Original article

Audit of emergency airway drugs and equipment at a Johannesburg hospital

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\begin{abstract}
\textbf{Introduction:} In-hospital advanced life support and acute airway management is critically time sensitive and requires the immediate availability of key equipment. While most acute airway emergencies present to emergency centres, clinical deterioration may occur at any point during a patient’s care process. Thus, all areas of the hospital should be equipped to provide acute airway management. The aim of this study was to audit the availability and functioning of emergency airway equipment and drugs at a large academic Johannesburg hospital.

\textbf{Methods:} A prospective, observational, cross-sectional spot audit was conducted at nineteen patient care units at Chris Hani Baragwanath Academic Hospital (CHBAH), Johannesburg, SA from January to March 2018. Using a modified list of equipment and drugs derived from the EMSSA Practice Guideline of Rapid Sequence Intubation, each unit’s emergency trolley was spot audited by a single investigator, assessing both availability and if the equipment was in good working order. A selection of drugs was assessed for availability and location.

\textbf{Results:} Overall, approximately two thirds (67%) of the listed equipment were available and in working order in the audited units. Almost a third (31%) of the listed equipment was not available at all, while 2% of the equipment was available but not working. The Intensive Care Unit, Medical Emergency Unit and Trauma Unit had the highest (≥80%) of available and working equipment, with the Psychiatry Ward and the Labour Ward having the lowest percentage (≤45%).

\textbf{Conclusion:} This audit highlights specific deficiencies in emergency airway management equipment within this institution, as well as the need for improved strategies to address equipment shortages. The causes for these shortages were not explored. Recommendations following this audit include further qualitative research to explore and address the barriers to well stocked emergency trolleys, the standardization of equipment checklists and to provide regular staff training in resuscitation.
\end{abstract}

\section*{Introduction}

In-hospital advanced life support (ALS) requires the immediate availability of functional key equipment \cite{1}. It takes approximately 4 minutes of anoxia for irreversible brain injury to occur \cite{2}. Even short periods of hypoxia can result in neurological dysfunction, denoting the critically time-sensitive nature of the availability of emergency airway management.

Traditionally, airway management has been conducted by anaesthetists in a controlled theatre environment with pre-assessed and well-prepared patients \cite{3}. With the development of emergency medicine (EM) as a specialty, focus has shifted to training and advances in emergency airway management in the emergency centre (EC). Difficult airways occur more frequently in the EC than any other clinical area as the EC is faced with a high volume of high acuity, undifferentiated patients \cite{4}. Patient clinical deterioration may occur at any point during their care-process, but patients are particularly vulnerable following emergency hospital admission, post-resuscitation, post-operatively and during critical illness recovery \cite{5}. Therefore, all areas of a hospital should be equipped to provide ALS measures, including emergency airway management.

The success of ALS attempts relies largely on the availability of working resuscitative equipment. Stocking and organization of the emergency trolley are of crucial importance and the use of checklists can be used in this process \cite{6}. State facilities in South Africa were initially governed by the National Core Standards \cite{7} checklists and now by the Ideal Hospital framework \cite{8} checklists for emergency trolleys. However, for the purposes of this audit, a checklist specifically aimed at emergency airways drugs and equipment was used. The Emergency Medicine Society of South Africa (EMSSA) Practice Guideline of Rapid Sequence

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Intubation (RSI) [9] includes all the essential equipment for routine airway management, including rescue and surgical devices (Appendix A). Using a modified version of this checklist, the aim of this study was to audit the availability and functioning of essential emergency airway management equipment and drugs at a large academic Johannesburg hospital.

Methods

A prospective, observational, cross-sectional spot audit was conducted at various units/wards at Chris Hani Baragwanath Academic Hospital (CHBAH) over the period of January to March 2018.

CHBAH is a tertiary and quaternary level hospital located in Soweto, Johannesburg, South Africa, where approximately 70% of all admissions are emergencies [10]. Acutely ill patients first present to the emergency centres - either the Medical Emergency Unit or Surgical/Trauma Emergency Unit. Thereafter, once stabilized for admission, patients are admitted to the relevant speciality unit's admission ward. Of the 73 wards at CHBAH, the areas where acutely admitted patients would be found were selected for the audit. The emergency units, operating theatres and the acute admission ward of each speciality were selected: Cardiac Care Unit (CCU), Emergency Operating Theatres (Theatres 7,8, 9 and 10), ENT Ward (Ward G4), General Surgery Admissions Ward (Ward 10), High Care Unit (ICU-HCU), Intensive Care Unit (ICU), Labour Ward, Medical Admission Ward (Ward 20), Medical Emergency Unit (MEU), Medical Short Stay Ward (SSW), Neurosurgery Ward (Ward G3), Paediatric Outpatients (Ward 31), Paediatric Admission Ward (Ward 36), Psychiatry Ward (Ward 50), Trauma Admission Ward (Ward 1) and Trauma Emergency Unit (TEU).

