Airway management in paediatric emergencies outside of an intensive care setting: a quality improvement project using Lean/Six Sigma methodology

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ABSTRACT
Use of a Lean/Six Sigma methodology in a quality improvement project to reduce variation and improve safety in airway management outside of the intensive care environment in a tertiary paediatric hospital.

PROBLEM
Recent evidence has shown that while advanced airway management is clearly an important aspect of many critically unwell children, adverse events associated with tracheal intubation can have significant effects on mortality and morbidity. Furthermore, when paediatric patients are critically unwell, they are much more likely to suffer an adverse event due to intubation, and there is a high frequency of difficult airways in these patients even when expert teams and clinicians are involved. There is some evidence to suggest that in cardiac arrest, there are better outcomes with bag–valve–mask (BVM) ventilation rather than supraglottic airway devices or endotracheal tube intubation.

AIMS
The motivation of the project was a growing understanding of the need for specialist personnel in advanced airway management in paediatric emergencies. The concern was that the variation in equipment storage and availability of advanced airway equipment to potential non-expert practitioners increased the risk of adverse events related to airway management in emergencies.

LEAN/SIX SIGMA APPROACH
A Lean/Six Sigma approach was used for this project. Lean/Six Sigma consists of five steps: Define, Measure, Analyse, Improve and Control.

Define
The aim of the project was to reduce adverse events related to airway management in emergency situations in the Royal Hospital for Children (RHC), Glasgow outside of the paediatric intensive care unit (PICU) and theatre environments.

Measure
All emergency calls to the wards at RHC identified from January 2019 to October 2020 were reviewed. Forty-three cases were able to be identified. In the majority of cases, the airway was managed with either no airway equipment or basic airway manoeuvres and a BVM or equivalent anaesthetic circuit.

Outcome measure
The outcome for this project was adverse events related to airway management. Throughout the project, no adverse events were found in review of emergency airway management. This is likely due to the fact that adverse events are a low frequency occurrence with identification dependent on personnel involved in recognising them and recording them through the DATIX incident system.

Process measure consideration
In considering a process measure for adverse events, we looked for incidents involving the use of advanced airway management by non-expert practitioners (defined as a healthcare practitioner not at consultant or senior trainee level in paediatric emergency medicine, intensive care or anaesthetics).
Therefore, the initial data collected was further analysed for cases of advanced airway management. In four patients, advanced airway management was performed for either seizure cessation or airway security due to haemodynamic instability prior to PICU transfer. All were intubated either by a consultant paediatric anaesthetist or intensivist.

**Analyse**

To establish the causes for variation in airway management practice, a root cause analysis was undertaken (see figure 1).

Following this, the equipment available was decided to be the focus of the project as it was felt this aspect of the process had the most influence on variation between users in their airway management.

**Improve**

In consultation with the relevant hospital departments, we discussed moving to a Structured Critical Airway Management (SCRAM) bag of portable airway equipment rather than having different variations of airway equipment based in various emergency trolleys. A process map was created and shows the process for using airway equipment at the start of the project (see figure 2).

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**Figure 1** Root Cause Analysis of variation in Emergency Airway Management in RHC

**Figure 2** Initial process for airway management in ward-based emergencies. etCO2 end-tidal CO2, LMA Laryngeal Mask Airway, RS Robert Shaw
After a successful consultation and trial period in the emergency department and PICU initially, the SCRAM bag system was implemented throughout the hospital.

Control
With multiple interventions occurring concurrently, the paediatric emergency review committee continued to monitor and observe these implementations. Additionally, there is the established resuscitation committee for the hospital, which holds bimonthly reviews including for equipment issues.

From June to September 2021, there was one case of difficult airway management. Encouragingly, there were two cases of excellent practice regarding both basic and advanced airway management and a further case of a patient requiring advanced airway management in the ward setting with no equipment issues recorded.

Cost analysis
In addition to the benefits in patient care, there is an additional cost–benefit to the changes detailed above. Despite the increased cost of the advanced equipment carried by PICU/anaesthetics, the changes resulted in immediate cost-savings of £917.80 (see table 1).

LEARNING AND NEXT STEPS
This project is an example of how the Lean/Six Sigma approach can be used to improve healthcare delivery through reduced variation.

With the support of the data, it was decided that the use of SCRAM bags would be implemented with a transition and consultation period over the following months within the appropriate departments (see figure 3).

The proposed new process for airway equipment is shown in figure 4.

Figure 3  SCRAM Bag in closed and open positions

Figure 4  Proposed process for airway management in ward-based emergencies. etCO2 end-tidal CO2, LMA Laryngeal Mask Airway, RS Robert Shaw
Quality improvement short report

In this project, the focus was on equipment with the implementation of the SCRAM bag system and concurrently encouraging initial responders to the emergency to focus on high-quality basic airway management.

This was able to be implemented safely and with additional benefits of cost reduction for the hospital and reduced waste of unused equipment, reducing the hospital’s detrimental environmental impact.

However, while the equipment aspect of this project was successful, there are many other factors influencing variation in airway management. In particular, training of non-specialist clinicians in excellent basic airway management is essential.

In future, this project hopes to include further training and simulations as well as including other geographical areas including the emergency department and paediatric intensive care.

Acknowledgements

We thank all additional contributors to the project for their support.

Contributors

All authors contributed to the project with JP and MW contriving the project. JB was responsible for the cost analysis. JP and JB created the manuscript with MW providing supervision and editing the manuscript. Additional contributors to the project are: Dr Micheala McGlone and Dr Cheryl Gillis who provided guidance and support throughout the project as well as ongoing feedback through the review of emergency calls in the hospital; Alan Logan and Fiona Clements, resuscitation officers, who provided information, advice and assistance in the implementation of the project; and Jeanna Drummond, PICU housekeeper, who provided information regarding item costs and use. JP acts as guarantor of the content of this article.

Funding

The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests

None declared.

Patient consent for publication

Not required.

Provenance and peer review

Not commissioned; externally peer reviewed.

Data availability statement

All data relevant to the study are included in the article or uploaded as supplemental information.

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