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RESEARCH

Errors and clinical supervision of intubation attempts by the inexperienced

VM Satyapal, CC Rout* and TE Sommerville

Department of Anaesthetics, Nelson R Mandela School of Clinical Medicine, University of KwaZulu-Natal, Durban, South Africa
**Corresponding author, email: rout@ukzn.ac.za*

Background: Tracheal intubation is an essential skill for anaesthetists and other disciplines that require emergency establishment of a secure airway. Early attempts in patients often meet with failure. Existing publications focus mainly on trainees in emergency settings and highlight the role of experience in success; most recommend prior simulation training. Common factors identified as contributing to difficulty have been difficult airways, emergencies and rapid sequence induction. Early intubation skill development in patients with anticipated straightforward airways in a controlled environment has received little attention.
Objectives: This qualitative observational study aimed to identify common difficulties associated with a supervised intubation process by inexperienced personnel in the relatively stress-free conditions of elective surgical procedures in the operating theatre.
Methods: Following institutional and ethical approval, participants, supervisors, anaesthetic assistants and patients consented to observation and video-recording of supervised intubations in a Durban teaching hospital. Anonymity and confidentiality were assured. Contemporaneous observations were recorded in theatre, and video-recordings were subsequently reviewed for content. Errors, and interactions between supervisor, assistant and participant, and associated outcomes, were identified.
Results: Twenty participants (medical interns and medical, paramedical and nursing students) performing 72 intubations were observed. All participants had prior training using manikins or simulators. There were 61 successful intubations and 11 unsuccessful attempts. Factors associated with failure included unfamiliarity with airway, equipment or process. Process errors included inadequate head positioning, laryngoscope handling and tracheal tube manipulation. Anaesthetic assistants contributed to difficulties in some cases. Supervisor support was either verbal, physical or both. Less experienced supervisors tended to intervene earlier. There was a significant trend for success associated with the reported number of prior successful intubations. A successful intubation within the study was, however, no guarantee of subsequent success.
Conclusion: Despite prior simulation training, many participants demonstrated lack of familiarity with the airway, intubation process and equipment. While improved simulation training might partly address these issues, supervision of early clinical intubation attempts needs to be redirected from the process of intubation itself to the process of intubation skills acquisition. A first step would be to ensure that all supervisors and assistants are trained for the latter goal, anticipating common errors and providing standardised conditions for success. The use of video-recording of the events is an invaluable aid to observation and interpretation, and is recommended as an adjunct to further studies of mechanical skills transfer.

Keywords: clinical supervision, core clinical skills, skills assessment, skills transfer, tracheal intubation, video recording

Introduction

Tracheal intubation is a core skill for South African interns before their community service year. Difficult or failed intubation accounted for half the deaths associated with general anaesthesia, and also featured as a direct cause of mortality in deaths associated with spinal anaesthesia in the last report into maternal deaths in South Africa.[1] Lack of skill in intubation in community service doctors has also been highlighted as a particular concern,[2] and intubation is an essential skill for other healthcare workers. Despite the importance of intubation, first attempts to intubate patients frequently fail, even following simulation training.

Success in intubation improves with experience,[3] and factors associated with failure include difficult airways and emergencies requiring rapid sequence induction (RSI).[4] Most studies have observed early intubation attempts in emergency departments or at remote sites; few have observed trainees in operating theatres, and none from the perspective of skills transfer of straightforward intubation in the uncomplicated patient. Indeed, the term 'skills transfer' usually refers to the transfer of an 'acquired' skill from one situation to another, rather than from one person to another. The initial process of learning a new skill is usually referred to as 'skills acquisition'; however, the latter term implicitly places the main burden of the process upon the aspiring recipient of the skill.

Similarly, the Conscious Competence learning model,[5] which illustrates the evolution of skills acquisition, again concentrates on the recipient of the process. This model describes four stages of transition, from an 'unconsciously incompetent' trainee, unaware of his/her lack of ability to carry out a task, to 'conscious incompetence' (awareness of a need to learn), to 'conscious competence' (awareness of what has been learnt), to the 'unconsciously competent' expert, who completes the task without having to actively recall each element of the skill. Transfer of the skill of intubation from the trainer to the trainee should aim to bring the trainee to the third stage ('conscious competence'), where the trainee is proficient at the skill, still requiring concentration and appreciation of the means required to attain success. It should be seen as a process involving both trainee and trainer.