Following ethics approval from University of Witwatersrand Human Research Ethics Committee (Certificate No M171009), permission was requested from the head of each department included in the audit. To limit bias, the request letter to the Head of Department requested that they do not inform his/her staff about the audit being conducted.

The Emergency Medicine Society of South Africa (EMSSA) Practice Guideline of Rapid Sequence Intubation (RSI) was modified by the Investigator to group the listed items into categories for ease of statistical analysis: basic resuscitation monitors, airway equipment, airway disposables, rescue airway devices, surgical airway devices and the paediatric weight estimation tool. Three commonly used induction agents and two muscle relaxant drugs were selected for the audit, and the location of these drugs in each unit was also assessed. Using this modified list, each unit/ward’s emergency trolley was spot audited by a single Investigator, assessing both availability and whether the item was in working order. Equipment was assessed as “in working order” if the item had all its necessary components and was in good condition to be used for its intended purpose. The Investigator independently audited the emergency trolley at each unit, without asking staff at the unit for equipment not found or near the emergency trolley. The audit was conducted at random times of day since emergency equipment should be always prepared. None of the equipment was in use for an active resuscitation at the time of the audit.

Data were entered onto a Microsoft Excel® spreadsheet and descriptive statistics were reported as percentages.

Results

Overall, the audit revealed that about two thirds (67%) of the listed equipment across the 19 wards/units at CHBAH was available and in working order. Almost a third (31%) of the equipment was not available, while only 2% of the equipment was available but not in working order.

The comparative analysis for each unit/ward audited (Table 1) shows that the Intensive Care Unit, Medical Emergency Unit and Trauma Unit had the highest (≥80%) of available and working equipment. The

| Equipment Description | Available and working | Available but not working | Not Available |
|-----------------------|-----------------------|---------------------------|---------------|

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|-----------------------|-----------------------|---------------------------|---------------|

Table 1

Availability and working order of equipment by wards/units.

| Equipment Description | Available and working | Available but not working | Not Available |
|-----------------------|-----------------------|---------------------------|---------------|

| Equipment Description | Available and working | Available but not working | Not Available |
|-----------------------|-----------------------|---------------------------|---------------|

Table 2

Availability and working order of equipment categories.
Table 3
Summary of audited equipment (complete audit tool - Appendix B).

| Equipment                                      | Available and working | Available but not working | Not Available |
|------------------------------------------------|-----------------------|---------------------------|---------------|
| Basic oxygen delivery                          | 100%                  | 0%                        | 0%            |
| Bag valve mask with oxygen reservoir           | 84%                   | 0%                        | 16%           |
| Face mask x 2 (BSOD)                           |                       |                           |               |
| Oropharyngeal airway (at least 2 sizes)        | 95%                   | 0%                        | 5%            |
| **Definitive airway**                          |                       |                           |               |
| Laryngoscope handle                           | 89%                   | 11%                       | 0%            |
| Spare batteries                                | 53%                   | 0%                        | 47%           |
| Laryngoscope blade x 2                        | 95%                   | 5%                        | 0%            |
| Suction tubing                                | 58%                   | 0%                        | 42%           |
| Atraumatic rigid suction                       | 63%                   | 0%                        | 37%           |
| Soft suction catheter                          | 100%                  | 0%                        | 0%            |
| Bougie                                         | 5%                    | 0%                        | 95%           |
| Introducer stylet                              | 84%                   | 0%                        | 16%           |
| Endotracheal tubes (ETT) (different sizes)     | 100%                  | 0%                        | 0%            |
| ETCO2 detector                                 | 32%                   | 0%                        | 68%           |
| Oesophageal detector-device (EDD)              | 0%                    | 0%                        | 100%          |
| **Rescue airway: non-surgical**                |                       |                           |               |
| Laryngeal mask airway (LMA) or laryngeal tube airway (LTA) | 63% | 0% | 37% |
| **Rescue airway: surgical**                    |                       |                           |               |
| Cricothyroidotomy set                          | 42%                   | 5%                        | 53%           |
| Percutaneous tracheostomy set                  | 21%                   | 0%                        | 79%           |
| **Paediatrics**                                |                       |                           |               |
| Weight Estimation Tool                         | 89%                   | 0%                        | 11%           |

lowest percentages of working available equipment were found in the Labour Ward and the Psychiatry Unit.

The largest deficit of equipment was found to be the surgical airway equipment - only 32% available and working in the audited units (Table 2).

In Table 3, all units had a bag valve mask in working order, which consists of self-inflating and reservoir bags, all relevant valves and a face mask. Sixteen percent (three units) did not have a minimum of two basic supplementary oxygen devices (BSOD), which include simple face masks, Venturi masks, partial and non-rebreather face masks.

