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Original Research

Long-term Effectiveness of the Airway Registry at Sydney Helicopter Emergency Medical Service

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A B S T R A C T

Objective: Prehospital rapid sequence intubation (RSI) is prone to suboptimal documentation. The Greater Sydney Area Helicopter Emergency Medical Service (GSA-HEMS) uses a dedicated Airway Registry (AR) to aid documentation. The AR was only evaluated shortly after its introduction. This first evaluation is followed up to assess the long-term effectiveness of the AR. The secondary objective was to compare the AR with templates in the literature.

Methods: A retrospective review of electronic records was undertaken to compare completeness of documentation between an immediate postintroduction and a long-term postintroduction cohort. Differences between the two cohorts were tested for significance.

Results: There was no significant difference in documentation for Cormack-Lehane laryngoscopy grade at the first intubation attempt ($P = .552$) and confirmation of end-tidal carbon dioxide ($P = .258$). A significant improvement in the documentation of laryngoscopy grade for the second attempt ($P = 0$) was found. The documentation of intubator details remained at 100% (165/165). The variables collected by GSA-HEMS corresponded well to the literature, but some definitions differ (eg, desaturation).

Conclusion: There was no significant change in completeness of documentation for most key intubation variables eight years after the introduction of the AR. GSA-HEMS performs well in registering variables as proposed in the literature; however, variable definitions need to be synchronized.

Prehospital interventions are prone to suboptimal documentation and data recording. The prehospital environment is challenging because of time-critical medical interventions, poor lighting, a moving vehicle, weather, and competing priorities. Documentation may not have a high priority for physicians in this environment. However, without proper documentation, it is impossible to evaluate and study prehospital care. The need for robust documentation of prehospital procedures was recognized already in a position paper of the National Association of Emergency Medical Services Physicians in 2004.[1] One of the most complicated and high-risk procedures performed by prehospital clinicians is endotracheal intubation, which can result in significant morbidity and mortality in patients if not performed properly.[2] To facilitate proper clinical governance on this high-risk procedure, complete documentation is mandatory. In 2009, the Greater Sydney Area Helicopter Emergency Medical Service (GSA-HEMS) introduced the Airway Registry (AR) as mandatory documentation for every advanced airway procedure. Before the introduction of the AR, there was no specific method of gathering data on this subject. The effect the AR had on improving the quality of documentation of airway management has been evaluated previously in an article published in 2013 by Bloomer et al.[3] They compared the quality of documentation on rapid sequence intubation (RSI) in a cohort immediately before and after the introduction of the AR. The introduction of the AR led to a significant improvement in the quality of data collection and a reduction in missing data. However, the AR has not been evaluated over the longer term, and, hence, it is unknown if the AR has a sustained positive effect on completeness of data collection. The primary aim of this study was to investigate if the AR has a long-term sustained improved effect on completeness of documentation of prehospital RSI by GSA-HEMS.

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In previous years, several studies have been published describing which data should be collected on prehospital RSI.[1,4] GSA-HEMS was also a site for the multicenter AIRPORT study,[8] which used Sollid et al's template[4] to gather data on prehospital RSI.[2] Most recently, Lockey et al[5] published a short list of minimum data collection variables in their guideline on safer prehospital anesthesia. A secondary aim of our study was to compare the variables suggested in the literature with that of the AR.

Methods

This study was a retrospective review of the AR. The AR is a separate section of the clinical mission form (CMF) that is completed electronically after each mission in the web-based AirMaestro system (Avinet, Australia). All intubations by GSA-HEMS are performed in accordance to the organization's own prehospital emergency anesthesia standard operating procedure.[6] Included in this review are all patients who underwent prehospital RSI in the 10-month period between May 1, 2015, and March 1, 2016. This was the most recent fully available period of the same time period Bloomer et al[3] studied. Patients who were intubated without the use of RSI drugs, in the setting of cardiopulmonary arrest, were excluded. Ethics approval was provided by the Royal Prince Alfred Hospital Human Research Ethics Committee.

