model (87% and 64% respectively). This area was particularly challenging to simulate as mannikins and simulated operating models will never feel completely realistic, with reduced capacity for haptic feedback and tissue feel. Despite this however, face validity still achieved a rating of 4/5 for the model, which is within the level of acceptability. It is also not surprising that the expert group scoring was harsher than the trainee group for this individual item.

6.5.3 Psychometric robustness of ENT-NOTCHS tool:

One of the main aims of this chapter was to report detailed evidence on the psychometric robustness of the newly devised ENT-NOTECHS tool for use in surgical teams.. Trainee's non-technical skills were assessed using the ENT-NOTECHS tool, and results were used to analyse and determine reliability and construct validity of the tool.

Reliability:

Whilst the ENT-NOTECHS tool was developed from a pre-existing behavioural tool (Revised-NOTECHS), behavioural elements within the over-arching categories were

adapted; including the important addition of the "Pre-op checks" category which was a strong recommendation from preliminary work and expert focus groups. Elements within the rest of the tool were also adapted or switched between categories to make it more applicable to the order of process in an ENT operating theatre. As a result of these modifications, it was vitally important that the tool therefore exhibited internal consistency within each of the behavioural categories in order to maintain its original psychometric robustness.

Excellent Cronbach alpha correlation coefficient scores (>0.7) where obtained for internal consistency across all categories when all data was analysed as an aggregate, ranging from 0.797 to 0.925. When data was analysed according to subspecialty, differences in reliability were seen for the anaesthetic team for the categories of "situational awareness" and "Decision making". Further analysis did however show that removal of *"anticipates potential problems and shows evidence of contingency plan"* from the situation awareness category and *"asks for opinion of other colleagues"* from the Decision making/crisis management category led to improved Cronbach alpha coefficients of 0.702 and 0.727 respectively. One potential explanation is that behaviour has been shown to be easier to rate when either at extremes (very good or very bad behaviours) or when it is more explicitly on show(48, 57). Certainly, studies have also commented that anaesthetists find it harder to rate the cognitive behaviours of "situational awareness" and "decision making" compared to the interpersonal skills of communication and leadership(57). Equally, anaesthetists may draw up and administer drugs when "anticipating

problems" and rather than announcing and verbalising their actions to the theatre as a whole, these acts are often undertaken "behind the scenes". It is therefore harder to rate these behaviours if things are not externally voiced to the team during a simulation. Indeed this is a known limitation of a behavioural skills marker(43). These findings were discussed with subject matter experts and were also a topic of discussion during the team debriefs, and following discussion it was felt that these behavioural elements were important and should therefore still be included in the final tool. This finding in itself reflects that the operating theatre environment and our behavioural norms are not necessarily perfect and by keeping these elements within the tool may indeed encourage and train team members to externalize their thoughts and actions to the team rather than internalizing them. Thus providing further evidence of the tool's applicability and usability within training.

Excellent overall inter-rater reliability was obtained for all subspecialities. Subgroup analysis was also undertaken to determine any difference in inter-rater reliability for each category of the tool for each subspecialty (surgeons, anaesthetists and nursing staff). Excellent inter-rater reliability was determined for all subspecialties apart from the category of "communication and interaction" for the nursing cohort. Again, following discussion with expert faculty, it was felt that inter-rater agreement was perhaps lower in this instance, as traditionally nursing staff may take a more passive role in the operating theatre when it comes to communicating with the wider team. Surgeons and Anaesthetists may feel more comfortable taking a leading role here and hence it is easier to rate this behaviour when it is on show for all to

observe. Communication and interaction are particularly important skills and through this training, nursing staff should be encouraged to communicate more with the team; ignoring "hierarchical norms". By training together as a team in this safe environment, there is a hope that all team members can be encouraged to voice concerns and interact between the specialties.

Construct validity:

Construct validity of the tool was demonstrated on multiple levels. We were able to show a statistically significant positive correlation between ENT-NOTECH scores with increasing seniority. The tool was able to differentiate between junior (ST3-ST4) and senior (ST7-ST8), Junior and consultant, and intermediate (ST5-ST6) and consultant with statistical significance. And lastly, we were able to show that participating in simulation training in non-technical skills can lead to a statistically significant improvement in ENT-NOTECH scores. By demonstrating construct validity, this tool together with high fidelity simulation offers a safe and effective way to train as a team in crisis scenarios without impacting on patient safety.

6.5.4 Usability and feasibility of tool:

it is equally valuable to determine the usability and feasibility of the tool by those people for whom the use of the tool is intended. If faculty do not feel the tool is usable or applicable to real life then the value of the tool is significantly diminished.

Feedback from expert faculty was very positive, with 100% agreement on overall tool satisfaction. 100% of faculty agreed that this tool was useful to provide feedback to trainees regarding their non-technical skills and that they would recommend its use in training teams in theatre, and that the tool was applicable to real life cases. Interestingly, while faculty completely agreed that it was easy to rate the interpersonal skills of leadership and teamwork, there was only an 86% agreement that it was easy to rate the cognitive skills (situational awareness and decision making). Subgroup analysis showed that the anaesthetic team in particular were more able to easily assess the interpersonal skills (100% agreement) compared to the cognitive skills (50% agreement). This is in stark contrast to the scrub nurses who felt equally confident to rate both these skill domains. This finding mirrors that of Beard et al (2011)(57), when using the NOTSS tool to assess surgical trainees in the operating theatre. Perhaps this reflects the closer working relationship between the surgeon and scrub nurse at the sharp end of the patient, with the focus of the anaesthetist, quite rightly, on other factors such as patient vitals and observations. Whilst a lot of the "cognitive skills" of surgeons and scrub nurses are verbalized eg, by asking for equipment or actively enquiring with the anaesthetist regarding blood pressure etc, the work of the anaesthetist is often less obvious and they go about their role in more understated and introverted manner, only interrupting the surgeon if there are concerns that they cannot address etc.

Lastly, it was important that the tool did not take too much time to complete, as again, this would severely restrict its use in the operating theatre if the assessment process was too onerous. There was overwhelming agreement that the tool did not take too long to complete (median rating 2, range 1-3) with all specialty's reporting similar findings.

