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Pre-Hospital Emergency Anaesthesia in trauma patients: an observational study from a state-wide Australian Pre-hospital and retrieval service

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Abstract

Objective:

To assess the performance of an Australian Prehospital and Retrieval Medicine (PHRM) Service against the National Institute for Health and Clinical Excellence (NICE) standard which recommends that Prehospital Emergency Anaesthesia (PHEA) in Trauma patients should be conducted within 45-minutes of first contact with Emergency Services.

Methods:

Retrospective observational study of all adult trauma patients in which PHEA was conducted by the PHRM service covering a 5-year period from January 2015 to December 2019.

Results:

Over the 5-year study period, 1,509 (22%) of the PHRM service workload comprised primary retrievals from scene. Most 1,346 (89%) of these cases had a primary diagnosis of trauma. Of these we have complete data for 328 of the 337 cases requiring a PHEA and 121 (37%) patients received this within the recommended 45-min timeframe.

The service attended in rapid response vehicles (n=160, 49%), Rotary Wing (n=151, 46%) and Fixed-wing (n=17, 5%) transport modalities. For a service covering 983,482 km², the median distance travelled to patients was 35 (16-71) km and the median time to PHEA was 54 (38-80) minutes.

Conclusions:

In a cohort of 337 patients treated by a dedicated PHRM service in South Australia, the median time to PHEA was 54 (38-80) minutes with only 37% of patients receiving PHEA within 45 minutes from the activation of the team. Despite differing patient demographics, the percentage of patients receiving PHEA within the recommended timeframe was greater than a similar cohort from the UK. However, both data sets still fall short of recommended targets

Introduction

A significant proportion of severely injured trauma patients require advanced airway interventions [1] and this intervention is sometimes provided in the pre-hospital setting. The timing and quality of this care can impact survival [2,3].

The 2007 National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) reported high levels of airway compromise on arrival to the Emergency Department in UK trauma patients [4]. Airway compromise is a preventable cause of morbidity and mortality in trauma [5]. In 2016 The National Institute for Health and Care Excellence (NICE) issued the guidance that, if required, a definitive airway should be obtained within 45 minutes of the initial call to emergency services for all trauma patients [6]. This led to further recommendations that pre-hospital airway management should be performed expediently and to the same standards as in hospital emergency anaesthesia; by trained and competent clinicians [7].

NICE recommends that rapid sequence induction of anaesthesia and intubation delivered by a competent clinician is the gold standard of care when maintaining the airway and reduces long-term morbidity and mortality when compared with other methods of intubation [6]. This recommendation was based on studies looking at patients with traumatic brain injury (TBI), which was deemed representative of the general UK trauma population with respect to the need for Pre-Hospital Emergency Anaesthesia (PHEA) [8, 9]. 45-minutes was believed to be a reasonable amount of time before PHEA should occur. If intubation is not achievable in this time frame the guideline recommends the transport of the patient to a trauma centre within 60-minutes or the use of a supraglottic device, which are commonly available for UK paramedics.

In 2011 an expert consensus process identified advanced airway management as one of the top five research priorities in pre-hospital critical care [10]. Despite all UK Helicopter Emergency Medical Services (HEMS) being physician-led, work published in 2020 showed that these teams were only successful in securing a definitive airway within the recommendation 45 minutes in 25% of cases [11].

South Australia has a dedicated, centralised pre-hospital and retrieval medicine (PHRM) service (MedSTAR) affiliated with the South Australian Ambulance Service (SAAS). SAAS-MedSTAR has multiple, 24-hour, doctor-led PHRM teams operating by road, rotary and fixed-wing platforms. The service undertakes both primary (roadside) trauma and inter-facility retrieval of critically unwell adults. SAAS MedSTAR keeps a database of all patients utilising the service.

The aim of this study is to assess the airway management of pre-hospital trauma patients by SAAS MedSTAR and assess compliance with the UK standard.

Methods

We conducted a retrospective observational study by performing a database review of all adult Pre-Hospital Emergency Anaesthesia (PHEA) undertaken by SAAS MedSTAR from January 2015 to December 2019. Due to the impact that COVID-19 had upon the SAAS MedSTAR service in 2020 it was decided to only analyse data to the end of 2019. Ethical approval was granted from the Central Adelaide Local Health Network Human Ethics and Research committee (HREC/16/RAH/464).

Inclusion criteria

All adult trauma cases in which PHEA was performed.