Analysis

Data were extracted from AirMaestro into Excel (Microsoft, Redmond, WA) following filtration for time period and intubated patients. To facilitate computer analyses, some variables had to be flattened ("indication for intubation," "difficult airway indicators," and "intubation events") because they were saved as string values. Many data entry fields were free-text boxes, resulting in both Arabic and Roman numerals and qualitative and quantitative data. In case of ambiguous or incorrect data entries, we reviewed the original digital CMF, AR and scanned case sheet. If an effort was made to document in the AR and it was done incorrectly but there was no possible ambiguity on the meaning of the data (eg, II instead of 2), the data were reconciled and included. If there was any doubt what the physician was trying to report, these data were not included for further analyses.

Statistical analysis was performed using SPSS software (Version 23, IBM Corp, Armonk, NY). Descriptive statistics were used to describe relevant demographics and AR variables. The completeness of documentation (if the variable was reported or not) of various key variables was compared with the original study.[3] The key variables were Cormack-Lehane laryngoscopy grade (at first and/or second attempt), confirmation of end-tidal carbon dioxide ($ETCO_2$) after intubation, and intubator details (doctor or paramedic). Differences between groups were assessed for statistical significance using the chi-square test (or the Fischer exact test when expected cell numbers were smaller than 5). The Bonferroni correction was applied because of testing for multiple hypotheses. We tested for 3 different hypotheses, so $P < .0167$ ($\alpha = 0.05/3$) was assumed to be significant.

Results

During the 10-month study period, 190 prehospital patients were intubated by GSA-HEMS clinicians. Of those, 25 patients were excluded because they were intubated during cardiopulmonary resuscitation without the use of RSI drugs. One hundred sixty-five cases (125 males) remained. The case characteristics are provided in Table 1. The median age was 34 years (interquartile range = 31 years). The median weight was 80 kg (interquartile range = 20 kg), and the maximum weight was 175 kg. The mode of transportation most commonly used was helicopter (92/165). The highest frequency mission type was "road traffic accident" (85/165). The patient category most commonly recorded was "trauma with head injury" (76/165).

Table 1
Case Characteristics

	Long-term Post–Airway Registry
N	165
Sex, n (%)	
Male	125 (76)
Female	40 (24)
Age, median (IQR)	34 (31)
Weight (kg), median (IQR)	80 (20)
Mode of transportation	
Helicopter	92
NSW retrieval ambulance	51
Road/helicopter	14
NSW road ambulance	5
Fixed wing	2
Fixed wing/helicopter	1
Type of mission	
Road traffic accident	85
Bush/recreational	18
Bush	8
Cliff/remote access	5
Farm	5
Water	5
Snow	1
Missing	38
Trauma type	
MVC	72
Falls	23
Pedestrian	12
Assault	9
Recreation/sport	8
Burns	6
Pedal cyclist	6
Other	6
Industrial	4
Drowning	2
Train	2
Patient category	
Trauma with head injury	76
Trauma without head injury	43
Isolated head injury	28
Extremity only trauma	2
Burns	7
Medical	7

IQR = interquartile range; MVC = motor vehicle collision; NSW = New South Wales.

Difficult airway indicators were reported with a 100% completeness rate (as this had become a mandatory field). For the first intubation attempt, the Cormack-Lehane laryngoscopy grade was recorded in 155 cases (93.9%). For the second attempt, the Cormack-Lehane laryngoscopy grade was recorded 20 times (95.2%). The presence of $ETCO_2$ monitoring postintubation was recorded in 158 cases (95.8%). Intubator details were recorded for all cases included. We performed the chi-square test to test for a significant difference between Bloomer et al's results[3] on documentation of laryngoscopy grade at the first attempt and $ETCO_2$ confirmation documentation and our data. The test showed a 2-sided P value of .552 and .258, respectively. For the grade at the second attempt, we used the Fisher exact test, which showed $P = .000$ (Table 2).

We also compared the data recorded by GSA-HEMS with the data variables proposed in the literature. The results are shown in Table 3.