In order to gain insight into this process of intubation skills transfer in our own institution, we felt that the first step would be to observe and record the process in a controlled environment, such as elective lists in the operating theatre.

The purpose of this observational study was to explore and document factors affecting success in early attempts at tracheal intubation by junior doctors and allied health trainees in a controlled clinical environment at a South African teaching hospital.

Methods

Following institutional ethics and gatekeeper approval, operating lists were identified that provided most opportunity for observation of intubation by personnel with little or no experience. Participants were recruited at convenience from all groups of students and medical and allied health personnel who required supervised intubation training. All patients were seen preoperatively by the principal investigator (PI) to exclude patients with features known to be associated with difficult intubation. Children, other vulnerable groups and patients requiring emergency intubation were also excluded.

Participants and their clinical supervisors gave written informed consent to observation and digital video-recording of the attempted intubations. Confidentiality was assured; the video-recordings were to be viewed only by the investigators. Patients also gave informed consent, with assurance that they would not be identifiable and their clinical details would not be documented. Patient anonymity was safeguarded by using a low camera angle that included only the bottom of the patient's chin and nose, whilst supervisor and participant were visible during the recording (i.e. unblinded).

Trainees were asked to complete a short questionnaire containing closed and open questions about prior intubation experiences and training.

The in-theatre observer, following initial consent and questionnaire administration, was in no way to participate with the training process or interact with participants and supervisors during or afterwards.

Following patient transfer to the operating table, a digital camera was positioned on a tripod beyond the foot of the table. The height, angle and focal length were adjusted to include the intubation action space, comprising the anaesthetic assistant, the anaesthetic machine, participant, and any intervention by the supervisor, precluding patient identification. The PI was positioned perpendicular to the patient's head to observe and record events that were subsequently matched to the video record.

A structured data sheet was used to document different elements of the intubation attempt, defined as time from removing the facemask following mask ventilation to removing the laryngoscope blade following either successful insertion of the tracheal tube or to recommence mask ventilation. As there is no globally standardised nor structured algorithm for intubation, the data sheet was constructed according to the anticipated sequence of the intubation process, namely: equipment checks, head positioning, mask oxygenation and ventilation, laryngoscope handling, insertion and securing of the endotracheal tube and checking for successful bilateral ventilation. Observations were documented both in theatre by the observer and at subsequent review of the videos.

Videos were subsequently reviewed by all authors, both individually and as a group, to confirm the data extracted and permit timing of successful intubation. Errors and difficulties were identified, described and grouped according to themes such as 'head positioning', 'laryngoscopy', etc. During video review, seminal errors (that appeared to be strongly influencing subsequent difficulties with or failure of intubation) were identified where possible.

Supervisor responses to participants' difficulties or failure were noted, as were the actions of the anaesthetic assistant. Attempts by participants observed on more than one occasion were compared. Review of the videos was a qualitative visual content analysis using a constructivist/interpretive approach where data were allowed to emerge rather than sought. No statistical analysis was planned beyond simple descriptive summary statistics and there was no preliminary power analysis, as there was no predefined quantitative outcome variable. However, a priori 60 to 100 observed events were considered likely to provide sufficiently accurate point estimates for an exploratory study of this nature. The study was to continue for five weeks, spread over a three-month period according to the availability of the principal investigator or until no novel events were occurring (data saturation).

Results

There were 20 participants from various disciplines (Table 1). Seventy-two observations were obtained from the 20 participants, some of whom were observed more than once.

Questionnaire findings

All participants reported having received supervised training on some sort of intubation manikin or more sophisticated simulator, and the majority (14) felt able to intubate a patient. Fifteen had already attempted intubation under supervision before entry to the study; 10 reported having experienced difficulties. In 15 of the reported unsuccessful attempts, the supervisor had pointed out their mistake and allowed a second attempt; in seven the supervisor had taken over. With two exceptions, participants conceded that they required more training (Table 2).