6.5.5 Limitations:

Simulation training days will never completely replicate the real operating theatre but by constructing a high fidelity operating environment complete with working ventilator and operating theatre lights, we can at least aim to get this as life like as possible – usually borrowing actual operating sets and equipment and having the full range of "theatre staff" participating fully in the simulation. Certain limitations however will be present. Candidates were limited in the type and amount of equipment they could request during the simulation, and whilst a real life crisis situation may require specialist airway or emergency equipment, we were limited to the basics .i.e no ventilating bronchoscope present, and no fibreoptic intubation. This was not intentional, but necessary in order to ensure that vital equipment was not taken away from the working hospital and that patient safety was not compromised as a result of running these training days.

The training day itself was only one day in duration and consequently this was an intense learning experience for candidates. Ideally, a two day course may have been

more beneficial to candidates, as this would have allowed candidates more time to observe, digest and reflect. However, due to difficulties with staff shortages, especially with the theatre nurse availability, it was decided that a one day was best in order to get the full compliment of specialties attending.

Whilst the surgical ENT trainees had mandatory simulation training for ST3-ST6 grades, participants who attended the course from ENT ST7 and above, Anaesthetics (all training grades) and Nursing departments (all bands) were self selective. Consequently candidates may have already had an interest in human factors/non-technical skills, possibly accounting for the highly positive feedback. Despite this however, we were able to demonstrate that candidate's views and attitudes towards the subject matter were still enhanced and improved as a result of attending the training day.

There was a larger sample size of participants for the trainee group as opposed to the expert group. Whilst it would be ideal to have a similar number of participants in each group, trainees were the intended audience of the simulation training days and hence their opinion is extremely valuable. Surgical Trainees in particular were able to attend these sessions regularly and consistently due to compulsory simulation attendance within the training region, whereas consultants often had multiple commitments and thus a reduced number were able to attend.

The assessment was based on direct observation of the candidates in the simulation scenarios and therefore was not blinded. However, feedback from the raters to the participants in the simulation debrief was a key part of the learning opportunity for the day and has been shown to be the most valuable part of MDT team simulation in feedback from similar studies. Whilst the majority of raters were based at Imperial NHS trust, the participants from ENT and Anaesthetics were from a total of 9 NHS trusts and therefore on the whole were not familiar to the expert faculty rating them.

As part of our MDT simulation training there were 6 different simulation scenarios over the course of the day, meaning that candidates were assessed across a variety of different scenarios and not against one standard set scenario. Whilst other studies have assessed candidates undertaking the same simulation scenario repeatedly(38, 44), it was felt that holding a full day of high fidelity training covering a range of simulation scenarios would provide a richer learning environment for the candidates.

Whilst we were exceptionally grateful to the faculty for giving up their time to attend the training days and assess the candidates, we do acknowledge that there were more surgeons (10), than anaesthetists (6) than nurses (4). This was largely due to staffing shortages and the trust being unable to spare senior nurses for training. We also had one aviation pilot attend the day with a background in human factor and

safety. Whilst his feedback was not statistically analysed by itself in subgroup analysis of the participating specialties (as n=1), his feedback was included in the overall feedback statistics. His professional background in safety and human factors within the aviation industry made him a subject expert and was indeed a very valued opinion at the training days and their evolution.

Whilst the majority of faculty were in general agreement regarding feedback for the training day and the ENT-NOTECHS tool feedback, there were a few instances where there was a significant difference in the ratings of the nursing staff compared to either the surgeons or anaesthetists. Whilst their small sample size could add skew to the data, data was analysed as non-parametric and scrub nurses opinions were important to include due to their wealth of experience and skill. They are an integral part of the operating team and therefore their engagement and opinion was crucial

6.6 Conclusion:

This training model serves as an excellent platform to teach and train non-technical skills; a learning opportunity which is difficult to come by in the real life operating theatre. By training as a team with our anaesthetic and nursing colleagues, we are able to improve the factors which commonly lead to error in operating theatre.

Additionally we have demonstrated that the ENT-NOTECHS tool is psychometrically robust. The ability to measure non-technical skills in trainees, affords us the ability to improve it. Feedback has shown that this tool is not only acceptable as a framework for feedback and assessment but can potentially be a valuable adjunct to enhance patient safety in the operating theatre.

7 GENERAL DISCUSSION:

7.1 Chapter overview:

This chapter reviews the main research findings from this body of work. A brief background of the work is summarized, together with consolidation of the general themes and aims of the thesis. Key findings, and general limitations of the work are also discussed together with future implications and future direction of work. My personal reflections of my work complete this thesis.

7.2 Background summary; setting the scene:

Human factors or non-technical skills in the operating theatre has gained significant traction over the last decade and has been shown to be vitally important in improving patient safety(19, 99). Whilst technical skill and operative experience has continued to be the cornerstone of surgical training, it is often the softer skills of leadership, teamwork and communication which will often distinguish excellence in the operating theatre with its multi-layered facets of interaction(99, 100). These skills have traditionally not been taught and instead trainees are expected to acquire

these skills by self development and taking cues from role models and trainers as they advance through training. Additionally, theatre teams are often thrown together in emergencies and expected to work seamlessly together with exemplary team skills. The time available for trainees to acquire these skills has also been compromised over the years due to numerous factors including the introduction of the European Working Time Directive (EWTD), meaning that trainees have a reduced exposure to training opportunities in the operating theatre, with an even rarer chance to participate and be exposed to emergency crisis scenarios.

Simulation in surgical training has established itself as the ideal vanguard and is now an integral part of the surgical curriculum(101). Not only does it provide trainees with increased opportunities to develop skills, but allows trainees to gain the skills and competencies in a risk free environment with no compromise on patient safety. Whilst a number of simulation models have been developed in ENT to train the next generation in the technical/operative skills(33, 102), very little has been undertaken in the literature with regards to human factors training. Otolaryngology in particular is a specialty which can benefit immensely from dedicated human factors training. With airway emergencies and complex head and neck patients a day to day reality for ENT surgeons, teamwork and communication is especially important and crucial for improving patient safety. Our literature review highlighted in particular that there was a paucity of non-technical skills training in ENT. The few studies which did exist featured training that was largely part of a wider simulation day with human

factors playing a small side role. Crucially, only one study made any attempt to assess the trainees non-technical skills(68).

Structured assessment is now a crucial part of modern surgical training, and recently there has been a move to develop tools which can assess and provide feedback on the non-technical skills of the trainee(35, 42, 44). Feedback and assessment is integral to understanding, improving and enhancing skills. Whilst a number of behavioural markers have been developed in the literature, there is no gold standard and it is widely accepted that a behavioural marker is context specific(57). Whilst the majority of behavioural marker tools in the literature have bene developed with General Surgery in mind, we felt strongly that Otolaryngology has enough nuances to merit its own tool.