Discussion

There was no significant difference between the study by Bloomer et al[3] and our study in completeness of documentation for first attempt laryngoscopy grade (0.552) and $ETCO_2$ confirmation postintubation ($P = .258$). There was a significant difference for second attempt laryngoscopy grade ($P = 0$). Intubator details and difficult airway indicators both remained at 100% completeness of documentation.

Table 2
Comparison of Key Variables With Results From Bloomer et al[3]

	Immediately Post-AR (Bloomer)	Long-term Post-AR	*P* Value
Difficult airway indicators			
Recorded	90	165[a]	NA
Not recorded	0	0	
Laryngoscopy grade			
First attempt			
Recorded	87	155	.552
Not recorded	3	10	
Second attempt			
Recorded	1	20	.000
Not recorded	20	1	
Confirmation $ETCO_2$			
Recorded	83	158	.258
Not recorded	7	7	
Intubator details			
Recorded	90	165	NA
Not recorded	0	0	

AR = Airway Registry; $ETCO_2$ = end-tidal carbon dioxide; NA = not applicable.
[a] Difficult airway indicators mandatory to report in the long-term cohort.

Completeness of documentation of the laryngoscopy grade at the first attempt is sustained over time, and documentation of the second attempt has significantly improved. One possible explanation could be the tight auditing and review of the AR at monthly clinical governance days. Here the need for complete documentation of airway maneuvers is highlighted, especially if the procedure does not go according to plan the first time around. There was a substantial increase (but not significant) in completeness of documentation of $ETCO_2$ confirmation postintubation. Possibly staff has become more aware of this variable as a key registration variable for clinical governance. Although the intubator details were not mandatory to report, the 100% response rate was sustained over time. It is common practice for physicians in any field of medicine to document their personal details for procedures they perform on patients, which could explain why there was no decrease in completeness of documentation for intubator details. Difficult airway indicators had become mandatory to report in the meantime, resulting in 100% completeness of documentation.

Comparison With Templates

Most of the data gathered by GSA-HEMS corresponds to what are regarded as core variables in the templates (Table 3).[4,6] The "core patient variable" comorbidity (American Society of Anesthesiologists physical status classification) is not routinely recorded by GSA-HEMS for prehospital patients because it is often not known and not deemed relevant to the immediate prehospital treatment. Any known previous medical history or comorbidity is recorded in a free-text field on the CMF. The diagnostic category of patients is recorded by the Acute Physiology and Chronic Health Evaluation IV (nonoperative) diagnosis list.[7] This gives detailed injury subtypes but is

Table 3
Greater Sydney Area Helicopter Emergency Medical Service (GSA-HEMS) Registered Data Compared With Literature Templates

	Sollid et al[4]	Lockey et al[6]	GSA-HEMS
Core system variables			
Highest level of EMS provider on scene	✔	✔	NA
Airway devices available on scene	✔	✔	Standard
Drugs for airway management available on scene	✔	✔	Standard
Main type of transportation	✔	✔	✔
Response time	✔	✔	HEMS team
Core patient variables			
Comorbidity	✔	✔	On case sheets
Age	✔	✔	✔
Sex	✔	✔	✔
Patient category	✔	✔	APACHE list
Indication for airway intervention	✔	✔	✔
Respiratory rate, initial	✔	✔	✔
Systolic blood pressure, initial	✔	✔	✔
Heart rate, initial	✔	✔	✔
GCS, initial	✔	✔	✔
SpO_2, initial	✔	✔	✔
Core postintervention variables			
Postintervention ventilation	✔	—	On case sheets
Postintervention SBP	✔	✔	✔
Postintervention SpO_2	✔	✔	✔
Postintervention $ETCO_2$	✔	✔	✔
Postintervention heart rate	✔	✔	✔
Postintervention SBP on arrival	✔	—	✔
Postintervention SpO_2 on arrival	✔	—	✔
Postintervention $ETCO_2$ on arrival	✔	—	✔
Survival status	✔	—	Not in AR
Number of attempts at airway intervention	✔	✔	✔
Complications	✔	✔	"Intubation events"
Drugs used to facilitate airway procedure	✔	✔	✔
Intubation success	✔	✔	Use of 2nd device
Device used in successful airway management	✔	✔	✔
Fixed system variable			
Tracheal tube confirmation technique	✔	—	Every case
Other			
Trauma type	—	—	✔
Weight	Optional	✔	✔
Management of failed intubation	Indirect	✔	✔
Intubator designation	Senior on scene	—	✔
Intubator experience (no. of intubations)	Optional	—	—
Difficult airway indicators	—	—	✔

