Resident Scholarly Project / Resident Proposal
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Characterization of Pauses during Extracorporeal Cardiopulmonary Resuscitation in Pediatric Cardiac Arrests

Background: The American Heart Association (AHA) defines five components that determine high-quality cardiopulmonary resuscitation (CPR) in the event of a sudden cardiac arrest: adequate rate, adequate depth, full chest recoil between compressions, avoiding excessive ventilation, and minimizing interruptions. In particular, the AHA recommends a pause, lasting no more than 10 seconds, every 2 minutes for an adequate pulse check during CPR.[17] Previous studies have suggested that prolonged pauses are associated with worse survival during in-hospital and out-of-hospital cardiac arrests.[2,3,18] These pauses have also been associated with pulse checks and multiple tasks necessary during a resuscitation.[12] Chest Compression Fraction is another metric used to assess interruptions in CPR. Chest compression fraction is the fraction of time spent compressing the chest during a resuscitation. The AHA defines high-quality CPR as a chest compression fraction of >80%, meaning greater than 80% of the time during CPR is spent performing chest compressions.[11]

With the advent of extracorporeal membrane oxygenation (ECMO), more pediatric patients are being transitioned to ECMO during resuscitation. This practice of cannulation to veno-arterial ECMO during a sudden cardiac arrest requiring CPR is known as extracorporeal cardiopulmonary resuscitation (ECPR). ECPR is used as a life-supporting measure to perfuse the body during a cardiac arrest and, once the ECMO circuit is established, compressions are stopped. ECPR is a surgical procedure that requires insertion of venous and arterial catheters either peripherally (in the neck or femoral vessels) or centrally, where the vessels are accessed through a surgically open chest.[11] Due to this, CPR may be interrupted during cannulation and establishment of the ECMO circuit. There is a paucity of data characterizing the quality of CPR before and during ECMO cannulation in pediatric patients undergoing ECPR.

Hypothesis: Chest compression fraction is smaller during cannulation to ECMO than prior to cannulation in pediatric cardiac arrests located in the pediatric intensive care unit (PICU).

Outcome Measures:
Chest Compression Fraction
Pause Duration
Number of Pauses
Longest Pause

Analysis: Descriptive Statistics, Paired T-Test

Methods:
During cardiac arrests in a pediatric ICU, cutaneous and invasive cardiopulmonary monitoring are utilized to provide real time feedback. Respiratory leads are placed on a patient's chest to monitor respiratory rate; an arterial line may be inserted into a patient's artery to monitor blood pressure in real time. However, while compressions are ongoing, artifact from compressions can obscure the usual data obtained from both respiratory and arterial monitors. The artifact correlates with compressions and can be used to assess when compressions are ongoing; when the artifact is absent from the monitor data it correlates with a pause in compressions. This pause can be measured and duration calculated. We seek to utilize this to our advantage

to understand timing of pauses during a resuscitation. As previously described, invasive arterial blood pressure monitoring can be used as a surrogate for compression quality.[13] The artifact seen on both arterial and respiratory monitors seems to correlate well to when compressions are occurring, and may provide both real time and retrospective data regarding timing of compressions, pauses, and overall chest compression fraction during arrests when monitoring is available. For patients who experience a cardiac arrest in the PICU at our institution, monitor printouts are retrieved for quality improvement and internal review on a routine basis.

Data were analyzed from both respiratory and arterial monitors and compared for accuracy in patients who experienced a cardiac arrest and were subsequently cannulated on to ECMO during the arrest. Monitors print data in 1-minute increments; using a ruler fit to this timeline, pauses were measured from the start of the arrest to the time the code ended due to death or successful establishment of the ECMO circuit.

Using a retrospective chart review from April 2016 to July 2021, a total of 54 cardiac arrests with ECMO team activation occurred in one of the PICUs at our institution. On first pass, 27 of these events had some monitor data collected. 15 events occurred after our transition to EPIC and had data readily available for analysis. Monitor data were reviewed for completion and a total of 12 events had arterial monitor data for the duration of the resuscitation and 10/12 had additional respiratory monitor data available as well. The remaining 12 events (from before the EPIC transition) may be available for analysis however, will require retrieval from the former electronic medical record.

Data from events will be analyzed in two discreet phases, before ECMO cannulation during routine CPR, and during ECPR while ECMO cannulation was ongoing. This allows for analysis by a paired T-test where pauses are compared within the same event (in the same subject), before versus during ECMO cannulation during CPR. Power analysis suggests that 12 events will be sufficient to detect a difference of 0.085 in chest compression fraction between before and during cannulation CPR.

After completion of data collection, data will be analyzed using descriptive statistics and a paired t-test allowing for comparison of pauses before ECMO before cannulation and during cannulation within the same event. If all events are able to be acquired (24 in total), a secondary analysis will be performed, quantifying these differences in pauses between patients who underwent central or peripheral ECMO.

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