7.3 Summary of thesis aims and results:

The overarching theme and aim of this thesis was to incorporate human factors into the education, training and assessment of ENT trainees. With an increasing emphasis on patient safety and how best to enhance this, research has demonstrated that the training interventions shown to be most effective are those which are simulation based and have a foundation in human factors, together with simulation which incorporates multidisciplinary team training(7).

With that in mind, the following aims were addressed:

Primary aims:

1. To develop a psychometrically robust assessment tool for assessing nontechnical skills in ENT: A revised ENT-NOTECHs tool.

2. To develop and validate an ENT themed multidisciplinary simulation programme for the assessment and feedback of non-technical skills.

Secondary aims:

1. Evaluate the effectiveness of the training day and its impact upon the participating trainees

7.4 Key findings by aim:

1. *To develop a psychometrically robust assessment tool for assessing nontechnical skills in ENT: A revised ENT-NOTECHs tool.*

An initial systematic review of the literature (Chapter 4) showed a significant lack of human factors training within ENT, with even fewer studies in the literature making

any attempt to assess the nontechnical skills of the trainees(68). We subsequently concluded that there was clearly a need to do better and the development of a psychometrically robust behavioural rating tool specifically dedicated to ENT was felt to be the best way to assess and improve these skills.

This was achieved by using a multimodal approach. Triangulation of data from a variety of methods was used to ensure that the developed tool was highly applicable to ENT whilst being grounded in the basic principles and concepts of a proven psychometrically robust behavioural tool. We were able to modify this tool to make this more applicable to an ENT operating theatre environment through expert faculty consultation and general field observations in the ENT operating theatre. There are key differences which sets an ENT operating theatre apart from other specialties and we wanted our tool to reflect this. Indeed, if the tool was going to have the intended goal of improving patient safety, it was imperative that we took note of the key findings of the NAP4 audit and ensured that communication and situational awareness between the surgeons and anaesthetists was given particular attention. Consequently, the main modification of the NOTECHS tool was the addition of "Pre-operative checks" category, which included essential behavioural elements of: "liaises with anaesthetic team regarding anaesthetic plan", "discusses contingency plan with anaesthetist eg if difficult airway is suspected", and "makes relevant equipment checks" etc (see Chapter 5 on the development of ENT-NOTECHS tool for full details of behavioural elements).

Ensuring that the developed tool was psychometrically robust was an essential focus of the research. Content validity was ensured in a variety of ways. Firstly, an expert faculty focal group was conducted to discuss the tool and experts within ENT, anaesthetics, and senior theatre nurses were consulted throughout the development. Secondly, field observations were conducted in the ENT operating theatre to ensure behavioural elements were indeed observed in the correct setting and lastly, formal content validation by subject matter experts was also undertaken using an item content validity index (CVI). 23 out of a total 29 elements (79.3%) reached and exceeded the pre-determined I-CVI value of >0.78. 6 out the 29 elements (20.7%) scored below the predetermined I-CVI level but following further expert faculty discussion, just 2 of these behavioural elements were officially removed from the tool.

Furthermore, data to determine reliability and construct validity of the ENT-NOTECHS tool was gathered through the MDT simulation training days. Excellent internal consistency and inter-rater reliability was obtained across all sub-specialties using the tool. Construct validity was also established through a variety of methods. We were able to demonstrate that participating in the Human factors simulation training day led to an improvement in ENT-NOTECHS scores, and that the tool was able to differentiate between novice and experts, with a significant difference seen between junior trainees and senior trainees, junior trainees and consultants, and intermediate trainees and consultants. There was a positive correlation between ENT-NOTECHS scores and seniority.

Responses from faculty regarding acceptability were very positive, and there was 100% agreement that the tool was useful to provide feedback on non-technical skills, 100% of faculty would recommend the use of the tool in training theatre teams and there was 100% agreement on overall tool satisfaction.

2. *To develop and validate an ENT themed multidisciplinary simulation programme for the assessment and feedback of non-technical skills.*

Secondary aims:

3. *Evaluate the effectiveness of the training day and its impact upon the participating trainees*

A multidisciplinary high fidelity simulation training day was designed. The overarching aim of the training days were to improve awareness and attitudes towards non-technical skills, particularly in high stress crisis scenarios, and to use the training day to test the psychometric robustness of the developed ENT-NOTECHs tool (results discussed above).

Simulation scenarios were developed based on real life faculty experiences. A total of 74 trainees participated in 6 MDT simulation training days held over a 15 month period, with 210 assessments using ENT-NOTECHS undertaken during this time

period. Excellent face and content validity ratings were obtained from expert and trainee groups for the MDT simulation training day. There was a 100% agreement that scenarios and team interaction was realistic.

The effectiveness of the simulation training day was assessed using Kirkpatrick's evaluation principles, with positive results for each level of the evaluation.

7.5 Strengths and Limitations:

A huge amount of important data has been gathered as result of this research. However, inevitably there will be strengths and limitations of the study, and whilst some of these have been highlighted in previous chapters, further generalized discussion of these areas are considered here.

Simulation and the environment:

The findings of this thesis are largely based on results drawn from simulation. Whilst we have endeavoured to create a high fidelity environment with the use of the simulated operating theatre, inevitably there will be limitations to this, in particular to the models used regarding tissue feel and haptic feedback. The need to obtain the most suitable realistic equipment and models, yet still be cost effective can be a huge challenge. To the best of our ability we have tried to overcome this by employing high fidelity mannikins, using actual theatre operating instruments and

props (including drugs, drapes and suction) and using a combination of artificial blood, along with animal models such as porcine skin and porcine larynx to ensure that procedures such as Front of Neck Access (FONA) are life like. On the whole, simulation "buy in" and immersion in the scenario was excellent, with just a handful of occasions where the trainees were not fully emersed.

Additionally, the nature of the simulation day invariably made candidates "on their guard" and it was questionable at times whether the Hawthorne effect (tendency of candidates to change their behaviour as a result of being observed) may be influencing certain behaviours. For example, the scenario may have asked candidates to lead a team brief for a standard tonsillectomy procedure, but due to anticipation of things about to go wrong, trainees "overcompensated" by asking for a tracheostomy set 'just incase" the airway was difficult. Whilst this in some ways defeats the point of the simulation, it can in itself have a learning point: the training had obviously prompted them to think about possible complications that might be encountered and at least therefore they had mentally considered options and shown some awareness – albeit premature! It was therefore particularly important that each scenario during the training day was different and a variety of crisis management skills were demonstrated in order to keep candidates in their toes and reduce complacency.

