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Clinical Paper

The epidemiology of respiratory arrests in a teaching hospital☆

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ABSTRACT

Aims: We aimed to characterise antecedent causes and outcomes of respiratory arrests occurring within a metropolitan tertiary teaching hospital in Melbourne, Australia.
Methods: We conducted a retrospective audit of respiratory arrests within our hospital over a 6-year period. Data were collected regarding patient characteristics, preceding clinical state, presumed causes and outcomes of arrests. We also compared outcomes of respiratory arrests to that of cardiac arrests occurring over the same period.
Results: We identified 82 respiratory arrests, occurring at a rate of 0.57/1000 inpatient admissions. Pre-existing respiratory, neurologic and cardiac disease was common, as was multi-morbidity. Preceding clinical instability was evident in 39% of arrests, most commonly elevated respiratory rate or progressive hypoxia. Pulmonary oedema was the most common cause of respiratory arrest followed by aspiration, neurologic events, medication side-effects, and tracheostomy-tube complications. In-hospital mortality for respiratory arrests was 25.1%, compared with 74.9% for cardiac arrests ($p < 0.001$) over the same time period.
Conclusions: Although rare, respiratory arrests are associated with significantly lower in-hospital mortality than cardiac arrests. Further studies are needed to better predict respiratory arrests and identify interventions to reduce incidence and improve outcomes.

1. Introduction

In-hospital cardiac arrests are associated with a mortality rate of greater than 80%, and multiple studies have described antecedent warning signs and outcomes of in-hospital cardiac arrest.[1] Most studies explicitly exclude pure respiratory arrests (RAs), in which a patient becomes apnoeic, but maintains cardiac output. RAs are excluded despite comprising 8–27% of cardio-pulmonary arrests.[2,3]

Primary RAs may progress to cardiac arrest if not recognised and treated. Wang et al. found that 65% of RAs progressed to cardio-pulmonary arrest within 10 min, with the presence of pulmonary embolus, hypotension, or failed invasive airway attempts increasing the likelihood of progression.[4] In a series of 2121 in-hospital cardio-pulmonary arrests, Cooper et al. found that 20% of events originated as primary RAs.[5] Further analysis of antecedents to RAs may identify interventions to prevent progression to cardiopulmonary arrest.

Available data, though limited, suggest that pure RAs may have a better prognosis than cardiac or cardiopulmonary arrests. For example, Cooper found improved survival in the 24 h following RA compared with cardiac arrests, although survival at discharge was the same between groups.[5] Further, in an analysis of 954 *out-of-hospital* RAs, Jones et al. found that RAs had a 40% survival-to-hospital-discharge rate, compared with only 5% for cardiopulmonary arrests.[6]

We conducted a retrospective audit of in-patient respiratory arrests occurring at our hospital between January 2005 and August 2010. We assessed patient characteristics, presumed causes, and outcomes of RAs, and compared the outcomes of RAs and cardiac arrests over the same period.

2. Methods

2.1. Setting

The Austin Hospital is a tertiary level teaching hospital in metropolitan Melbourne, Australia. It has 400 acute care beds and

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is a statewide referral centre for spinal cord injuries, chronic ventilatory failure, and liver transplant medicine.

The spinal and respiratory wards contain high-dependency areas in which non-invasive and invasive ventilation (via tracheostomy tube) can take place outside of the intensive care unit (ICU). Nursing staff in these areas has special expertise and training in the care of ventilated patients. Patients receiving ventilation in these areas are monitored with continuous pulse oximetry and routine hourly nursing observations. All ventilators used for ward-based invasive ventilation have programmable alarms. The cardiac ward is the only ward-based area in which continuous telemetry monitoring is performed.

A Medical Emergency Team (MET) operated for the duration of the study period and has been described elsewhere.[7] The MET consists of an ICU registrar and nurse, medical registrar and medical staff of the treating unit of the unstable patient. The Emergency Code team is activated when a patient has an immediate life-threatening emergency such as a cardiac or respiratory arrest, or immediately threatened airway. The MET is used to review all other life threatening emergencies and escalation (or "up-grade") to Emergency Code occurs in the infrequent occasions when cardio-respiratory arrest or RA develops during the course of a MET review. An Emergency Code upgrade triggers the attendance of an anaesthetist or senior anaesthetic trainee and cardiac nurse, in addition to MET personnel.

2.2. Study design

We conducted a retrospective observational audit study.