Of the 72 attempted intubations observed, 49 were oral intubations (including four planned rapid sequence inductions) and 23 nasal intubations. There were 61 successful and 11 unsuccessful intubations. Sixty-eight were video-recorded. (Three were unrecorded due to equipment difficulties and in one the participant declined.)

Oral intubation

Thirty-eight (78%) oral intubations were successful, 30 on the first attempt and eight on a subsequent attempt. Of the eight requiring more than one attempt, two self-corrected and the remainder were successful with either verbal or physical assistance or both.

Table 1: Number of participants from each discipline

Discipline	No.
Medical interns	8
Medical officers new to anaesthesia	1
Paramedics	1
Paramedic students	4
Nursing students	1
Medical students	3
Overseas exchange medical students	2

Table 2: Participant responses to questionnaire

Factor		No.
Problems encountered during training	Junior anaesthetists hesitant to allow interns to intubate	1
	Fear of intubation	1
	Left-handed	2
	Laryngoscope handling	2
	Visualising the vocal cords	3
	No difficulties	10
Exposure to simulation	All reported prior successful simulation training; detailed information on the type of training was not sought	20
Previous intubations supervised by	Anaesthetic consultant	10
	Anaesthetic registrar	11
	Paramedic instructor	2
Supervisor response to unsuccessful attempt	Supervisor took over	7
	Pointed out mistake and allowed second attempt	15
Difficulties during unsuccessful attempt	Patient factors (obese)	2
	Difficult airway	1
	Head position	1
	Laryngoscope handling	1
	Displacing tongue	1
	Wrong size laryngoscope blade	1
	Blade too deep; visualising oesophagus	1
	Secretions	2
	Visualising cords	8
	Guiding the endotracheal tube through the vocal cords	2
	Unsure of technique/remembering the order of steps	2
	Tissues softer than rubber manikin	2
	No difficulties	2
Confidence in intubation (n = 19)	Yes	14
	No	5
More training required (n = 19)	Yes	17
	No	2

Table 3: Relationship of reported prior intubations to observed successes

Successful intubations/total attempted within the study	Previous intubations attempted prior to study			
	0	< 10	10–20	> 20
	5/10	12/16	31/32	11/11

There were 11 failed intubations (nine participants; two failed twice). Four of these participants were making their first clinical attempt (three were talked through the process beforehand). All four were allowed more than one attempt, but demonstrated difficulty in identification of landmarks and failure to grasp the correct sequence of actions; one participant failed twice in two consecutive patients, however the second 'failure' was associated with early supervisor intervention due to concern over the haemodynamic response to intubation in a hypertensive patient. This case was removed from analysis as it did not represent a participant-related failure.

The other five participants had made previous attempts on patients. There was one unanticipated difficult airway. Despite a satisfactory preoperative assessment, the participant had difficulty displacing a large tongue, to reveal a grade three laryngoscopy where only the epiglottis was visualised, necessitating senior intervention. Another had been successful previously and then failed (early supervisor intervention), had a subsequent success and then failed again. Both failures were associated with poor laryngoscope technique: the second failure was also associated with failure to insert a reinforced tube through moving cords. A third participant had three successful intubations, followed by a failure to insert a reinforced tube through moving vocal cords, and then two subsequent successes. The remaining two participants had been previously successful (unrecorded) and then failed. One was left-handed and failed despite several manoeuvres and supervisor assistance. The other failed to obtain a view of the cords at laryngoscopy, returned to mask ventilation following desaturation, then failed again, and the supervisor completed the intubation without difficulty.

There were five cases when a reinforced tube with an introducer was used, three of which failed, and there were four planned rapid sequence inductions in elective cases, indicated by an increased risk of regurgitation, all of which were successful.

Prior experience

Four of five participants with no previous experience were unsuccessful (one twice), giving five successes out of 10 attempts. The proportion of successful attempts increased (Fisher's exact probability, $p = 0.00082$) with the reported number of intubation attempts before entry to the study (Table 3).