The evaluation and validation of this tool has used simulated scenarios in a controlled high fidelity setting. This is similar to the development and validation of other tools(43, 47). However, in contrast to the scripted videos used to validate NOTTS and ANTS(43, 47), ENT-NOTECHS has been evaluated and validated using truly multidisciplinary simulation, where all candidates were blind to the simulation scenario and fully emersed in the drama and stress of the situation. It could be argued therefore that ENT-NOTECHS may be more easily transferrable to the real life operating room. Interestingly, the validity of this study rests on the assumption that teamwork and non-technical skills in the simulated environment is directly comparable to the operating theatre. Future work should consider non-technical skills assessment of the team in real time; both elective and emergency cases.

Tool Development:

This tool was developed using triangulation of data in order to ensure content validity. A relatively small focus group of experts was used (n=6), all of whom were from the same Trust. However, studies have recommended that content validation can be established by setting an item Content Validity index of 0.8 when there are 6 or more experts(91) and this guidance was adhered to. Ideally, we could have sought a wider group of experts from other trusts and regions in the country, and indeed a greater total number of experts. The smaller group did however provide us with more in-depth discussion of the tool and its elements. Additionally this tool was developed for use in the North Thames Otolaryngology training deanery, and

therefore the views and thoughts regarding the behavioural assessment tool were appropriately set out and defined by the intended users of the tool.

Rating of skills:

Observing and assessing non-technical skills of the operating team is critical to improving patient safety and has been the main focus of this thesis. Whilst a behavioural skills marker is a good method to assess these skills, there will inevitably be limitations to this also. Rating errors can occur and it is very easy not to notice or rate a behaviour; particularly in a noisy, stressful environment where interactions between the various team members are frequent and can occur simultaneously between numerous individuals. Additionally, bias and cognitive error can occur, with behavioural tools susceptible to the halo effect (where a single trait or behaviour can positively influence your impression on other behavioural ratings) and the horn effect (where one negative behaviour can reduce subsequent ratings on other behaviours). Where there were disagreements between whether a behavioural item did or didn't occur between the expert observers (distinct from how good or bad a behavioural item was performed), they were encouraged to discuss this prior to the trainee feedback/debrief and gain a consensus, so that feedback was consistent and human error of observers "mitigated" by forming a collective view. There was no formal training for the faculty in the use of ENT-NOTECHS as we wanted this tool to be as easy to use as possible and not intimidate people from using it. Faculty were simply briefed regarding the rating scale and what constitutes a rating of 3 (satisfactory) versus a rating of 5 (CCT level) for example, and simply took a few

minutes at the beginning of each training day. However, training in the use of the tool may reduce rating errors further and is worth considering providing this training if planning to role this out to a wider audience. Indeed, faculty training for the NOTTS tool is recommended in order to achieve acceptable reliability results(47).

Additionally, it has been reported that the cognitive skills can sometimes be difficult to rate, especially when the candidate does not verbalize his or her thought processes and quietly goes about their job in the background. Whilst this approach may not be detrimental in itself to patient safety, ratings obtained through the use of these tools may consequently be inaccurate and not reflective of the actual skills of the individual. However, in the interests of team training and improving teamwork, these findings may be useful in feedback and debriefing to the individuals, prompting them to be more verbal and hereby bolster the communication and interaction of the team as a whole.

Bias:

Assessors were not blinded during this study. Therefore there is room for bias in ratings, particularly if a trainee is well known to a particular consultant, ratings may be coloured by previous experiences. However, surgical and anaesthetic candidates attended from all training hospitals in North Thames, with a variety of consultant trainers, and this is in line with other work based assessments (WBAs) used in the assessment of surgical trainees. Similarly, scrub nurses from Imperial College Trust

were being rated by senior sisters in their own theatre/department, meaning that the potential for bias also existed within the nursing cohort. However, whilst the aim of my research may focus on accuracy of metrics, scores and outcomes, for the participating trainees and faculty, the value of the training days are focused on improvement in skills and establishing confidence in their role within the team. Critique from your own day to day team members may actually help to further improve teamworking by establishing expectations from colleagues and providing transparency to the subjective nature of observational feedback.

Sample size:

Sample sizes of the observational studies reported here were relatively small in comparison to large scale observational studies. 74 candidates undertook the simulation training, which encompassed 6 full training days, and 210 assessments of ENT-NOTECHS in total over a 15 month period. Running of the simulation training days was incredibly resource heavy; both from a time commitment, personnel and financial perspective. The sample size of candidates attending was also not balanced, with far fewer nurses attending the training days compared to anaesthetic and surgical trainees. This was restricted mainly due to staffing issues within theatre, with nursing staff often having to cover real life operating lists due to illness or emergencies. Additionally, this research highlighted to me the lack of formal study leave for nursing staff.

Patient safety:

Patient Safety was one of the main driving factors in the development of this research. Whilst we know that teamwork and non-technical skills are key factors in improving patient safety, it is yet to be established whether this data will indeed translate to a real life effect. This has long been a well known limitation of previous work, with a review of the literature on MDT simulation in the operating theatre concluding that no studies were designed to demonstrate any direct link between MDT training and patient outcomes(90).

7.6 Implications of research and contribution to knowledge:

This project highlighted the relative lack of ENT themed multidisciplinary simulation training in the literature, and is one of the first studies attempting to formally assess the non-technical skills of the ENT trainee and the subspecialties in the ENT operating theatre. It is the first study to produce a novel dedicated tool for the assessment of non-technical skills in the ENT theatre environment, and we have shown this to be psychometrically robust.

The most obvious and immediate application of these research findings is the formative feedback and assessment of non-technical skills in the ENT operating theatre. Assessment of skills is particularly important as it helps to guide standards,

facilitates learning and monitors progress of a particular skill(103). With an increasing importance of non-technical skills and a move towards competency based medicine(103), a formal assessment in these skills seems the next likely step. Additionally, as previous evidence has stated, the main learning benefit from MDT simulation training days is usually gained from the structured debrief(73) and numerous studies have shown that regardless of format, the single most effective feature of simulation based training is the feedback(104). ENT-NOTECHS can serve as a tool not only for the formative assessment of these skills but also serves as a structure on which to base a debrief; highlighting areas of good and bad behaviour and identifying areas for improvement. Feedback from expert faculty stated that they would recommend the use of ENT-NOTECHS in training theatre teams.

