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RESEARCH

Intubation and mechanical ventilation: knowledge of medical officers at a South African secondary hospital

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Background: Medical officers frequently need to initiate the management of critically ill patients requiring endotracheal intubation and mechanical ventilation. The knowledge of hospital-based medical officers at a South African secondary hospital was evaluated on indications for endotracheal intubation and the initiation of mechanical ventilation in adults (defined as persons aged 13 years and older).
Method: Data were collected through questionnaires using 18 multiple-choice questions. Questionnaires consisted of a short test on the basic principles of intubation and the initiation of mechanical ventilation.
Results: Forty-four medical officers participated in this study, conducted in 2008. The mean test score for medical officers taking the test was 6.2, with a range of 2–10, out of a possible 15 marks. 77.3% of participants answered fewer than half of the questions correctly. Nobody answered more than 70% of the questions correctly. More than two thirds of the medical officers could not correctly identify indications for endotracheal intubation, 97.7% of medical officers could not correctly identify all of the contraindications to orotracheal intubation, and 97.7% were unable to choose appropriate initial ventilator settings.
Conclusion: Most medical officers at this secondary hospital were lacking in essential knowledge needed to make decisions on which patients required intubation and how to initiate mechanical ventilation. Pre- and postgraduate training on these basic principles needs to improve.

Keywords: artificial ventilation, intubation, knowledge, mechanical ventilation, medical officers, secondary hospital

Introduction

Emergency medicine physicians frequently need to manage critically ill patients who require endotracheal intubation and mechanical ventilation.[1] These physicians often include medical practitioners on the multidisciplinary team without any specialist qualifications.

Doctors working in the intensive care unit (ICU) at the secondary hospital where this study was conducted are frequently called upon to assist medical officers in the casualty department and wards with intubation and the initiation of mechanical ventilation. It seems that hospital-based medical officers have difficulty recognising patients needing respiratory support, and struggle with endotracheal intubation and the initiation of mechanical ventilation.

Intensivists are a rarity in Africa, according to Bhagwanjee. Most patients are cared for by doctors in the basic specialities.[2] Skilful airway management is the first step in the successful resuscitation of a compromised patient.[3] Endotracheal intubation is an effective means of ensuring a patent airway, as well as adequate ventilation and oxygenation.[4] Therefore, it is important for the emergency physician to recognise a patient who needs intubation and ventilation, and to have working knowledge of the basic principles of positive-pressure mechanical ventilation.[1]

We attempted to evaluate the knowledge of hospital-based medical officers on indications for endotracheal intubation and the initiation of mechanical ventilation in adults in this descriptive study.

Method

The study was conducted at a 562-bed secondary hospital in South Africa. Patients were primarily seen by the Department of Family Medicine, after which they were referred to the appropriate departments or disciplines.

Data were collected in the form of questionnaires. Each questionnaire consisted of a short evidence-based intubation and mechanical ventilation test, administered with the purpose of measuring the knowledge thought to be necessary when deciding on intubation and safely initiating ventilation in an adult patient.

A total mark was calculated for the knowledge questions. One was allocated for every correct answer. If there was more than one possible answer to a question, a mark was allocated, but only if all of the possible correct answers had been given. Negative marking did not apply. If a question was omitted or was not answered, it was assumed that the participant did not know the answer, and no mark was allocated for that particular question. The answers to the knowledge questions were calculated out of 15 marks.

The protocol was approved by the Ethics Committee of the Faculty of Health Sciences, University of the Free State, on 11 November 2008. The questionnaires were completed anonymously and results treated confidentially. No prejudice or harm was intended towards any participant or particular department. Consent to perform this study at the hospital was obtained from the hospital management. Consent to publish the study was obtained from the medical director of the hospital.

The results of the study were used to identify gaps in the knowledge of the medical officers.

Selection and description of participants

Doctors working in departments in which adult patients requiring intubation and mechanical ventilation are often encountered were evaluated. The number of doctors in each department is shown in Table 1.

Medical officers working in the departments detailed in Table I were included in the study. Medical officers included community service medical officers, as well as senior, principal and chief medical officers. Persons with a postgraduate qualification in any medical or surgical speciality were not included in the study. By completing the questionnaire, the participants voluntarily agreed to participate in the study.

Statistics

Results were summarised by means of percentiles (numerical variables) and frequencies and percentages (categorical variables).

Results

Forty-four out of a possible 50 medical officers (88%) completed the questionnaire. Most of the participants were in the Department of Surgery. The characteristics of the medical officers are listed in Table 2.

The mean test score for medical officers taking the test was 6.2, with a range of 2–10, out of a possible 15 marks. The mean test scores for each department are shown in Table 3. The median test score for medical officers with previous intensive care unit (ICU) experience was 6.5. The median test score for medical officers with no previous ICU experience was 6.