Exclusion criteria

The patient exclusion criteria were pre-hospital anaesthesia episodes in patients aged less than 18-years or anaesthesia not initiated by SAAS MedSTAR.

Data collection

Every SAAS MedSTAR retrieval teams record data at the scene which is later entered into a SQL database (Air Maestro, Avinet, Adelaide, South Australia) by the same treating team. The database records the times teams were dispatched, time they arrived at the patient and time of intubation in cases of PHEA. The PHRM team for trauma cases is comprised of a doctor, nurse or paramedic. An additional paramedic is also dispatched to all pre-hospital activations (i.e. a team of 3). The doctors sub-speciality is also recorded, with most doctors coming from anaesthesia, emergency medicine (EM) and intensive care medicine (ICM) backgrounds. De-identified data were extracted by the study investigators for analysis. The operation time points used for analysis were:

1. Team activation: Time retrieval team were dispatched.
2. Travel time: Time from team activation to arrival at the patient.
3. Time of PHEA : documented as '*time of intubation*' by the attending team.

Primary outcome

The primary outcome was the time from team activation to the time of PHEA and the proportion being performed within 45-minutes of team activation.

Secondary outcomes

1. To describe the mode of transport utilised by the PHRM team.
2. To describe the time of day the PHEA was undertaken.
3. To assess the effect of clinician sub-specialty on time to PHEA.
4. To assess the effect the distance travelled had on time to PHEA.

Statistical Analysis

Data are reported as mean and standard deviation for normally distributed data and medians and inter-quartile ranges for non-normally distributed data. The Kruskal-Wallis test was used for comparison between the groups. Pearson correlation coefficients were calculated to assess the strength of relationships.

Results

Provider characteristics

During the period January 2015 to December 2019 SAAS MedSTAR retrieved 6784 patients, 1509 (22%) were primary retrievals from scene (most commonly trauma), 163 didn't have a trauma diagnosis and were excluded. Of the 1346 trauma cases we identified 337 (25%) primary team activations that involved PHEA.

Table 1: Demographics of included patients and mode of transport

Demographics		
Male n (%) (missing data n=27)	225 (76%)	
Age (mean (SD)) (missing data n=105)	45 (19.1)	
Mode of Transport (missing data n=9)	Total Primary Taskings	Number meeting 45-minute target
Rapid response vehicle (RRV)	160 (49%)	106/160 (66%)
Rotary Wing	151 (46%)	10/151 (7%)
Fixed Wing	17 (5%)	0/17

Primary Outcome

We were able to utilise time from team activation to intubation for 328 (97%) episodes of pre-hospital emergency anaesthesia. The median time to PHEA was 54 (38-80) minutes. 121 (37%) of patients received PHEA within 45 minutes from the activation of the retrieval team.

Secondary Outcomes

Mode of transport:

Mode of transport is described in Table 1. Of the 121 patients that met the 45-minute target we have transport data for 117 of the episodes. 106/117 were RRV and 10/117 were by Rotary Wing. Rotary wing take-off times are within 10 minutes during the day and 20 minutes at night and are monitored as performance indicators. If the retrieval team travelled by RRV there was a 66% (106/160) chance that the PHEA would be completed within the recommended 45-minute time-frame.

Time of day when pre-hospital emergency anaesthesia was performed:

PHEA was most frequently performed during daylight hours between 12:00 and 20:00. PHEA was undertaken less frequently in the early hours of the morning between 00:00 and 07:00 (Figure 1).