Within the study there was no pattern of success between initial and subsequently observed successful intubations, as in three cases failure was preceded by a prior success. Similarly there was no clear pattern in the time taken to achieve successful intubation in those participants with several previous successes.

Mean time to success with oral intubation was 95 seconds (median 94, IQ range 60–125).

Omission of muscle relaxant

In two cases the neuromuscular blocking agent was omitted because nerve blockade was planned using motor nerve location by electrical stimulation. Both participants failed to intubate.

Patient positioning

In 14 attempted oral intubations, head position initially either did not conform to the generally accepted 'sniffing the morning air' position (neck flexed on shoulders, head extended on neck) or was awkward to maintain, and was changed in order to improve laryngoscopy view. In two, a pillow or head-ring was added, and in another two the supervisor lowered the head of the bed. A head-ring was removed on another occasion. Four patients had large hairpieces, and five cases were intubated on a trolley (height unadjustable) rather than the adjustable theatre table, for the purposes of transferring the patient into the prone position, requiring participants to bend into a suboptimal position. These manoeuvres appeared to be mainly successful,

with only one subsequent failure to intubate, which was also in association with laryngoscopy handling, tube insertion, assistant and supervisor errors. In three the malpositioning was relatively minor and easily remedied

Laryngoscopy

Of the 38 successful oral intubations, 10 demonstrated laryngoscopy difficulties that were corrected. However, in the 11 failed attempts there were eight laryngoscope handling errors; in seven of these, the attempt did not progress beyond the failed laryngoscopy.

In all 72 cases in which a laryngoscope was used, 51 laryngoscopy errors were observed. Twelve were associated with incorrect prior head positioning, 13 were associated with inappropriate wrist movement to view the cords, nine with inadequate displacement of the tongue, and eight with insertion of the laryngoscope on the wrong side of the mouth (of which two intubations were subsequently successful and six unsuccessful). Three participants received the laryngoscope in the wrong hand and attempted laryngoscopy before self-correction and six participants inserted the laryngoscope blade too far. Also, two participants making their first clinical attempt at intubation were unfamiliar with anatomical landmarks relevant to visualising the cords, which might have been associated with advancing the laryngoscope along the wrong line. More than one error was observed in several attempts.

Manoeuvres to improve laryngoscopy followed by intubation success

Manoeuvres to optimise laryngoscopy view following a failed initial attempt were associated with subsequent successful intubation in four cases. These were repositioning the head, application of laryngeal backward-upward-rightward-pressure ('BURP'), changing laryngoscope blade size, and the use of suction. In four other cases, the supervisor obtained an adequate view of the cords and allowed the participant to pass the tube.

Error clusters for oral intubations (Tables 4 and 5) indicate that in both successful and unsuccessful intubation attempts several errors may combine. Most difficulties appeared to be in association with head positioning and laryngoscope handling. The latter featured more prominently among the failed intubations.

Nasal intubation

All participants attempting nasal intubations had accomplished previous successful oral intubations. All 23 nasal attempts were successful, four using a 'blind' technique. The ENT and maxillo-facial lists presented the highest number of intubation training opportunities; hence, the relatively high number of nasal intubations in the study. Trainees who had successfully intubated nasally using a laryngoscope and Magill forceps were allowed to attempt a blind nasal intubation to improve their range of skill.

Table 4: Error clusters in successful oral intubations

Most serious error (*n*)	Associated errors			
	HP	LH	TI	AE
Head position (HP) (*n* = 10)		5	3	1
Laryngoscope handling (LH) (*n* = 10)	1		0	1
Tube insertion (TI) (*n* = 2)	0	0		0
Assistant error (AE) (*n* = 1)	0	0	0	

Nasal intubations took longer, with additional time spent inserting the tube through the nostril, or difficulty experienced manipulating the tube with the Magill forceps (four participants). All nasal intubations were confirmed with laryngoscopy.

Mean time to success with nasal intubation was 115 seconds (median 103, IQ range 92–190). As with oral intubations, there was no clear trend in time-to-success amongst participants who were observed more than once.