7.7 Future work:

Further work on the validity of ENT-NOTECHS would seem the next logical step. Investigation of concurrent validity could be undertaken by determining whether ENT-NOTECH scores correlate with general overall teamworking within the operating theatre. OTAS is one such tool which aims to capture an overall measure of teamworking within the operating theatre(55). Subsequent work therefore could focus on whether we can determine a correlation between ENT-NOTECHs and OTAS scores (Observational Teamwork Assessment for Surgery).

Additionally, further exploration of the relationship between ENT-NOTECH scores and technical skill may help to develop our understanding of the interaction between these skills and how they impact on patient outcomes. Can we determine a correlation between other Work Based Assessments (WBA's) such as Procedure Based Assessments (PBA's) and ENT-NOTECHS? And crucially, undertaking a more detailed assessment may help us to understand how teams respond when surgical errors occur, or indeed how teams act to mitigate the effects of unplanned complications and ultimately impact the overall outcome of the case.

We chose to run simulation scenarios which had a crisis, as it was felt that simulation in these rare stressful scenarios would be a unique learning opportunity for the whole team. Trainees in particular are rarely exposed to emergencies alone and often the consultant will naturally step up to a leading role in a crisis. Invariably however there will come a time where the trainee is now the junior consultant and suddenly thrust into the "hot seat". Being able to step up seamlessly with little or no experience is difficult and so it was hoped that these training days would help to provide some contextual experience for the trainee and the surrounding team. Alongside this, there is also evidence to suggest that crisis scenarios bring out extremes of behaviour which in turn are considered easier to rate on a behavioural skills marker. Consequently it may be difficult to generalize the findings from this study when applying this tool to a real life elective operating setting. Further work should now concentrate on using this tool in the operating theatre for both elective and emergency cases.

Initial data from trainees showed that they received the training well and were very positive in feedback. Feedback at 6 months also confirmed that they felt the skills learnt on this training day had helped them in real life emergencies. Unfortunately due to the time and financial constraints of this research, teams only underwent the one training day and whilst we were able to show that non-technical skills improved as a result of the training, it is not known whether this effect is sustained and indeed how often this training my need to be undertaken in order to maintain those skills. Further work could concentrate on learning curves; the acquisition of these skills and the maintenance of them. Simulation has the benefit here of offering repeated immersive practice of these skills, with no detriment to the patient. Repeated simulation in Non-technical skills should be a focus of safer surgical training and repeated team training as a whole should be encouraged by the various healthcare trusts. Engaging in regular team training in the NHS is reliant on releasing the staff to participate. There ultimately needs to be a culture change within management and a drive from the top down to enable these activities to take place: only then will we really be able to see the impact of organizational change and ultimately improved patient outcomes.

Self Assessment of non-technical skills or assessment of other trainees by trainees themselves may be another avenue to explore. The post simulation debrief is such an effective method to analyse behaviour and identify learning points, as it empowers the candidates to tease out their own thoughts and feelings about how a

simulation went and what could have been improved. Equally, the candidates who are not participating in the current simulation scenario and are observing the scenario together with the faculty, form an important role in giving feedback to the group, which in turn stimulates various topics for discussion and debate. Work could look into self assessment and assessment by trainees; to see if there is a relationship and to determine how trainees rate their own skills compared to their assessors.

The work presented in this thesis has largely been grounded in the ethos of patient safety and how we can improve that through improved non-technical skills of the operating team. However, we know through the systems approach to patient safety that the outcome of a case is dependent on a variety of factors; not just the technical or non-technical skills of the team, but also patient factors. Surgical patients may have role to play in their own safety; taking a more involved role in the decision making process, consent process and post operative course. Research has started to explore how patients can help to reduce their own susceptibility to medical errors, and is an area to consider in the overall "patient safety"(105, 106). Whilst this is outside the remit of this thesis, if we really are to make inroads into patient safety, then all aspects of the patient pathway need to be considered.

7.8 Personal Reflections

Since embarking on this research, I have been truly grateful for the opportunity and experience to help train and shape the next generation of ENT trainees and theatre teams. I can vividly recall hosting the first pilot MDT simulation day and the trepidation that people would not enjoy or engage in the training. This was certainly something new for the North Thames simulation trainees, who whilst they have a mandatory simulation programme, were usually used to attending simulation days with an emphasis on technical skills. How would they react to training in these softer skills? And how would the addition of anaesthetic trainees and scrub nurses be received? Whilst attendance for ENT trainees was mandatory, attendance for anaesthetists and scrub nurses were voluntary - was the course what they were expecting? Did I even fulfil my brief? I needn't have worried; from day one feedback has been exceptional, largely due to the "novel" concept of teams who work together training together. I was astounded that this very obvious and basic requirement is so rarely done.

Since that first pilot day, the ENT-NOTECHS simulation programme went from strength to strength over the intervening 15 months and I now feel a "mini expert' in my small field of non-technical skills simulation in ENT. This research has equipped me with confidence to talk about the importance of human factors in patient safety and I have gained so many skills relating to medical education and training. Whilst I feel incredibly privileged to have contributed to this field, it is also glaringly obvious that more work needs to be undertaken to continue to drive the importance of non-

technical skills in ENT surgery and to encourage teams who work together, to find the time to train together.

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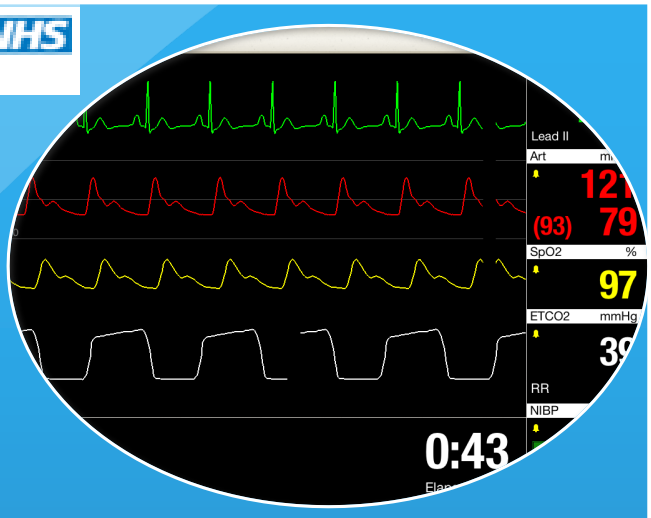
APPENDIX:

Appendix 1: Anaesthetic advertisement for recrutment of trainees

Imperial College Healthcare NHS
NHS Trust



Tuesday 22nd September 2016
St Marys Hospital
Clinical skills level 2
Patterson building

Multidisciplinary Simulation day for Anaesthetic and ENT trainees,

HOW would you cope in an airway emergency>
Do you have the skills?.....

