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Original paper

Factors and outcomes associated with inpatient cardiac arrest following emergent endotracheal intubation☆

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ABSTRACT

Background: Inpatient peri-intubation cardiac arrest (PICA) following emergent endotracheal intubation (ETI) is an uncommon but potentially preventable type of cardiac arrest (CA). Limited published data exist describing factors associated with inpatient PICA and patient outcomes. This study identifies risk factors associated with PICA among hospitalized patients emergently intubated out of the operating room and compares PICA to other types of inpatient CA.

Methods: Retrospective case-control study of patients at our institution over a five-year period. Cases were defined as inpatients emergently intubated outside of the operating room that experienced cardiac arrest within 20 min after ETI. The control group consisted of inpatients emergently intubated out of the operating room without CA. Predictors of PICA were identified through univariate and multivariate analysis. Clinical outcomes were compared between PICA and other inpatient CAs, identified through a prospectively enrolled CA registry at our institution.

Results: 29 episodes of PICA occurred over 5 years, accounting for 5% of all inpatient arrests. Shock index ≥1.0, intubation within one hour of nursing shift change, and use of succinylcholine were independently associated with PICA. Sustained ROSC, survival to discharge, and neurocognitive outcome did not differ significantly between groups.

Conclusion: Patients outcomes following PICA were comparable to other causes of inpatient CA. Potentially modifiable factors were associated with PICA. Hemodynamic resuscitation, optimized staffing strategies, and possible avoidance of succinylcholine were associated with decreased risk of PICA. Clinical trials testing targeted strategies to optimize peri-intubation care are needed to identify effective interventions to prevent this potentially avoidable type of CA.

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Introduction

Emergent endotracheal intubation (ETI) in a decompensating critically ill patient is commonly performed in the inpatient setting. The procedure is not without risk, and complications include hypotension, hypoxemia, esophageal intubation, aspiration, pneumothorax, and death [1–5]. Peri-intubation cardiac arrest (PICA) in the operating room (OR) is exceeding rare, with an estimated prevalence of 0.02% to 0.05% [6,7]. However, cardiac arrest (CA) following ETI in critically ill inpatients out of the OR remains an under-described but increasingly recognized phenomenon.

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Several studies have attempted to describe the risk of PICA with emergent ETI. A small study evaluating emergent intubations in the ICU over a 10-month period found that 7/238 (3%) of patients died within 30 min of endotracheal intubation and that pre-procedure hypotension was a risk factor for death [8]. Another study evaluated prevalence of cardiac arrest in critically ill patients intubated by anesthesiologists at a single center [9]. The authors found that approximately 2% of all emergent intubations were complicated by PICA and the majority were associated with profound hypoxemia during ETI. A prior study of emergent ETI in the emergency department (ED) found that elevated body mass index (BMI), and high shock index (SI) were independent risk factors of PICA [10]. The prevalence of PICA was 4% in this population and the authors found that even if these patients obtained return of spontaneous circulation, they had an in-hospital mortality of 84%.

The goal of this study is to identify patient characteristics, pre-intubation interventions, and other conditions that may predict PICA in an inpatient population undergoing emergent ETI. We also seek to compare clinical outcomes of PICA to other types of inpatient cardiac arrest. Our main hypothesis is that potentially modifiable patient characteristics readily identifiable to providers at the time of ETI may predict PICA; better characterization and recognition could potentially decrease rates of PICA in the inpatient setting.

Methods

Study design & setting

This is a retrospective case-control study examining cardiac arrest following emergent out-of-OR intubations in patients admitted to the University California, San Diego (UCSD) Healthcare System, a tertiary referral center. UCSD includes two separate hospitals; one functions as a safety-net hospital, the other as an advanced tertiary and quaternary care center, and totals 530 beds, of which 74 are licensed ICU beds. This study includes all patients with PICA between September 2011 and May 2016. This study was approved by the local institutional review board (IRB #150889).

Emergent out-of-OR intubations are performed by a variety of physicians including emergency medicine residents, anesthesiology residents and fellows, and pulmonary & critical care fellows. All trainees require airway-certified, attending-level supervision. Emergent intubations are assisted by licensed respiratory therapists, critical care nurses and pharmacists, and may occur at any location within the hospital.