The supervisors

Experience of 16 supervisors is given in Table 6. One intubation was taken over by a less experienced supervisor after one failed attempt at laryngoscopy with no change in oxygen saturation. The same supervisor allowed another participant multiple attempts to optimise his/her view at laryngoscopy with no deterioration in saturation, and then proceeded to take over the intubation. One intubation following a successful laryngoscopy was taken over due to concern about a hypertensive intubation response.

Two intubations were taken over after the participants struggled to pass the tube through moving vocal cords following omission of muscle relaxant. (Both attempts were supervised by the same consultant.) In one attempt, the participant succeeded at laryngoscopy, and in the other the participant required senior assistance with laryngoscopy and still failed.

One intubation was taken over by a non-consultant supervisor following desaturation and a further attempt at laryngoscopy once the saturation was optimised. This attempt also failed despite supervisor assistance.

Two of the four first attempts at intubation were supervised by consultants, and two by non-consultant anaesthetists. In all four, the supervisors allowed multiple attempts. Both medical officers and one consultant talked the participant through the procedure before the attempt, and one consultant demonstrated the procedure after the first failed attempt.

Participants were physically and verbally supported by their supervisors, with a tendency to start with verbal supervision first and progress to physical assistance. There was more verbal assistance during first-attempt success, and equal verbal and physical assistance in multiple-attempt success.

In six observations, the process was demonstrated and discussed by the supervisor before the attempt. This was in the scenario of a less experienced participant with an experienced (> 1 year) supervisor. In six observations the process was discussed during the attempt, usually where the participant was less experienced and struggling.

The anaesthetic assistant

The anaesthetic assistant was always a theatre nurse. In three cases, the assistant was unsure of the intubation process and could not optimally assist. In another three, the tube was passed to the participant with the cuff inflated, and in one observation the assistant was unfamiliar with laryngeal 'BURP'. Airway equipment (laryngoscope and airway) was checked by the anaesthetic assistant in 62/72 observations. In the remaining 10, the supervisor checked in five and the participant in five.

Of the oral intubations, participants took the tube from the assistant by grasping the top in 21 observations, and the middle

Table 5: Error clusters for failed oral intubations

Seminal error (*n*)	Associated errors					
	HP	LH	TI	AE	SE	U
HP (*n* = 1)		1	1	1	1	0
LH (*n* = 7)	**3**		**3**	**2**	**0**	**2**
TI (*n* = 1)	0	0		0	0	0
AE (*n* = 0)	0	0	0		0	0
Supervisor error (SE) (*n* = 0)	0	0	0	0		0
Unfamiliarity with airway, process, equipment (U) (*n* = 0)	0	0	0	0	0	

Table 6: Experience of supervisors

Supervisor	No.
Specialist anaesthetist (consultant)	5
Medical officer following completed registrar training	6
Registrar in training	1
Medical officer > one year's experience	2
Medical officer < one year's experience	2

in 24, usually because the assistant was holding the tube at the top. Holding the tube in the middle was clearly associated with insertion in short, shuffling movements rather than one smooth action. This was never associated with a failed intubation, but was an unnecessary distraction, wasted time, and might prove problematic in the face of a full stomach RSI, where upper airway stimulation should be kept to a minimum.

Discussion

Skill acquisition has three phases: initial instruction (learning 'how to'), practice (developing the skill with the safety-net of supervision), and experience (becoming 'expert' by repetition and adaptation to new circumstances, without external feedback and correction).[5] Before developing unsupervised experience, the point of conscious competence must be reached. The focus of our study was the journey from incompetence to conscious competence, and obstacles along the way. For transfer of skill from expert to novice, much depends upon firm groundwork and the ability of the supervisor to recognise the next required step.[6] Neither was particularly evident in our study.