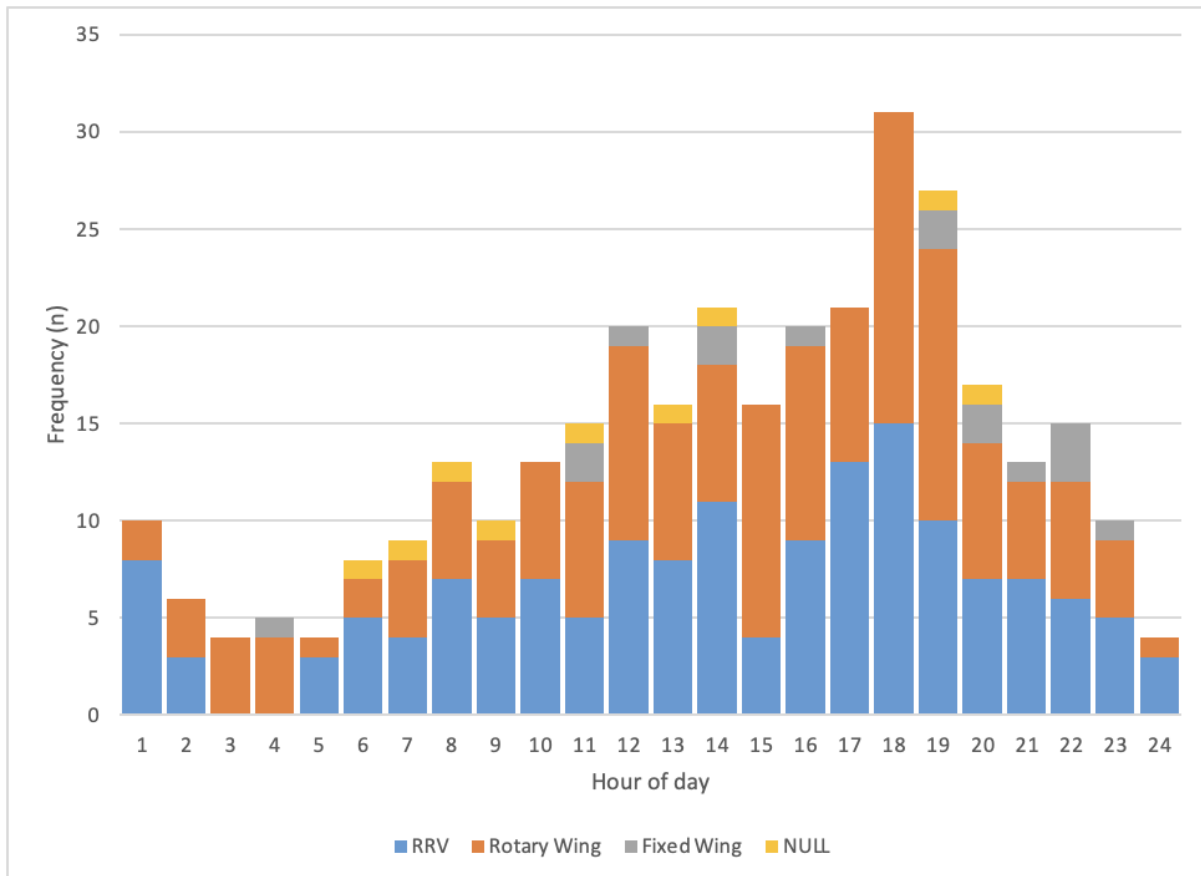


Figure 1: Frequency histogram showing time of day when pre-hospital emergency anaesthesia (PHEA) was performed and the mode of transport utilised

Sub-speciality of Intubator:

To exclude the effect of travel time, we assessed the effect of the intubator's speciality background on the time from team arrival at the patient to PHEA. We were able to assess this time for 326 (97%) of intubations. There were 152 intubations performed by doctors with an anaesthetic background, 132 with an EM backgrounds, 33 with an ICM background and 9 performed by individuals with other backgrounds. The overall median time was 19 [13-28] minutes. Median time to intubation for anaesthetic physicians was 18 (14-27) minutes, EM 20 (13-28) minutes and those with an ICU background 17 (12-26) minutes. The differences between the groups were not significantly different (Anaesthetics vs ICU U=2237 p=0.33204, Anaesthetics vs ED, U=9770 p=0.704, ED vs ICU U=1940 p=0.332).