Following inpatient cardiac arrest, resuscitation attempts are conducted by a multi-disciplinary team, certified in Advanced Resuscitation Training (ART) and may include internal medicine residents or fellows and attending physicians, critical care nurses, respiratory therapists and pharmacists. ART is a resuscitation program designed specifically for inpatient cardiac arrest and is used as an alternative to Advanced Cardiac Life Support (ACLS) at UCSD [11].

Inclusion & exclusion criteria

Patients who were 18 years or older and experienced a cardiac arrest within 20 min after out-of-OR ETI were included. This time frame was selected based upon prior investigations of PICA that found PICA typically occurs within this period [8,10]. CA was defined as the initiation of chest compressions, the absence of a palpable pulse, and/or at least one defibrillation attempt. Only index CA episodes, defined as the first CA during a hospital admission, were included. Patients were excluded if they had out of hospital cardiac arrest, arrest prior to intubation (even if ROSC had occurred), intubation in the ED prior to admission, in the OR, or the trauma bay.

Table 1
Demographic data of patients who underwent emergent endotracheal intubation with and without PICA.

	Peri-intubation arrest (n = 29)	Controls (n = 116)	*p*
Demographic factors			
Age (yrs)	58.7 (±19.3)	59.5 (±15.8)	0.665
% male, (n)	69% (20)	64 (64%)	0.665
Weight (kg)	78.6 (±22.8)	76.4 (±28.0)	0.607
Height (m)	1.71 (±0.1)	1.70 (±0.1)	0.649
BMI	27.2 (±8.8)	26.4 (±8.7)	0.680
Co-morbidities			0.241
% COPD, (n)	7.4% (2)	7% (8)	
% Heart failure, (n)	24.1% (7)	11% (13)	
% MI, (n)	7.4% (2)	15% (17)	
% Prior stroke, (n)	3.4% (1)	5% (6)	
% CKD, (n)	7.4% (2)	18% (18)	
% Cirrhosis, (n)	7.4% (2)	13% (15)	

Comparison groups

During the same time period as the enrollment of patients who had a PICA, we randomly selected 4 controls for every case. Thus, the control group consisted of 116 patients who had an out-of-OR emergent intubation that did not result in CA. We limited this group to inpatients who were intubated either in the ICU or wards; those intubated in the trauma bay or upon arrival to the ED were excluded. If a patient had already been admitted to either the wards or the ICU, and was then intubated in the ED, they were eligible for this study.

A robust CA database is maintained as part of ART at UCSD. Inpatient CA are identified and confirmed by a multidisciplinary committee using a review of the medical record, resuscitation reports, "Code Blue" committee meeting minutes and a continuous quality improvement database. All patients age 18 years or older who suffered an index inpatient CA other than a PICA were included for comparison.

Data collection & integrity

Demographic data for both cases and controls were abstracted from the medical record and CA database and included age, gender, race, weight, height, and body mass index (BMI). Factors related to the intubation itself included pre-intubation heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), oxygen saturation (spO2), and shock index (SI; defined as last recorded heart rate divided by systolic blood pressure prior to intubation attempt), degree and type of oxygen support preceding intubation [non-invasive ventilation, high-flow oxygen nasal cannula, other (including non-re-breather mask and nasal cannula)], use of vasoactive medication prior to intubation, as well as indication for emergent intubation, use of paralytic, as well as type (succinylcholine, non-depolarizing agent, none) during ETI, type of sedative (etomidate, benzodiazepine, propofol, other/multiple, none), number of attempts, physician specialty (anesthesia, pulmonary critical care, or emergency medicine), location of arrest (ward or ICU), time of arrest (day defined as between 7 AM and 7 PM), if the arrest occurred on a weekday (defined as Monday 7 AM until Friday 7 PM) or weekend, and if the arrest occurred within one hour of nursing staff shift change. We also recorded in-hospital mortality for all patients.

Demographic and outcome data for all patients with non-PICA was abstracted from the medical record. The underlying rhythm of CA was also recorded.

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