Advanced life support


Effective cardiopulmonary resuscitation with appropriate airway management improves outcomes following out-of-hospital cardiac arrest (OHCA). Historically, tracheal intubation has been accepted as the optimal form of OHCA airway management in the UK. The Joint Royal Colleges Ambulance Liaison Committee recently concluded that newer supraglottic airway devices (SADs) are safe and effective devices for hospital procedures and that their use in OHCA should be investigated. This study will address an identified gap in current knowledge by assessing whether it is feasible to use a cluster randomised design to compare SADs with current practice, and also to each other, during OHCA.

Methods and analysis: The primary objective of this study is to assess the feasibility of a cluster randomised trial to compare the ventilation success of two newer SADs: the i-gel and the laryngeal mask airway supreme to usual practice during the initial airway management of OHCA. The secondary objectives are to collect data on ventilation success, further airway interventions required, loss of a previously established airway during transport, airway management on arrival at hospital (or termination of the resuscitation attempt), initial resuscitation success, survival to intensive care admission, survival to hospital discharge and patient outcome at 3 months. Ambulance paramedics will be randomly allocated to one of the three methods of airway management. Adults in medical OHCA attended by a trial paramedic will be eligible for the study. Ethics and dissemination: Approval for the study has been obtained from a National Health Service Research Ethics Committee with authority to review proposals for trials of a medical device in incapacitated adults. The results will be made publicly available on an open access website, and we will publish the findings in appropriate journals and present them at national and international conferences relevant to the subject field. Trial registration ISRCTN: 18528625.


We conducted a crossover-randomised study to evaluate the performance of a novel optical stylet, the InnoScope, for tracheal intubation in simulated normal and difficult airways. Twenty-five anaesthetists attempted tracheal intubation on a SimMan 3G simulator using the InnoScope first followed by the Macintosh laryngoscope or vice versa. Three airway scenarios were tested: (1) normal airway; (2) difficult airway with swollen pharynx; and (3) limited neck movement. In each scenario, the laryngeal view, duration of and success rate for tracheal intubation were recorded. Compared with the Macintosh laryngoscope, the use of InnoScope increased the percentage of glottic opening seen by 17% in normal airway, 23% in the difficult airway and 32% with limited neck movement, p < 0.01. Despite this better laryngeal view, successful tracheal intubation achieved with the InnoScope (88.0%) was lower than that for the Macintosh laryngoscope (98.7%), p = 0.008. Using the InnoScope, tracheal intubation during the first attempt was only successful in 48% of cases with difficult airway. In this scenario, the median (interquartile range
duration of tracheal intubation was significantly longer with the InnoScope (53 (20–100 [15–120]) s) compared with the Macintosh laryngoscope (27 (20–62 [15–120]) s), p = 0.01. We conclude that an improved laryngeal view with the use of the InnoScope did not translate into better conditions for tracheal intubation.


The choice of a shock-first or a cardiopulmonary resuscitation (CPR)-first strategy in the treatment of prolonged cardiac arrest (CA) is still controversial. The purpose of this study was to compare the effects of these strategies on oxygen metabolism and resuscitation outcomes in a porcine model of 8min CA. Methods: Ventricular fibrillation (VF) was electrically induced. After 8min of untreated VF, 24 male inbred Wu-Zhi-Shan miniature pigs were randomized to receive either defibrillation first (ID group) or chest compression first (IC group). In the ID group, a shock was delivered immediately. If the defibrillation attempt failed to attain restoration of spontaneous circulation (ROSC), manual chest compressions were rapidly initiated at a rate of 100 compressions min⁻¹, and the compression-to-ventilation ratio was 30:2. If VF persisted after five cycles of CPR, a second defibrillation attempt was made. In the IC group, chest compressions were delivered first, followed by a shock. Results: Hemodynamic variables, the VF waveform and blood gas analysis outcomes were recorded. Oxygen metabolism parameters and the amplitude spectrum area (AMSA) of the VF waveform were computed. There were no significant differences in the rate of ROSC and 24h survival between two groups. The ID group had lower lactic acid levels, higher cardiac output, better oxygen consumption and better oxygen extraction ratio at 4 and 6h after ROSC than the IC group. Conclusions: In a porcine model of prolonged CA, the choice of a shock-first or CPR-first strategy did not affect the rate of ROSC and 24h survival, but the shock-first strategy might result in better hemodynamic status and better oxygen metabolism than the CPR-first strategy at the first 6h after ROSC.