The performance of the medical officers with respect to the specific test items is shown in Table 4.

Thirty respondents (68.2%) did not recognise all of the appropriate indications for endotracheal intubation with the use of a laryngoscope. However, 16 respondents (36.4%) correctly identified two of the three indications for intubation. These 16 respondents failed to comprehend that, in addition, intubation may be indicated for the endotracheal administration of drugs during resuscitation when intravenous access is difficult to obtain.

Only one respondent (2.3%) could correctly identify all of the contraindications to orotracheal intubation with the use of a laryngoscope in adults. Eleven respondents (25%) correctly acknowledged one of the possible two causes, but did not recognise infectious processes, such as epiglottiditis, as a contraindication to orotracheal intubation. However, they considered traumatic or severely degenerative cervical spine disorders to be a contraindication to orotracheal intubation.

Twenty-eight respondents (63.6%) correctly said that the gas values in arterial blood are not a requirement for the diagnosis of respiratory failure. Thirty-eight respondents (86.4%) correctly indicated that supplemental oxygen should be given to a patient before intubation.

Only 12 respondents (27.3%) correctly identified the two possible mechanisms of acute respiratory failure.

Only 14 respondents (31.8%) correctly recognised the signs of respiratory failure. However, 12 respondents (27.3%) were familiar with three of the four signs of respiratory failure. These 12 respondents failed to comprehend that bradypnoea could also be a sign of respiratory failure.

Twenty-two respondents (50%) correctly said that oxygenation was the main goal of ventilation in septic or haemorrhagic shock. Another 11 respondents (25%) indicated that the main goals of ventilation in this regard were to optimise peripheral perfusion and oxygenation, although the instructions were to choose the most appropriate answer when answering the question.

Only three respondents (6.8%) knew that ventilator modes may be preset to deliver a target inspiratory pressure or a target tidal volume. Thirteen respondents (29.6%) indicated that a ventilator breath, in addition, could be preset to deliver a target minute volume. Thirty-seven respondents (84.1%) correctly noted that mechanical ventilators are not designed to give mandatory breaths only.

Forty-three respondents (97.7%) could not recognise the typical ventilator settings when initiating mechanical ventilation in adults. Of these, 46.5% chose a maximum positive end-expiratory pressure (PEEP) level that was much higher than the recommended value.

Table 1: Number of doctors working in each department

Department	Doctors
Family Medicine	11
Surgery	13
Orthapaedic	5
Obstetrics and Gynaecology	8
Urology	3
Internal Medicine	10

Table 2: Characteristics of the participants

Characteristics	Percentage of participants
Medical officers by department	
Family Medicine	15.9
Surgery	34.1
Orthapaedic	11.4
Obstetrics and Gynaecology	18.2
Urology	2.3
Internal Medicine	18.2
Medical officers with ICU experience	
Any previous ICU experience	27.3
No previous ICU experience	72.7

ICU: intensive care unit

Table 3: Mean test scores for each department

Department	Test score*
Family Medicine	7.3
Surgery	5.7
Orthopaedic	6.6
Obstetrics and Gynaecology	4.9
Urology	7
Internal Medicine	7.1

* Test scores indicate the mean test score out of a possible 15 marks

Thirty-two medical officers (72.4%) could not identify the appropriate initial tidal volume per kg of ideal body weight for a patient with acute respiratory distress syndrome (ARDS). Seventeen participants (38.6%) said that they would have provided a tidal volume that was double the recommended 6 ml/kg of ideal body weight. A further 13 (29.6%) suggested that they would have provided an even higher tidal volume.

Thirty-four respondents (77.3%) recognised that it is not advisable to set the respiratory rate higher in severe airflow obstruction in order to improve oxygenation.

Forty-two participants (95.5%) recognised that PEEP is the most effective way of recruiting collapsed alveoli and improving oxygenation in diffuse lung injury or lung infiltration.

Eleven respondents (25%) correctly identified midazolam as a pharmacological agent used during intubation that may produce a drop in blood pressure. However, 11 respondents (25%) suggested that midazolam and rocuronium were both pharmacological agents used during intubation that may bring about a drop in blood pressure. Only three respondents (6.8%) could identify all of the contraindications to the use of suxamethonium as a neuromuscular blocking agent during adult intubation.

Discussion

The principal aim of the study was to determine whether hospital-based medical officers at this secondary hospital had difficulty in recognising patients in need of respiratory support, and if they struggled with endotracheal intubation and the initiation of mechanical ventilation.