Spare batteries for the laryngoscope were also largely unavailable, with only 53% having functioning spare batteries available on the trolley.

Only 1 unit had a bougie available.

Suction tubing, which connects the suction device (soft suction catheter or atraumatic rigid suction device) to the wall or portable suctioning unit, was not found in 42% of audited units, rendering these units unable to provide any form of suction, even if the suction device was available.

Not a single unit audited had an oesophageal detector device. Only 32% had an end-tidal CO2 detector device, and incidentally, all of these were found to be wave form capnography monitors. No end-tidal colorimetric devices were found.

Rescue airway equipment (LMA/LTA) was only 63% available and in working order.

The availability of the paediatric weight estimation tool was only assessed in the nine units expected to treat children, namely Emergency Theatres, ICU, MEU, TEU and Paediatric Wards 36 and 31. A paediatric weight estimation tool was found on or near the resuscitation trolley of all units (89%), except in TEU.

Selected drugs required for emergency airway management (Etomidate, Ketamine, Propofol, Rocuronium and Suxamethonium) were found in all the audited units; the location of which is described in Figure 1. The one unit that had emergency drugs kept outside the ward was due to renovations to the ward and a broken fridge that was awaiting repairs. The drugs were then kept in an adjacent ward within a short walking distance.

**Discussion**

It is alarming that almost one third of critical emergency airway equipment was not found in the audited units of this institution. Al-though the use of a bougie has been shown to increase the success rate of first-attempt emergency intubation [11], the bougie was one of the items least stocked across all units audited, with only one unit stocking this item. Moreover, more than a quarter of all units had no rescue devices (LMA or LTA), no surgical airway equipment and no bougie rendering these units unable to handle a failed intubation attempt or difficult airway. Especially concerning is the lack of equipment in the Labour and Psychiatric wards. Unlike Emergency Medicine and Surgery registrars, those specializing in both Psychiatry and Obstetrics and Gynaecology are not required to complete any emergency life support or airway management courses during their training [12].

The lack of a working, complete laryngoscope in three units and the lack of suction tubing in 58% of units highlights an important limitation of the use of checklists. The item may be marked as available, but not checked if it is usable. To check equipment, the operator must be able to identify and assemble the parts as per the manufacturer’s recommendation. Inadequate training or lack of operator familiarity with the equipment items leads to a failure to identify dysfunctional or damaged equipment [13].

This was a single centre study, which limits generalisability. However, similar findings to this audit were found in other African countries [14-16]. This study was also a spot audit, rather than a series of audits over a time period. It is thus difficult to conclude if the unavailable equipment was due to an overall institutional shortage or if the equipment was recently used and not yet replaced by the time of the audit.

Staff at the units were also not questioned regarding missing or dysfunctional equipment items. Perhaps some of the unavailable items were in other areas of the units for safe keeping or for other reasons.

The study did not investigate the number of patients managed with airway emergencies or frequency of resuscitations in each unit, to cor-
relate this with availability of equipment and drugs. Staff competency and level of training was also not assessed.

The Investigator selected only three commonly used induction agents for the purpose of this audit. Other induction agents, such as Midazolam, may have been used by the units. Other adjunctive pharmacological agents (such as topical aesthetic spray) were also not included in this study.

The lack of essential equipment may be multi-factorial, such as institutional poor planning and lack of accountability, lack of training, inadequate funding in resource limited settings or the lack of perceived need. Although this study was not designed to correlate the level of staff training in acute airway management to equipment availability, it did find that areas in which emergency courses were not mandatory had the lowest levels of equipment.

Access to emergency drugs is limited by South African pharmaceutical guidelines and hospital policy which dictates that scheduled drugs must be controlled [17]. Therefore, emergency drugs for intubation are not usually kept on the resuscitation trolley, but rather kept in a locked area in the unit. All staff should be aware of the location and availability of emergency drugs to reduce medication errors and retrieval time.

This audit highlighted major deficiencies in emergency airway management equipment in this institution. However, the causes for these shortages were not explored. It is therefore recommended that further qualitative research is conducted to explore the barriers and facilitators to well stocked emergency trolleys within the institution. The institution’s resuscitation committee could also be tasked with standardization of equipment checklists and to provide regular staff training in the use of these checklists, as well as in the principles of resuscitation and airway management.

The development of Emergency Medicine as a specialty may provide more opportunities for training of hospital staff across all specialties and may ensure advocacy of improved emergency services in South African hospitals [18]. In future, it may be beneficial for the fraternity of Emergency Medicine to assist other departments to achieve emergency preparedness across all specialty units.

Dissemination of results

Hard copies of this report were made available to the Heads of Departments of the units audited as well as to the Medical Superintendent of the hospital.

Authors contribution

Authors contributed as follows to the conception and design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: SP contributed 50%, DH 30% and PP 20%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declare no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ajfem.2022.08.002.

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