We evaluated the association between TH use and “dose” and cumulative vasopressor and inotrope requirement, survival, and neurologic outcome. Background: Therapeutic hypothermia (TH) improves outcome after cardiac arrest, but may increase vasopressor and inotrope requirements. Methods: Chart review of in- and out-of-hospital cardiac arrests between 1/1/2005 and 3/15/2010. Data included demographic information, category of post-cardiac arrest illness severity ((I) awake, (II) coma (not following commands but intact brainstem responses)+mild cardiopulmonary dysfunction (SOFA [Sequential Organ Failure Assessment] cardiac + respiratory score <4), (III) coma + moderate–severe cardiopulmonary dysfunction (SOFA cardiac + respiratory score ≥ 4), and (IV) coma without brainstem reflexes), cumulative vasopressor index (CVI), inotrope use, survival, and neurologic outcome. The “dose” of TH (hours*temperature below threshold) was calculated using thresholds of ≤ 34℃ and ≤ 35℃. Data were analyzed using descriptive statistics, Student’s t-test, Wilcoxon test, and chi-squared analysis. Linear and logistic regression evaluated the effect of hypothermia “dose” on total CVI, survival and neurologic outcome. Results: Among 361 comatose patients, 233 (65%) received TH. Vasopressor administration (measured by CVI) was higher in normothermic subjects (60.2% vs. 46.4%; p=0.016). Using a 34℃ threshold, SOFA respiratory sub-score and PEA arrest predicted total CVI. Using a 35℃ threshold, severity of coma, SOFA respiratory sub-score, PEA arrest and use of inotropic agents in addition to vasopressors predicted total CVI. Initial motor examination predicted survival and neurologic outcome, while TH “dose” did not. Conclusions: TH delivery is not associated with vasopressor requirement. TH “dose” is not associated with total CVI, survival, or good outcome. Vasopressor or inotropic requirement should not contraindicate TH use.

Recent studies have shown that short duration ventricular fibrillation (SDVF) and long duration ventricular fibrillation (LDVF) are maintained by different mechanisms. The objective of this study is to evaluate how the defibrillation threshold (DFT) varies over the duration of fibrillation since the mechanism of VF maintenance changes as VF progresses. Methods: Twelve canines were randomly divided into two groups (Group A and B, n = 6 each). DFTs were measured three times in each group: SDVF (20 s), LDVF (3 min in Group A and 7 min in Group B) and the first episode of refibrillation after successful defibrillation for LDVF. Two 64-electrode baskets used to globally map the endocardium were deployed into the left ventricle and right ventricle, respectively. Results: LDVF-DFT in Group A was significantly higher than that of Group B (628 ± 98 V vs 313 ± 81 V, P < 0.001). In Group B, the DFT of refibrillation was significantly increased compared with the LDVF-DFT (570 ± 199 V vs 313 ± 81 V, P = 0.035) but did not differ from the DFT of refibrillation in Group A (570 ± 199 V vs 638 ± 116 V, P = 0.39). Highly synchronised activation patterns on the left ventricular endocardium were observed between 3 and 7 min of LDVF in Group B but not within 3 min-LDVF in Group A or during refibrillation in each group. Conclusions: DFT varied during different stages of VF. The highly synchronised activation patterns exhibiting after 3 min VF might contribute to the decreased LDVF-DFT.


This topic highlights the results of the literature review on calcium therapy during cardiac arrest and cardiopulmonary resuscitation according to the Patient/population, Intervention, Comparator, Outcome structure. Eligible studies were assigned to one of the five levels of evidence. Their quality was rated as either good, fair, or poor and then classified as supportive, neutral, or opposing according to the outcome benefits. Among the 48 articles retrieved, 10 articles fulfilled all the criteria for analysis for the Guidelines preparation. There is no evidence that the administration of calcium during cardiopulmonary resuscitation improves survival from cardiac arrest irrespective of the presenting rhythm. In the setting of hyperkalemia, calcium channel blocker intoxication, hypocalcemia, and hypermagnesemia, the role of calcium remains unclear because of the limited amount of evidence. The main limitation is the scarcity of data, most of which relate to anoxic cardiac arrest, accounting for no more than 25% of the causes of cardiac arrest in humans.


There is growing use of video laryngoscopy in US emergency departments (EDs). This study seeks to compare intubation success between the GlideScope video laryngoscope and the C-MAC video laryngoscope (C-MAC) in ED intubations. Methods: This was an analysis of quality improvement data collected during a 3-year period in an academic ED. After each intubation, the operator completed a standardized data form reporting patient demographics, indication for intubation, device(s) used, reason for device selection, difficult airway characteristics, number of attempts, and outcome of each attempt. An attempt was defined as insertion of the device into the mouth regardless of attempt at tube placement. The primary outcomes were first pass and overall intubation success. The study compared success rates between the GlideScope video laryngoscope and the C-MAC groups, using multivariable logistic regression and adjusting for potential confounders. Results: During the 3-year study period, there were 463 intubations, including 230 with the GlideScope video laryngoscope as the initial device and 233 with the C-MAC as...
the initial device. The GlideScope video laryngoscope resulted in first-pass success in 189 of 230 intubations (82.2%; 95% confidence interval [CI] 76.6% to 86.9%) and overall success in 221 of 230 intubations (96.1%; 95% CI 92.7% to 98.2%). The C-MAC resulted in first-pass success in 196 of 233 intubations (84.1%; 95% CI 78.8% to 88.6%) and overall success in 225 of 233 intubations (96.6%; 95% CI 93.4% to 98.5%). In a multivariate logistic regression analysis, the type of video laryngoscopic device was not associated with first-pass (odds ratio 1.1; 95% CI 0.6 to 2.1) or overall success (odds ratio 1.2; 95% CI 0.5 to 3.1). Conclusion: In this study of video laryngoscopy in the ED, the GlideScope video laryngoscope and the C-MAC were associated with similar rates of intubation success.