We found that 77.3% of the participants answered fewer than half of the questions correctly. Nobody answered more than 70% of the questions correctly. More than two thirds of the medical officers could not correctly identify the indications for endotracheal intubation. Furthermore, 97.7% of the medical officers could not correctly identify all of the contraindications to orotracheal intubation, while 97.7% of the medical officers could not select the appropriate initial ventilator settings.

Deductions on the different departments could not be made since the number of participants in some of the groups was very small. Although the previous ICU experience of participants was taken into account, this study did not investigate for how long the medical officers worked in ICU, and how long ago that exposure occurred. However, the results of the two groups were very similar.

The results of this study indicated that medical officers at this secondary hospital did not have adequate knowledge on the indications for intubation and the safe initiation of mechanical ventilation.

Better results were reported in a study by Cox and Carson.[8] In this study, knowledge, considered by a panel of experts to be necessary for graduating internal medicine residents to provide effective care for ventilated patients, was measured. The study by Cox and Carson was conducted on a different target group using questions that were appropriate to what was expected from the group in terms of knowledge. However, their conclusion was also that, during training, many senior internal medicine residents did not gain important evidence-based knowledge needed to provide effective care to patients requiring mechanical ventilation. They found that 10% of residents answered less than half of the questions correctly, and that more than one third answered less than 70% of the questions correctly. Almost half of the residents could not identify an appropriate tidal volume for a patient with ARDS. Of these, 85% indicated that they would have provided a tidal volume nearly double the recommended 6 ml/kg of ideal body weight.

The findings in the current study should be placed in context. Intensivists are a rarity in Africa and most patients are cared for by doctors in the basic specialities.[2] Also, skilful airway management remains the first step in the successful resuscitation of a compromised patient.[3]

Although we do not advocate that medical officers have such a detailed understanding of ventilator issues, as that required by intensivists, several cornerstones of management should be emphasised to medical officers so that the management of critically ill patients can be optimised.

Table 4: Specific test items that were answered correctly by the medical officers

Specific test items	Percentage of answers answered correctly
Indications for endotracheal intubation[1,3-6]	31.8
Contraindications to intubation[3,4]	2.3
Blood gas values that are not mandatory when diagnosing acute respiratory failure[6]	63.6
Need for supplemental oxygen before intubation[4]	86.4
Mechanisms of acute respiratory failure[1,6,7]	27.3
Clinical signs of respiratory failure[5,6]	31.8
Goal of ventilation in septic or haemorrhagic shock[6]	50
Target settings for ventilator breaths[5,7]	6.8
Ventilators that are capable of more than mandatory breaths[5,7]	84
Initial ventilator settings[1,5-7]	2.3
Correct tidal volume (6 ml/kg) in ARDS[5-7]	27.3
Setting of respiratory rate in COPD[1,7]	77.3
Recognising the use of PEEP in recruiting collapsed alveoli[5,7]	95.5
Identifying induction agents that decrease BP[3,5]	25
Contraindications to the use of suxamethonium[3]	6.8

ARDS: acute respiratory distress syndrome, BP: blood pressure, COPD: chronic obstructive pulmonary disease, PEEP: positive end-expiratory pressure

Firstly, a sound knowledge of the indications and contraindications to intubation and mechanical ventilation is required. Medical officers need to be able to recognise patients requiring intubation and ventilation.[1] Without this knowledge, a decision on airway management cannot be made.

Secondly, an understanding of basic ventilator settings, the kinds of ventilator breaths available, and how to select appropriate initial ventilator settings is vital. Medical officers need to understand the mechanisms of respiratory failure, and have a working knowledge of the basic principles of positive-pressure mechanical ventilation.[1]

The tidal volume of a patient with ARDS should be targeted at 6 ml/kg predicted body weight, rather than the more traditional 12 ml/kg. Use of this lower tidal volume would save one life for every ten patients treated in this manner.[5]

Although incorrect item responses do not necessarily reflect inadequate clinical knowledge of the relevant concept, the incorrect responses of many of the participants in the test were far off the mark. For example, nearly all of the medical officers who incorrectly identified the appropriate tidal volume to give a patient with ARDS reported that they would have provided a tidal volume double, or more than double, what is accepted to be the standard of care.

In this study, questions were only marked as correct if all of the answers were correctly selected to a specific question. This might have contributed to the poor results since the correct combination of answers was necessary. Marking needed to be carried out in this manner in order to ensure that participants did not merely mark all of the available options when uncertain about the answer.

It is recognised that although written tests such as these are easily administered, they may overestimate the knowledge level relative to clinical skills, as assessed by objective structured clinical examinations. However, it is believed that this observation simply highlights that pre- and postgraduate training on these basic principles needs to receive specific attention.

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Conflict of interest — The author declares no conflict of interest.

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