On the positive side, the proportion of successful intubations in the study increased steeply in relation to the reported number of previous clinical attempts, consistent with existing evidence that previous intubation experience is associated with subsequent success.[3,7] However, neither our study nor the literature[8–11] suggests that 20 prior attempts might reliably predict subsequent success, even in a controlled, supervised environment. Given the reduced numbers of tracheal intubations performed for elective surgical cases for which supraglottic airway devices are used, adequate supervised training may not be achieved within the locally recommended[12] 40 general anaesthetics required within a two-month anaesthetic internship. Trainees in allied health-care disciplines are likely to gain even less from their brief attachments to the operating theatres.

Elements associated with failed intubation have been divided into operator-, disease- and patient-related factors.[13] Our exclusion criteria largely removed the last two, but failed to anticipate the influence of the assistant and supervisor on operator performance. In observing performance, three broad themes emerged: head positioning, laryngoscopy and tube handling, the first two being evident from the error clusters for success and failure; the last, while not contributing to failure, impaired the ease and speed of intubation.

The commonest (almost universal) mistake in head positioning was the absence of a pillow. In only one case was a pillow used to assist intubation, in a moderately obese patient. In two cases, supervisors actually dropped the head of the table in an attempt to help. Many participants struggled to position the patient's head and neck, in association with difficult or failed laryngoscopy. The scarcity of pillows in resource-constrained hospitals should be regarded not as an inconvenient laundry issue but as a serious lack of vital equipment.

The assistant transferring the laryngoscope to the operator's right hand, offering the ET tube with the cuff inflated, or holding it towards the top so that the operator has to grasp it in the middle, were noted to distract the trainee in an already unfamiliar process, setting the scene for difficulty and possible failure. We recommend that assistants should be trained in handling equipment (and the provision of laryngeal displacement) so as to maximise chances of success. Alternatively, the supervisor should take the assistant's place for the tyro's first few intubations, permitting guided introduction of the tube from the right rather than in the midline, without obstructing the laryngoscopic view. The supervisor would also be optimally placed to look over the trainee's shoulder if required. Successful transfer of a clinical competency is said to depend on engagement and empowerment of the trainee, organisation of the environment to permit supervision while maintaining patient safety, and maximising learning with monitoring, assessment and feedback.[14] Our observations suggest that supervisors and assistants should be trained with these requirements in mind.

We observed supervisors intervening only when failure had occurred, seldom when equipment handling or patient positioning was incorrect. If training and evaluation are restricted to the sole outcome of placing the tube in the correct position, the structure is flawed. Obsession with successful tube placement is understandable on the part of the participant, but unnecessary on the part of the supervisor, who is immediately available to accomplish the task. While intubation itself is an appropriate end, the skills transfer process demands that the means to the end are also appropriate, which is where the supervisor should focus. Many of the 'successful' participants somehow managed to achieve intubation while working around errors of technique. This is highlighted by the participant who failed on two observed occasions due to poor technique, later managed to intubate successfully despite making the same errors, and later was recorded supervising other participants while still making the same errors. Thus might perseveration of error become normalisation of deviance. Whilst this seemingly had little impact in the controlled theatre environment, it could cause problems when the skill is being transferred to new unsupervised situations.

The Difficult Airway Society Guidelines[15] recommend the use of muscle relaxant for optimal conditions. Our findings support this; the omission of muscle relaxant on two occasions was associated with failure. We suggest that it is an error of judgement to allow an inexperienced trainee to attempt intubation under suboptimal conditions (although, in fairness, supervisors did

explain the issues and gave participants the chance to opt out). Similarly, trainees' awkwardness using reinforced tubes with introducers suggests that non-standard intubation techniques or equipment should be reserved for trainees consciously competent in the use of standard equipment under optimal conditions.