The purpose of this study was to examine the prognostic value of continuous amplitude-integrated electroencephalogram (aEEG) applied immediately after return of spontaneous circulation (ROSC) in therapeutic hypothermia (TH)-treated cardiac arrest patients. Methods: From September 2010 to August 2011, we prospectively studied comatose patients treated with TH after cardiac arrest who were monitored with aEEG. Monitoring at the forehead was applied as soon as possible after ROSC in the emergency department and continued until recovery of consciousness, death, or 72h after ROSC. Neurological outcome was assessed with the Cerebral Performance Category (CPC) scale at hospital discharge, and good neurological outcome was defined as a CPC score of 1 or 2. Results: A total of 55 TH-treated patients were included. Monitoring started at a median of 96min after ROSC (interquartile range, 49–174). At discharge, 28 patients had a CPC of 1–2, and 27 patients had a CPC of 3–5. Seventeen patients had a continuous normal voltage (CNV) trace at the start of monitoring, and this voltage was strongly associated with a good outcome (16/17 [94.1%]; sensitivity and specificity of 57.1 and 96.3%, respectively). No development of a CNV trace within the recorded period accurately predicted a poor outcome (21/21 [100%]; sensitivity and specificity of 77.8 and 100%, respectively). Conclusions: An initial CNV trace in aEEG applied to forehead immediately after ROSC is a good early predictor of a good outcome in TH-treated cardiac arrest patients. Conversely, no development of a CNV trace within 72h is an accurate and reliable predictor of a poor outcome with a false-positive rate of 0%.


High-quality chest-compressions are of paramount importance for survival and good neurological outcome after cardiac arrest. However, even healthcare professionals have difficulty performing effective chest-compressions, and quality may be further reduced during transport. We compared a mechanical chest-compression device (Lund University Cardiac Assist System [LUCAS]; Jolife, Lund, Sweden) and manual chest-compressions in a simulated cardiopulmonary resuscitation scenario during helicopter rescue. Methods: Twenty-five advanced life support-certified paramedics were enrolled for this prospective, randomized, crossover study. A modified Resusci Anne manikin was employed. Thirty minutes of training was allotted to both LUCAS and manual cardiopulmonary resuscitation (CPR). Thereafter, every candidate performed the same scenario twice, once with LUCAS and once with manual CPR. The primary outcome measure was the percentage of correct chest-compressions relative to total chest-compressions. Results: LUCAS compared to manual chest-compressions were more frequently correct (99% vs 59%, P < .001) and were more often performed correctly regarding depth (99% vs 79%, P < 0.001), pressure point (100% vs 79%, P < 0.001)
and pressure release (100% vs 97%, P = .001). Hands-off time was shorter in the LUCAS than in the manual group (46 vs 130 seconds, P < 0.001). Time until first defibrillation was longer in the LUCAS group (112 vs 49 seconds, P < 0.001). Conclusions: During this simulated cardiac arrest scenario in helicopter rescue LUCAS compared to manual chest-compressions increased CPR quality and reduced hands-off time, but prolonged the time interval to the first defibrillation. Further clinical trials are warranted to confirm potential benefits of LUCAS CPR in helicopter rescue.

To demonstrate the feasibility of doing a reliable rhythm analysis in the chest compression pauses (e.g. pauses for two ventilations) during cardiopulmonary resuscitation (CPR). We extracted 110 shockable and 466 non-shockable segments from 235 out-of-hospital cardiac arrest episodes. Pauses in chest compressions were already annotated in the episodes. We classified pauses as ventilation or non-ventilation pause using the transthoracic impedance. A high-temporal resolution shock advice algorithm (SAA) that gives a shock/no-shock decision in 3s was launched once for every pause longer than 3s. The sensitivity and specificity of the SAA for the analyses during the pauses were computed. We identified 4476 pauses, 3263 were ventilation pauses and 2183 had two ventilations. The median of the mean duration per segment of all pauses and of pauses with two ventilations were 6.1s (4.9 - 7.5s) and 5.1s (4.2 - 6.4s), respectively. A total of 91.8% of the pauses and 95.3% of the pauses with two ventilations were long enough to launch the SAA. The overall sensitivity and specificity were 95.8% (90% low one-sided CI, 94.3%) and 96.8% (CI, 96.2%), respectively. There were no significant differences between the sensitivities (P=0.84) and the specificities (P=0.18) for the ventilation and the non-ventilation pauses. Chest compression pauses are frequent and of sufficient duration to launch a high-temporal resolution SAA. During these pauses rhythm analysis was reliable. Pre-shock pauses could be minimised by analysing the rhythm during ventilation pauses when CPR is delivered at 30:2 compression:ventilation ratio.