We are running a FREE training day for Anaesthetic, ENT and nursing staff. (plus FREE lunch!) FIRST COME FIRST SERVED BASIS
Scenarios will cover a range of emergencies including difficult airway management, airway jetting, fibreoptic intubation, airway fires, and much more!
Come along and get to practice those rarely used skills in a safe life-like "high stress' environment. Be ready!

Please respond promptly…and allow enough time to put in study leave! Previous feedback has been excellent and a highly recommended day
Please contact: Jennifer_magill22@hotmail.com OR coll_woo@doctors.org.uk

Appendix 2: Sample timetable of simulation day.

IMPERIAL OTOLARYNGOLOGY AND ANAESTHETICS TEAM TRAINING DAY PROGRAMME
Simulation training in ENT/airway themed scenarios.

TRAINING DAY –Thursday 22nd September 2016.
St Marys Hospital, Paterson Building, level 2 clinical skills

Core Faculty	Mr Neil Tolley Mr G Mouchloulis	Consultant ENT Surgeon	Rhoda Winters Rhona Eslabra
	Mr N Dann	Air Accident Investigation Branch	Senior Theatre Nurse
	Miss Jennifer Magill Dr Tiffany Monroe-Gray Miss A Iacovidou	ENT SpR ENT SHO ENT SpR	
	Dr Dafydd Lloyd Dr Colleen Woo Dr John Myatt	Anaesthetic Cons	

9:00	Trainee welcome TEA AND COFFEE Tour of facilities, familiarization, airway equipment
10:00	Simulation 1: team one. scenario, consultant led assessment and de-brief.
11:00	Simulation 2: team two. scenario, consultant led assessment and de-brief.
12:00	Simulation 3: team three. scenario, consultant led assessment and de-brief.
LUNCH	
14:00	Simulation 4: team four. scenario, consultant led assessment and de-brief.
15:00	Simulation 5: team five. scenario, consultant led assessment and de-brief.
16:00	Trainee post assessment and feedback/evaluation of day.

Appendix 3: sample of scenario templates used in simulation days

Course – Scenario: Tonsil bleed
Patricia Smith
DOB: 31/4/1975
Hosp no: SM537779

<table>
<tr><th>Initial Candidate (s)</th><th>Reserve Candidate</th><th>Simulator Control</th></tr>
<tr><td>ENT SpR
Nurse/ Scrub
Anaesthetic SpR</td><td>confederate OPD</td><td rowspan="3"><u>Mannequin setup:</u>

<u>Initial Parameters</u>

A – patent
B – sats 100%
C – HR 90, BP 100/60
D –
E –</td></tr>
<tr><td colspan="2"><u>Candidate Briefing:</u>

This is the second case of the morning (of a 3 case list). The first case was an uneventful tonsillectomy, and the last case will be a PNS biopsy.

40 yr old lady listed for ML and laser to Right vocal cord lesion. (lesion on right vocal cord for excision biopsy with laser.) PMH: T1DM, HTN. NKDA. good exercise tolerance and previous uneventful anaesthetic for a right ORIF.

Pt is to be anaesthetised. Currently bag and mask by OPD. Commence procedure with the WHO form and proceed as appropriate.

First pt:
David Morris – tonsillectomy
CC568222
12/2/1981</td></tr>
<tr><td colspan="2"><u>Scenario Progression:</u>

• ISSUE1: Discussion re method of ventilation (jetting preferred by ENT: no laser proof ML tubes)
• WHO checklist completed - uneventful
• PRIOR to INDUCTION ….ISSUE 2: sudden arrival of recovery nurse….informs staff that previous pt found bleeding….sudden onset spurting from mouth

• Recovery nurse informs team that patient is being wheeled back to theatre….ISSUE 3: pt arrives in theatre, decision to cancel current case.
• ISSUE 4: Sats reducing, cardiovascular instability. Pt to be intubated, bloods to be sent off.
• ISSUE 5: no valid crossmatch.
• Boyle davis gag to be inserted and bleeding vessel identified. Haemostasis.
• ISSUE 6: nursing team interrupting asking about previous cancelled case and what to put on system as “cause for</td><td><u>Deteriorating Parameters</u>
A – coghing and spluttering,
B – reducing sats,
C – tachcardia, hypotension</td></tr>
</table>

Course – Supraglottitis: management of the difficult airway
Frank Sellwyn
DOB: 30/12/1944
Hosp No: SM778232

Initial Candidate (s)	Reserve Candidate	Simulator Control
ENT SpR Anaesthetic SpR Scrub Nurse	Confederate Nurse. Confederate Registrar	**Mannequin setup:** Reclined.
Candidate Briefing: Patient: 70 yr old male. he has been unwell for 4 days with a sore throat and fever, has attended A&E with DIB, and developed stridor. PMH: Diabetes, HTN, RA . NKDA. non-smoker. Acutely stridulous 70 yr old male patient who has just assessed in A&E by your registrar colleague. The FNE-showed a grossly swollen supraglottis, with minimal airway. impression: supraglottitis. The decision has been made to electively intubate the patient in theatre. You are the team in theatre having just completed your elective list. The on-call consultant has asked that the on site ENT team secure the airway. the scenario starts with the patient having just arrived in theatre.		**Initial Parameters** A – Stridor, unable to complete sentences B – RR 35, sats 89% via NRB mask C – HR 150, BP 135/75 D – alert E – temp - 38.5
Scenario Progression: • ISSUE 1 – quick/poor handover from ENT registar - unable to stay as has another emergency to see in another hospital. • pt in theatre - acutely stridulous, unable to speak in full sentences. • anaesthetist and surgical team to discuss options. • Discussion between surgeons and anaesthetists re plan if intubation fails. • attempt at awake fibreoptic intubation first • ISSUE 2 - Fibreoptic fails, attempts intubation • ISSUE 3 - intubation fails, proceeds to "cant intubate, cant ventilate" – DETERIORATING SATS as scenario progresses • Tracheostomy required. ISSUE 4 - cuff of 1st tracheostomy tube ripped. (if not picked up by ENT SpR, huge leak to be shown on anaesthetic machine) • Scenario endpoint: tracheostomy inserted and sats improved.		**Deteriorating Parameters** A – unresponsive B – RR 4bpm, sats 80% - 76% C – bradycardia, BP 120/60 Parameters continue to deteriorate until patient gets established airway.
Key confounders • Poor handover from Registrar colleague. • unable to intubate - all measures fail. (stiff neck, closed		**Imaging available** CXR - NAD