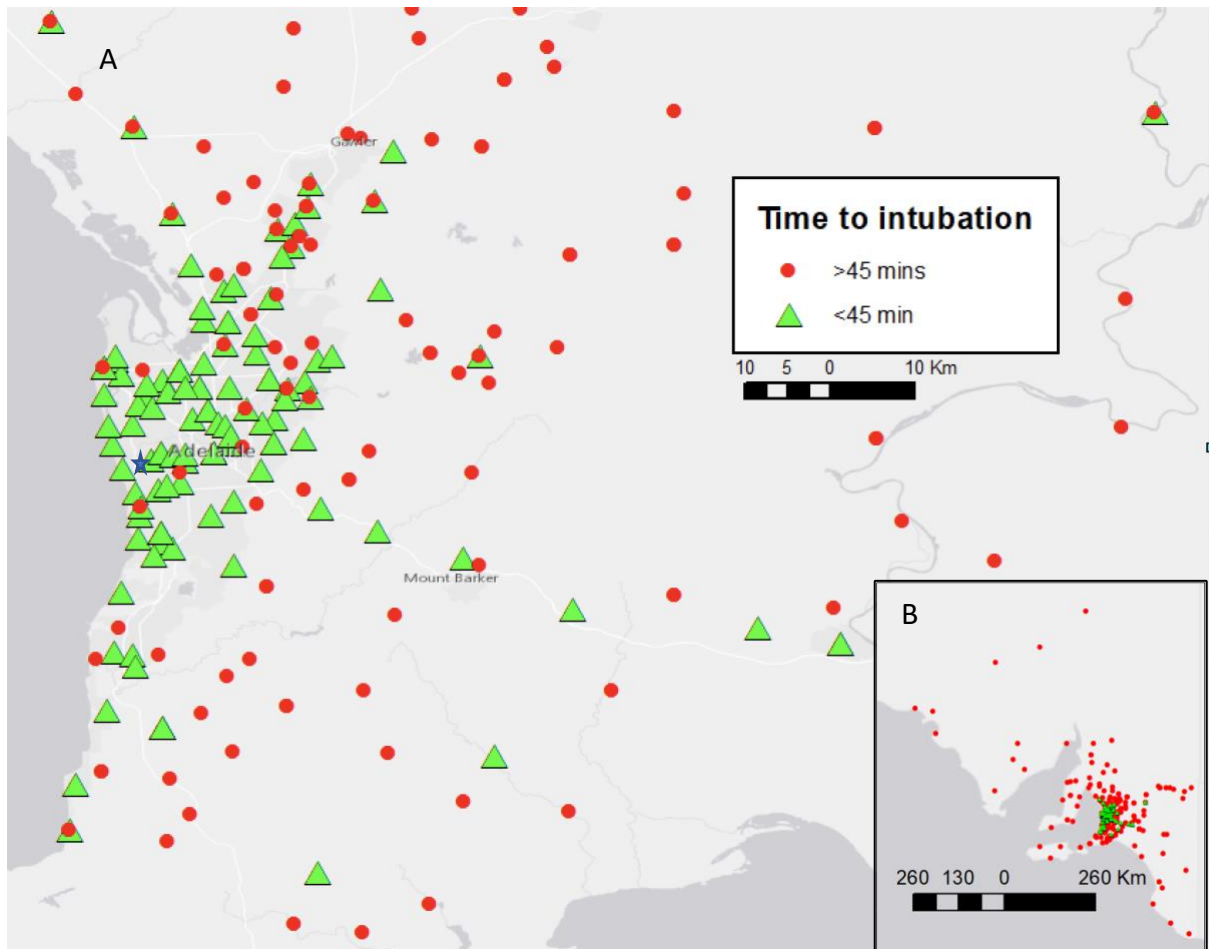


Figure 2: Map demonstrating the distribution and distance travelled by the PHRM team to Primary Retrievals. Shown are those achieving the PHEA within 45 minutes (green) and those falling outside this time-frame (red). Map A represents the metro Adelaide region, whereas Map B illustrates greater regional South Australia. The MedSTAR base location is denoted by ★

Distances travelled by the Retrieval Team

The median distance travelled by the retrieval team to a primary trauma was 35 [16-78] km. Figure 2 graphically illustrates the locations of the primary retrieval attended by SAAS MedSTAR. We had retrieval platform data for 328 (97%) the distances travelled by differing retrieval platforms varied greatly. The median distance travelled by RRV was 14 (9-24) km, Rotary wing 70 (49-106) km and fixed-wing assets 294 (243-511) km (Figure 3). There was a strong correlation between time from team activation to intubation and distance travelled Pearson $r = 0.803$ $p < 0.0001$. When the 45 min target was met teams travelled a median [IQR] of 12.5 [8.4 to 23.3] km compared to 61.5 [34.5 to 115.5] km when the 45 min recommend wasn't met ($p < 0.0001$). In a binary logistic regression for every km increase in distance the log odds of intubation within 45 minutes decreases by -0.078 ($p < 0.0001$). Figure 4 illustrates the timings between activation delay, travel times and time at scene when comparing those PHEA performed within the recommended 45-minutes and those outside of this recommendation. This illustrates the impact travel time and therefore, distance travelled, has upon the ability of the team to perform PHEA within the recommended time-frame.