AR = Airway Registry; APACHE = Acute Physiology and Chronic Health Evaluation; EMS = emergency medical service; $ETCO_2$ = end-tidal carbon dioxide; GCS = Glasgow Coma Scale; HEMS = helicopter emergency medical service; NA = not applicable; SBP = systolic blood pressure; SpO_2 = peripheral capillary oxygen saturation.

laborious and prone to error because often injury extent is not known. The diagnostic category of patients could be simplified into 4 categories as proposed by Sollid et al[4]: 1 = blunt trauma (including burns and strangulation), 2 = penetrating trauma, 3 = nontrauma (including drowning and asphyxia), and 4 = unknown.

The "core variables" proposed by the template do not include any details on the designation and experience of the intubator. We believe this is important information for governance and research and should be considered core variables, as should documentation of difficult airway indicators, the latter is standard at GSA-HEMS.

The "core postintervention variables" are recorded by GSA-HEMS, but the methods differ. Confirmation of $ETCO_2$ is recorded in multiple ways. The value is reported as part of the "final observations." In the AR, a tick box is provided to acknowledge intubation was confirmed by $ETCO_2$ monitoring, with a separate drop-down menu to specify how. This could be more efficiently combined into 1 multiple-choice question. Sollid et al's template[4] proposes the collection of the value of postintervention $ETCO_2$ or the option of "not recorded" but not for separate confirmation of endotracheal intubation by $ETCO_2$ or by which method. In view of the importance of proper placement of the endotracheal tube, we propose that a registry should include a specific, mandatory method of documenting correct tube placement directly after intubation, recording both the method of confirmation and the value of $ETCO_2$.

Complications during the intubations are reported under "intubation events" together with possible maneuvers used during the procedure to improve conditions for intubation. In the AR, there is no option to report that no adverse events or complications have taken place. This complicates the analyses of the data because one cannot be certain if no event happened or if it was not reported. The absence of data does not automatically mean the absence of the event. For future registries, it would be beneficial if a mechanism was built in to demand acknowledgment from the reporter that no adverse event had taken place. We recommend against the use of free-text fields and advocate a tick box list for complications per intubation attempt. Definitions of events also varied between the templates and values collected by GSA-HEMS (eg, desaturation/hypoxia: peripheral capillary oxygen saturation < 90% vs. < 93%).[4] To ensure homogenous data collection, standard definitions should be agreed on. Additionally, for ease of reporting, complications should be separated from additional airway procedures (Laryngeal Mask Airway insertion, External Laryngeal Manipulation, and so on).

Limitations

This study is a retrospective review of data recorded in an electronic prospectively entered database. This introduced difficulties in analyzing the data. Ambiguous data entries were reviewed by the authors and either converted or excluded, which could cause a bias in the total frequencies. All data reviewed in this study were self-reported by attending physicians, possibly introducing reporting bias of any adverse events or performance of known key performance indicators, like time on scene and desaturation during intubation. However, we believe it gives good insight into the use of a data registry and associated quality of documentation by a high-volume HEMS over a multiyear period.

Conclusion

The AR has a long-term sustained improved effect on completeness of documentation of prehospital RSI by GSA-HEMS. For some key variables, quality of documentation has even (significantly) improved. Additionally, GSA-HEMS collects most variables as proposed in the literature but with some heterogeneity in variable definitions (eg, patient category and desaturation). Incidentally, our analysis also illustrated the difficulty in analyzing data from free-text field entries. Any service setting up a registry should invest time in designing their data entry template to minimize free-text fields and unambiguous response options. Key variables should be recorded through mandatory fields to ensure 100% compliance. The template proposed in the literature will likely provide a good framework for uniform data collection once variable definitions are synchronized.

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