Appendix 3: ENT MDT simulation training evaluation form:

Imperial College Healthcare NHS Trust

ENT and Anaesthetic MDT Theatre Simulation Day - EVALUATION:	
Trainee name:	Date:
Trainee grade:	Speciality:
Have you attended any simulation training before?	YES / NO
If yes, please give details:	

Please indicate the extent of your agreement with the following statements:

	Strongly Disagree	Disagree	neutral	Agree	Strongly Agree
The simulation today addressed my learning needs	1	2	3	4	5
The scenarios in the simulations were realistic	1	2	3	4	5
The simulated environment was as realistic as a real operating theatre	1	2	3	4	5
The team interaction during the scenarios was realistic	1	2	3	4	5
The model was a realistic representation of the real procedure	1	2	3	4	5
I behaved in the same way i do in the workplace	1	2	3	4	5
My performance was similar to that in the workplace	1	2	3	4	5
The simulation replicated the likely level of stress amongst team members	1	2	3	4	5
The simulated procedure is a good method to train technical skills	1	2	3	4	5
The simulated scenario is a good method to train team skills and leadership	1	2	3	4	5
Participation helped me to improve my technical skills	1	2	3	4	5
Participation helped me to improve my teamwork and leadership skills	1	2	3	4	5
Scenario Simulation is useful to help increase confidence in managing real life crisis scenarios.	1	2	3	4	5

Comments:
What will you take away from today's simulation session?
Is there anything you would change about today? improvements?

Appendix 4: Pre and post ENT MDT sim attitudes and confidence questionnaire:

Imperial College Healthcare NHS
NHS Trust

ENT and Anaesthetic MDT Theatre Simulation Day - Pre/Post Questionnaire	
Name:	Date:
Grade:	Speciality:
Have you attended any simulation training before?	YES / NO
If yes, please give details: (please omit when filling out Post course questionnaire)	

Please indicate the extent of your agreement with the following statements:

	Strongly Disagree	Disagree	neutral	Agree	Strongly Agree
I have a good understanding of human factors in healthcare	1	2	3	4	5
I have a good understanding of the factors that contribute to error in surgery	1	2	3	4	5
Non-technical skills / human factors are important in surgery	1	2	3	4	5
Technical skills are important in surgery	1	2	3	4	5
I am confident in my technical ability to manage a crisis/ emergency	1	2	3	4	5
I am confident in my non-technical skills in managing a crisis/ emergency	1	2	3	4	5
I am confident to take control in an emergency	1	2	3	4	5
I am confident in my situational awareness skills	1	2	3	4	5
I am confident in my teamwork and leadership skills	1	2	3	4	5
I am confident in my communication skills	1	2	3	4	5
I am confident in my decision making skills	1	2	3	4	5
I feel confident managing airway emergencies	1	2	3	4	5
I understand the importance of a team brief and WHO checklist	1	2	3	4	5
I am confident to confront/ raise issues to other team members	1	2	3	4	5
I am confident to debrief my team	1	2	3	4	5
I believe training in non-technical skills for trainees is important	1	2	3	4	5
I believe assessment of non-technical skills is important for trainees	1	2	3	4	5

Appendix: 6 months post training questionnaire:

Imperial College Healthcare NHS Trust

ENT MDT Theatre Simulation Day – 6 month EVALUATION:	
Trainee name:	Date:
Trainee grade:	Speciality:
Have you attended any simulation training before?	YES / NO
If yes, please give details:	

Please indicate the extent of your agreement with the following statements:

	Strongly Disagree	Disagree	neutral	Agree	Strongly Agree
On reflection, I found the MDT simulation training day useful	1	2	3	4	5
Participation in the training day has improved my confidence managing crisis scenarios in the last 6 months.	1	2	3	4	5
Participation in the training day has improved my non-technical skills in the operating theatre over the last 6 months	1	2	3	4	5
I would benefit from repeating the simulation training again	1	2	3	4	5

Comments:
Are there any real life instances in the last 6 months which you feel were helped by attending the simulation day? Please give details:

Appendix 5: ENT -NOTECHS -surgeon

ENT and Anaesthetic MDT theatre simulation - Surgeon	
Trainee name:	Speciality and Grade:
Scenario:	Date:

Rating	n/a	0	1	2	3	4	5
	Not applicable	Not done	Done very poor	Done poor	Satisfactory	Done well	Done very well
ISCP rating:		Development required (D)			Satisfactory (S)		

TECHNICAL ASSESSMENT (GLOBAL):	n/a	0	1	2	3	4	5
Knows steps of operation and follows agreed logical sequence.							
Consistently handles tissues with minimal damage							
Uses instruments appropriately and safely							
Familiar with instruments and names							
Proceeds at appropriate pace with economy of movement							
Planned course of operation with effortless flow							
TECHNICAL ASSESSMENT (TASK SPECIFIC):							
Safe and diligent use of the laser							
Ensures adequate protection to teeth and gums from scope							
Inserts appropriate scope to visualize pathology and secures suspension device safely							
Demonstrates competency at efficient cutting technique with laser including economy of movement and avoidance of scatter/ eschar etc.							

CATEGORY	ELEMENT	n/a	0	1	2	3	4	5
PRE-OP CHECKS	gathers relevant information/ investigations and informs colleagues appropriately							
	liaises with anaesthetic team regarding anaesthetic plan for patient							
	if appropriate; specifically discusses contingency plan/Plan B with anaesthetist if airway concerns likely							
	gives effective briefing to team members							
	makes any relevant equipment checks							
	ensures WHO completed (consent and side of surgery checked) and any issues addressed							
COMMUNICTION AND INTERACTION	informs anaeasthetist that he/she is starting operation							
	waits for acknowledgement from anaesthetist							
	instructions to scrub nurse/ assistant clear and polite							
	waits for acknowledgement from scrub nurse/ assistant.							
LEADERSHIP AND MANAGEMENT	clearly follows theatre protocol and adheres to "best practise" during procedure. Eg no corner cutting							
	resource utilisation - appropriate task load distribution and delegation of responsibilities							
	Time management - appropriate time allocation; not too slow but does not rush team members							
	authority and assertiveness							
	remains calm under pressure							
TEAMWORK	maintains positive rapport with all team members							
	open to opinions of other team members							
	supportive of other team members							
	conflict handling - concentrates on what is right rather than who is right.							
SITUATIONAL AWARENESS	monitors patient parameters throughout procedure							
	awareness of anaesthetist							
	actively initiates communication with anaesthetist during crisis							
	anticipates potential problems and shows evidence of contingency plan (ie equipment on standby)							
DESCISION MAKING AND CRISIS MANAGEMENT	promptly identifies problem							
	clearly informs team of change in situation i.e emergency							
	outlines strategy and institutes a plan ie asks for suction, appropriate drug, airway equipment, glidoscope etc							
	asks for opinion of other colleagues / team opinion							