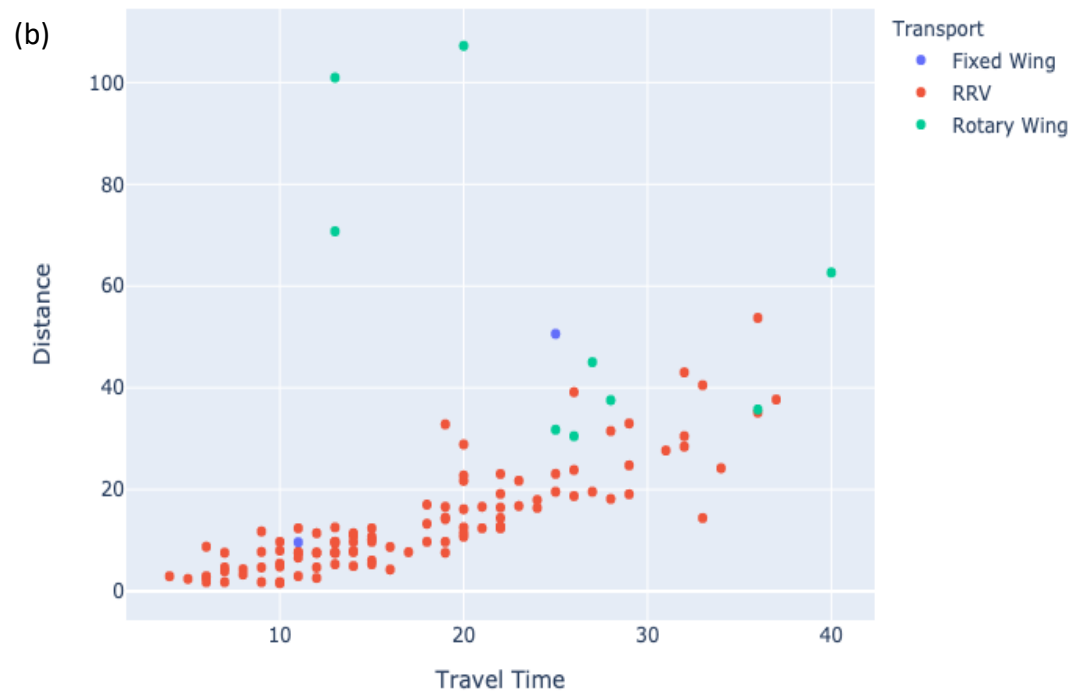
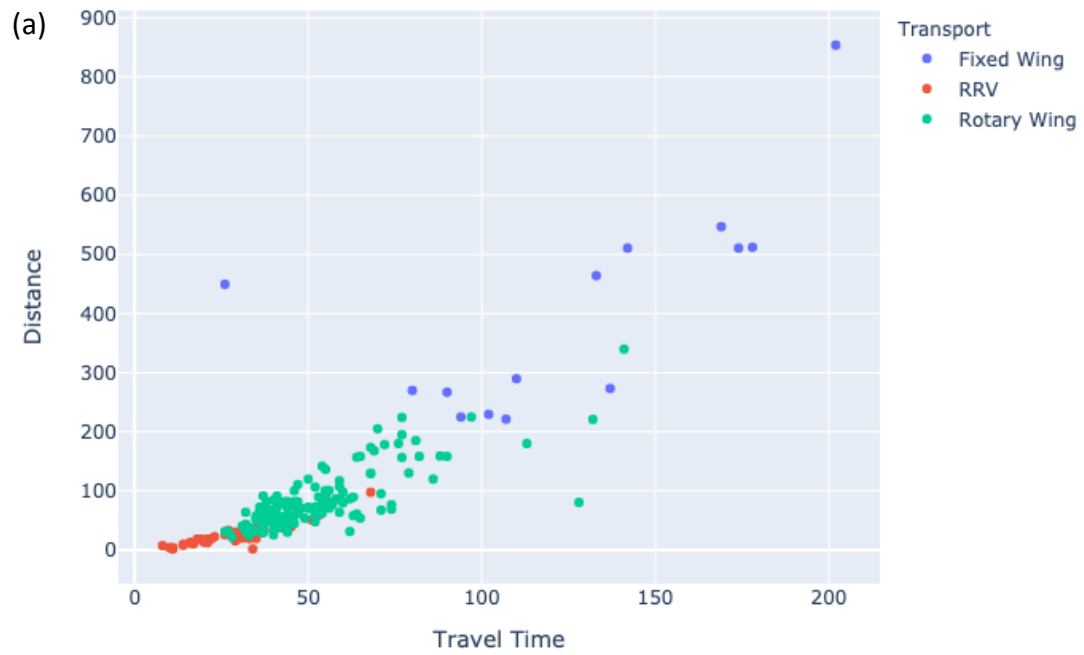


Figure 3: Distance travelled and travel time for different retrieval platforms. (a) the >45-minute to pre-hospital emergency anaesthesia group and (b) the <45-minute group.