While simulation training (on a manikin or simulator) was not the subject of this study, all participants had received such training prior to their in-theatre exposure. Given the limited number of clinical opportunities and the need to prevent the totally naive from practising on patients, there is clearly a place for simulation training. Refuting any assumption of a straightforward transition from simulator to patient, participants reporting no prior *clinical* experience struggled, showing little understanding of airway anatomy, equipment and process; similar findings have been reported elsewhere.[3,7,16] Simulation in airway training has been part of most international recommendations,[17] but despite the advantages shown for intermediate outcomes such as trainee satisfaction, skills acquisition and behaviour-process, simulation has not yet been demonstrated to have a significant impact on patient outcomes.[7,18–20]

Possible reasons why tracheal intubation training simulation may be ineffective, if this were the case, are first the inadequacy of the plastic airway models that are used, and second the way the training is performed and its results evaluated. 'A map is not the territory it represents';[21] to be of value the map's structure has to be similar to that of the territory. Two participants emphasised that intubating a rubber manikin is very different from human tissue, and inadequacies of design could explain other participants' inability to identify anatomical landmarks. Similarly, the training process itself (and subsequent evaluation) has to be mapped to the nature of the task.

As an exploratory exercise, this study was understandably small in terms of participant numbers, although a sample size of 72 observed events provided much information, and no novel events were occurring before the end of the study (data saturation). Other than the preliminary questionnaire, we were not looking for specific information and were prepared to allow natural emergence of events from the observed intubations. The use of video-recording was a novel approach for us and afforded detailed analysis of events, many of which might have gone unnoticed without the ability to 'freeze-frame' and 'rewind'. The method has been used extensively in video-reflexive ethnography, and training and assessment of both technical and non-technical clinical skills as an adjunct to reflective practice,[22] but we are unaware of its research use in the clinical setting of intubation training.

The method of video-recording required familiarisation of the PI with the equipment and sometimes, in an effort to ensure patient anonymity, a full view of the patient's mouth and chin was not obtained. The main limitation of the study was the convenience sampling of participants and restriction to one training centre, so generalisability of findings beyond our study participants is limited. However, our experience is likely similar to other centres in South Africa or elsewhere in the developing world.

Further investigation into the quality and benefit of simulation and clinical training with video assistance (for both performance assessment and the use of video laryngoscopy as a teaching aid particularly within the context of video-assisted deliberate practice) is warranted. Intubation should be broken down into its individual components as a valid (testable) construct for training and evaluation under optimal conditions. Supervisors and assistants should be trained around the construct with a focus on the skills transfer process rather than the process of intubation itself, anticipating common errors and providing optimal conditions for success. Creation of a basic algorithm for straightforward intubation may also assist during early training, and as a guide in emergencies.

Conclusion

In this study, we have shown that prior experience, if closely resembling the skill being learnt, is associated with subsequent performance—but not invariably or reliably with success. While our exclusion criteria attempted to standardise or negate the effect of two of Lim's[13] factors, we discovered a triad involved in the third: the intubator, the assistant and the supervisor. We noted three potentially problematic phases of the skill being learnt: positioning of the patient's head, use of the laryngoscope, and manipulation of the ET tube. While trainees improved with time, individual intubation attempts could be helped or hindered in each phase by the action or inaction of supervisor and/or assistant, in making more explicit the manoeuvres leading to conscious competence upon which the trainee could build expertise. We noted that determination to pass the ET tube led to trainees modifying their own technique, and, in one example, passing on this suboptimal technique to others. We conclude that step-by-step analysis of the intubation sequence and explicit training of supervisors, anaesthetic assistants and trainees is likely to better facilitate the process of skill acquisition.

Disclosure statement – The study was approved by the Biomedical Research Ethics Committee of the University of KwaZuluNatal (BREC, BE 489/14) and formed part of the research component towards Dr Satyapal's MMed degree. Prof Rout and Prof Sommerville co-supervised the project. Some of the results were presented in poster format at the 2017 annual conference of the South African Society of Anaesthetists held from 22–26 March 2017 at the Sandton Convention Centre, Johannesburg. The authors have no other conflicts of interest to declare.

Author contributions – VM Satyapal: Conceptualisation, design, collection, analysis and interpretation of data, drafting and critical revision of important scientific content, writing and revision of submitted article. CC Rout and TE Sommerville: Conceptualisation, design, analysis and interpretation of data, drafting and critical revision of important scientific content, writing and revision of submitted article.

ORCID

VM Satyapal http://orcid.org/0000-0002-1206-9350
CC Rout http://orcid.org/0000-0003-1767-3343

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