Appendix 6: ENT -NOTECHS - Anaesthetist

ENT and Anaesthetic MDT theatre simulation – Anaesthetist (ML)	
Trainee name:	Speciality and Grade:
Scenario:	Date:

Rating	n/a	0	1	2	3	4	5
	Not applicable	Not done	Done very poor	Done poor	Satisfactory	Done well	Done very well
ISCP rating:		Development required (D)			Satisfactory (S)		

TECHNICAL ASSESSMENT (GLOBAL):	n/a	0	1	2	3	4	5
Familiar with airway instrument names and demonstrates safe usage							
Demonstrates competent hand ventilation with bag and mask							
Demonstrates effective Pre-oxygenation of patient / optimizes patient prior to induction							
Knows steps of Induction and follows agreed logical sequence							
Familiar with anaesthetic drugs and doses							
Demonstrates ability to predict difficulty of airway and instigates appropriate plan							
TECHNICAL ASSESSMENT (TASK SPECIFIC):							
Adequately prepares airway (i.e local anaesthetic spray to vocal cords)							
Competent use of jet ventilation							
Appropriate choice of airway equipment for scenario							
Demonstrates competency at managing laryngospaam							

CATEGORY	ELEMENT	n/a	0	1	2	3	4	5
PRE-OP CHECKS	gathers relevant information/ investigations and informs colleagues appropriately							
	liaises with surgical team regarding anaesthetic plan for patient							
	if appropriate; specifically discusses contingency plan/Plan B with surgeon if airway concerns likely							
	gives effective briefing to team members							
	makes any relevant equipment checks							
	ensures WHO completed (consent and side of surgery checked) and any issues addressed/ actively engages in checklist							
COMMUNICTION AND INTERACTION	Instructions to surgeon clear and polite							
	waits for acknowledgement from surgeon							
	instructions to OPD clear and polite							
	waits for acknowledgement from OPD.							
LEADERSHIP AND MANAGEMENT	clearly follows theatre protocol and adheres to "best practise" during procedure. Eg no corner cutting							
	resource utilisation - appropriate task load distribution and delegation of responsibilities							
	Time management - appropriate time allocation; not too slow but does not rush team members							
	authority and assertiveness							
	remains calm under pressure							
TEAMWORK	maintains positive rapport with all team members							
	open to opinions of other team members							
	supportive of other team members							
	conflict handling - concentrates on what is right rather than who is right.							
SITUATIONAL AWARENESS	monitors patient parameters throughout procedure							
	awareness of surgeon							
	actively initiates communication with surgeon during crisis							
	anticipates potential problems and shows evidence of contingency plan (ie equipment on standby)							
DESCISION MAKING AND CRISIS MANAGEMENT	promptly identifies problem							
	clearly informs team of change in situation i.e emergency							
	outlines strategy and institutes a plan ie asks for suction, appropriate drug, airway equipment, glidoscope etc							
	asks for opinion of other colleagues / team opinion							

Appendix 6: ENT-NOTECHS – Nurse

ENT and Anaesthetic MDT theatre simulation – Nurse (ML)	
Trainee name:	Speciality and Grade:
Scenario:	Date:

Rating	n/a	0	1	2	3	4	5
	Not applicable	Not done	Done very poor	Done poor	Satisfactory	Done well	Done very well
ISCP rating:		Development required (D)			Satisfactory (S)		

TECHNICAL ASSESSMENT (GLOBAL):	n/a	0	1	2	3	4	5
Gowned and gloved appropriately							
Maintains a sterile field							
Ensures area draped appropriately (bottom 1st, top then 2 sides if needed)							
Correct handling of sharps							
Anticipates surgeons needs and has equipment ready as appropriate (eg suction)							
Maintains contact with surgeon and procedure (ie, trolley and eye contact)							
TECHNICAL ASSESSMENT (TASK SPECIFIC):							
Hands instruments to surgeon in a sterile manner							
Guides microlaryngoscopy instruments into field of view of microscope							
Has control of instruments (none on patient, dirty swabs removed etc)							
Counts and verifies swabs/instruments at end of procedure							

CATEGORY	ELEMENT	n/a	0	1	2	3	4	5
PRE-OP CHECKS	gathers relevant information/ investigations and informs colleagues appropriately							
	liaises with surgical team regarding equipment for operation							
	if appropriate; specifically discusses contingency plan/Plan B with surgeon regarding equipment on standby							
	gives effective briefing to team members							
	makes any relevant equipment checks							
	ensures WHO completed (consent and side of surgery checked) and any issues addressed							
COMMUNICTION AND INTERACTION	Instructions to circulating nurse clear and polite							
	waits for acknowledgement from circulating nurse							
	Instructions and questions to surgeon clear and polite							
	waits for acknowledgement from surgeon							
LEADERSHIP AND MANAGEMENT	clearly follows theatre protocol and adheres to "best practise" during procedure. Eg no corner cutting							
	resource utilisation - appropriate task load distribution and delegation of responsibilities							
	Time management - appropriate time allocation; not too slow but does not rush team members							
	authority and assertiveness							
	remains calm under pressure							
TEAMWORK	maintains positive rapport with all team members							
	open to opinions of other team members							
	supportive of other team members							
	conflict handling - concentrates on what is right rather than who is right.							
SITUATIONAL AWARENESS	monitors steps of procedure							
	awareness of all team members							
	actively initiates communication with team during crisis							
	anticipates potential problems and shows evidence of contingency plan (ie equipment on standby)							
DESCISION MAKING AND CRISIS MANAGEMENT	promptly identifies problem							
	clearly informs team of change in situation i.e emergency							
	outlines strategy and institutes a plan ie asks for suction, appropriate drug, airway equipment, glidoscope etc							
	asks for opinion of other colleagues / team opinion							