Figure 3 also demonstrates the variability in the scene time between the two groups. Additional factors that may negatively impact upon achieving the recommended 45-minute time frame, include factors that may hinder the timely administration of a PHEA when the team are on scene. This can include accessibility issues, including patient entrapment. Thirty-four of the 328 patients that we had complete data for were entrapped upon team arrival. The median [IQR] time to intubation was 54 [37-79] minutes when there was no entrapment and 51 [38.5-84.5] minutes when there was entrapment. However, 13 of the entrapped patients were in the <45-minute to PHEA group.

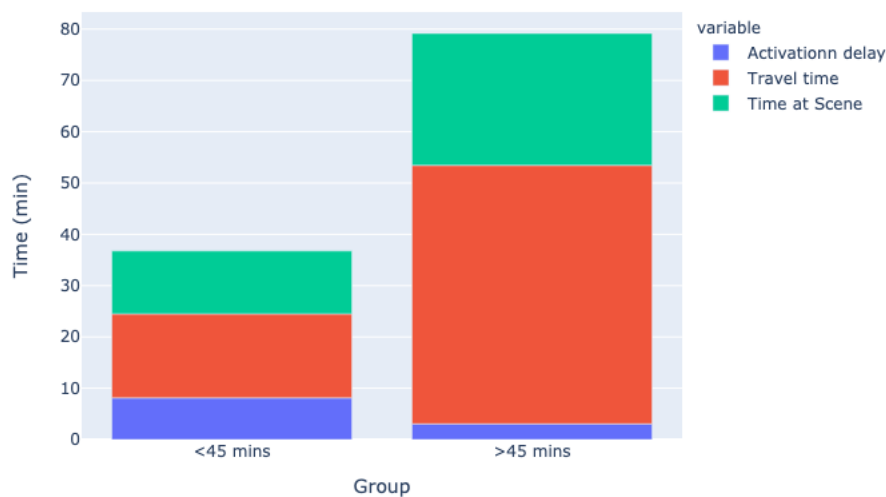


Figure 4: Breakdown off time to intubation between groups achieving the 45-minute target and those not.

Discussion

We believe this to be the first census report on PHEA delivery by an Australian Pre-hospital and retrieval service. During the 5-year study period we found that SAAS-MedSTAR were compliant with the UK national expert-guided consensus target [6] of achieving pre-hospital anaesthesia within 45 minutes in 37% of episodes.

The NICE (UK) target of 45-minutes was set from first contact with emergency services. Therefore, previous literature on this topic has investigated the ‘time to team dispatch’ and the interaction between emergency service coordination and the PHRM teams at their disposal [12]. The time from first call to the activation of the PHRM team can vary slightly in SAAS practice. Many cases are immediately activated as per the Advanced Medical Priority Dispatch System (AMPDS) [13] protocols. For cases where the clinical need for a PHRM team is not clear, the case will be discussed with a senior medical PHRM specialist working within the ambulance control room environment and exclusively operating in that role (the Medical Retrieval Coordinator).

Although our analysis does not include data on the timing to dispatch of the PHRM team we believe that any delay in team dispatch would be minimal due to a well-established AMPDS protocol. However, in the absence of such data the authors must acknowledge that our study likely marginally over-estimates compliance with the NICE 45-minute performance indicator.

During our 5-year study period the MedSTAR retrieval service did not significantly change any of its standard operating procedures concerning the rapid sequence induction of anaesthesia. However, there were a few other changes that may have impacted on the data. For example, there has been an increasing use of video laryngoscopy within the service over the last few years. In addition, the retrieval base changed location in 2017 to be adjacent to our rotary wing assets. This may have contributed to reduce the travel time for rotary wing taskings, however we believe that this potential improvement in time parameters would have minimal overall impact upon our data.