2.3. Participants

Potential RAs were identified from an existing hospital database of all "Emergency Code" events occurring within the Austin Hospital between January 1st 2005 and September 1st 2010. We included all events from the database that fulfilled our definition of RA. Two investigators (IM and DJ) worked simultaneously to characterise the call as "Cardiac arrest", "Potential RA" and "Non-arrest".

RA was defined as an event in which a patient became apnoeic or developed profound hypoventilation requiring manual ventilation with a non re-breathing ventilator bag or immediate endo-tracheal intubation, and in which cardiac output was maintained. A cardiac arrest (CA) was defined by the absence of a pulse, measurable blood pressure, unresponsiveness and the commencement of cardio-pulmonary resuscitation.

Amongst the events characterised as "Potential RA", a more detailed analysis of the patient file was conducted by a third investigator (AH) to confirm that each event fulfilled the case definition for RA.

RAs in which the patient had a "not-for-resuscitation" (do not resuscitate [DNR]) order were excluded, as were events occurring in outpatients, paediatric patients and in critical care areas such as intensive care, emergency department or operating theatre. Events occurring in ventilated patients in the spinal and respiratory high dependency areas were not excluded.

2.4. Data collection

We collected data from the medical records and hospital electronic pathology and radiology systems. Data was retrieved by a senior respiratory medicine fellow (AH), and was recorded using a standardised case report. All data was subsequently entered into an Excel (Microsoft, Washington, USA) spreadsheet for further analysis.

We collected information on patient demographics, admission diagnosis and comorbidities. Details leading up to the event were recorded, including ward setting, level and frequency of physiologic monitoring, presence of MET criteria within preceding 12 h, numeric values of vital signs prior to event, details of airway, supplemental oxygen and ventilatory requirement, conscious state and prior history of administration of sedating medications.

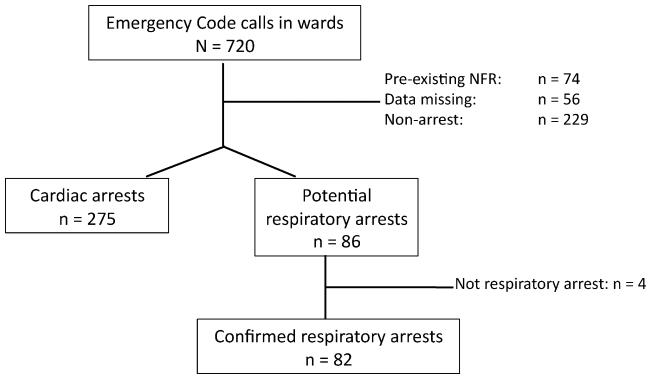

Fig. 1. Breakdown of Emergency Code calls at the Austin Hospital between January 2005 and August 2010.

Details of the event including time of day, suspected cause of deterioration, and interventions at time of event were also collected. Outcome measures included death at time of event, need for transfer to the ICU, hospital length of stay, in-hospital mortality, and discharge destination.

Causes of RAs were determined by the assessment of medical staff at the time of the event. The clinician's judgement of cause was recorded in data sheets completed at the time of each event as part of routine data collection for all Emergency Code calls.

Finally, we obtained the number of hospital admissions from the electronic clinical information system that occurred over the study period. An admission was defined as a multi-day stay (minimum of 24 h, and excluding same day and haemodialysis admissions).

2.5. Data analysis

We present descriptive statistics as crude numbers and percentage of totals, and distributed data are presented as median and inter-quartile range (IQR). Comparison of distributed data was performed using the Mann–Whitney *U* test. Comparison of categorical data was assessed using the chi-square, with continuity correction for non 2×2 tables. For all statistical analyses, a p-value < 0.05 was taken to indicate statistical significance. Statistical analysis was performed using SPSS-version 20 (IBM, NY, USA).

2.6. Ethics

Ethics approval was obtained by the local ethics review board (ethics approval number H2012-04543).

3. Results

3.1. Details of patient cohort

Over the study period there were 720 Emergency Code calls in ward patients (Fig. 1 and Table 1). Amongst these, there were 86 potential RAs. Four events were subsequently excluded as they did not meet our case definition of RA. Three patients had multiple RAs during the same admission. Thus, over the study period there were 82 RAs occurring in 79 patients. During the same period there were 275 CAs, occurring in 259 patients. Compared with CAs, patients suffering RA were significantly younger (median age 67.4 versus 71.3; $p = 0.011$).