Our data also shows the busiest time for PHEA was afternoon and early evening and this may have an impact on staffing and total number of PHRM teams available.

Speciality background of the clinician performing PHEA was a non-significant parameter in the time to intubation. All clinicians working with SAAS MedSTAR operate to agreed standard operating procedures (SOP) and airway management has its own SOP. The purpose of the SOP was to ensure a consistent, systematic approach to airway management within the service, encouraging good team dynamics and reducing cognitive overload. The non-significance of background speciality suggests that clinicians are following the SOP and not leaning towards autonomous practice influenced by background speciality.

Possible delays in the administration of pre-hospital anaesthesia may be related to the unique geographical challenges faced in the provision of the services. SAAS MedSTAR is a state-wide service covering 983,482 km² of South Australia. The fact that 5% of our PHEA were performed by teams travelling via fixed wing assets which incur a minimum 45-minute readiness time would negatively impact on the services ability to achieve the 45-minute target. Cases that were geographically distant tended to have an increased time to PHEA but several outliers demonstrated that this relationship may not be as linear as previously considered.

We have also tried to address other modifiable factors that can negatively impact upon the timely administration of a PHEA, including patient entrapment. Although entrapped patients did show an increased median time to intubation, it is noteworthy that 13/34 (38%) entrapped patients were within the <45-minute PHEA group. Although access to the patient undoubtedly plays a role in the PHRM team achieving recommended time frames when on scene, the relationship is not absolute.

Our analysis has highlighted that distance travelled is the primary variable that negatively impacts upon the PHRM team from achieving a PHEA within the 45-minute time frame. This is not surprising given the inherent geographical challenges placed upon the retrieval services in Australia. The current NICE guideline on PHEA has been written for the UK PHEM environment and the recommended time lines reflect this. The distances required to travel by a UK PHEM team are significantly less than that of our South Australian MedSTAR team.

However, in the absence of similar literature from other countries, these timelines may be viewed as a 'benchmark' for PHEA internationally.

Whilst early intervention in airway compromise is always going to be the ideal, there should be a realistic assessment and expectation based on local service case mix and demographics. Our data has added an Australian perspective to this key area and offers a potential benchmark for services with similar demographics.

Limitations

There may be a slight delay between emergency call and team activation in some cases. The emergency call timings are stored separately by the ambulance service and were not able to be accessed for this study. However, as previously highlighted, the utilisation of a well-established AMPDS protocol for primary taskings would mean that this potential delay to team tasking is unlikely to have a significant impact on our data.

The inclusion of metro and rural areas within our analysis would have contributed to the differences found between rotary wing and RRV travel times. Although we have evaluated our service against the NCEPOD recommendations, SAAS MedSTAR provides cover to rural South Australia with large travel distances and therefore a further subdivision of metro versus rural dispatches may be a better reflection of the actual time to PHEA.

A reliance on team data collection may introduce inaccuracies into the exact time of arrival on scene and other data concerning the PHEA entered by the PHRM team. Scene arrival times may represent the time that the helicopter or RRV arrives on scene or the actual time arrived at patient and there is not a data dictionary provided to the teams to make these definitions clear. The data does not take into account delays encountered by the team to get to the patient, for example, entrapment or the need to convey the team from the helicopter landing site to the patient. In addition, the timing of the PHEA may be interpreted differently by the PHRM team. Time of intubation, time of induction or immediate observations post induction could be utilised to identify the time PHEA was performed. Despite the multiple points identifying achievement of a PHEA, they all fall within a 60 second time window and therefore the potential for significant impact on our analysis is reduced.

Our analysis is concerned with those trauma patients attended to by a MedSTAR PHRM team. This has the potential to exclude those trauma patients being dealt with exclusively by SAAS paramedic teams. There are situations where this patient demographic will be transported to a trauma centre or managed with a supraglottic device prior to the PHRM team's arrival. The exclusion of these patients in our analysis has the potential to miss a broader compliance with the NICE guidelines for airway management within the SAAS environment.

Conclusion

In a cohort of 337 patients treated by a dedicated PHRM service in South Australia, the median time to pre-hospital emergency anaesthesia was 54 (38-80) minutes with only 37% of patients receiving pre-hospital emergency anaesthesia within 45 minutes from the activation of the team. The ability to achieve this target is strongly influenced by distance. This is better than similar data from the UK but still falls short of recommended targets.

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