The effect of prehospital use of supraglottic airway devices as an alternative to tracheal intubation on long-term outcomes of patients with out-of-hospital cardiac arrest is unclear. Study Objectives: We compared the neurological outcomes of patients who underwent supraglottic airway device insertion with those who underwent tracheal intubation. Methods: We conducted a nationwide population-based observational study using a national database containing all out-of-hospital cardiac arrest cases in Japan over a 3-year period (2005 - 2007). The rates of neurologically favorable 1-month survival (primary outcome) and of 1-month survival and return of spontaneous circulation before hospital arrival (secondary outcomes) were examined. Multiple logistic regression analyses were performed to adjust for potential confounders. Advanced airway devices were used in 138,248 of 318,141 patients, including an endotracheal tube (ETT) in 16,054 patients (12%), a laryngeal mask airway (LMA) in 34,125 patients (25%), and an esophageal obturator airway (EOA) in 88,069 patients (63%). Results: The overall rate of neurologically favorable 1-month survival was 1.03% (1426/137,880). The rates of neurologically favorable 1-month survival were 1.14% (183/16,028) in the ETT group, 0.98% (333/34,059) in the LMA group, and 1.04% (910/87,793) in the EOA group. Compared with the ETT group, the rates were significantly lower in the LMA group (adjusted odds ratio 0.77, 95% confidence interval [CI] 0.64 - 0.94) and EOA group (adjusted odds ratio 0.81, 95% CI 0.68 - 0.96). Conclusions: Prehospital use of supraglottic airway devices was associated with slightly, but significantly, poorer neurological outcomes
compared with tracheal intubation, but neurological outcomes remained poor overall.


Survival after cardiac arrest remains poor, especially when it occurs outside of hospital. In recent years, therapeutic hypothermia has been used to improve outcomes in patients who have experienced cardiac arrest, however, application to out-of-hospital cardiac arrest (OHCA) patients remains controversial. Methods: A total of 175 OHCA patients underwent therapeutic hypothermia (TH), which was performed using large volume ice crystalloid fluid (LVICF) infusions after ICU admission. Ice packs and conventional cooling blankets were used to maintain a core body temperature of 33°C, according to standard protocol for 36 hours. Patients in the control group received standard supportive care without TH. Hospital survival and neurologic outcomes were compared. Results: There was no significant difference between the groups with regards to patient characteristics, underlying etiologies, and length of hospital stays. The duration of cardiac pulmonary resuscitation (CPR) was also similar. In the 51 patients that received TH, 14 were alive at hospital discharge. In the 124 patients belonging to the supportive care group, only 15 were alive at hospital discharge (27.5% vs. 12.1%, p = 0.013). Approximately 7.9% of patients in the TH group had good neurologic outcomes (4 of 51) compared with the 1.7% (2 of 124) of patients in the supportive group (p = 0.04). There were no specific treatment-related complications. Conclusion: Therapeutic hypothermia can be safely applied to OHCA patients and can improve their outcome. Further large scale studies are needed to verify our results.


Objectives: Tracheal intubation is used to maintain a patent airway and can occasionally be difficult in a potentially difficult airway, especially for novice managers. In this study, we evaluated the time required, extent of the difficulty, and number of dental clicks in the tracheal intubation for novice medical students between the Macintosh (Truphatek International Ltd, Netanya, Israel) and 3 video laryngoscopes in normal and difficult simulated intubation positions on manikins on both the table and floor. Methods: We recruited 20 medical students as novice airway managers. They used the Macintosh, Truview (Truphatek International Ltd, Netanya, Israel), Glidescope (Verathon Inc., Bothell, WA), and Airway Scope (AWS) (Pentax Corporation, Tokyo, Japan) laryngoscopes in normal and difficult simulated airways on manikins on both the table and floor. The time to intubate, modified Cormack-Lehane score, intubation difficulty score, and dental click number were estimated and compared. Results: All 20 medical students completed the study. The AWS required the shortest intubation time, provided the best glottic view and easiest intubation, and resulted in less dental clicks compared with the other 3 laryngoscopes; these phenomena were particularly prominent in the cervical-spine immobilization position on the floor. Although all video laryngoscopes provided better glottic views than the Macintosh laryngoscope in terms of time to intubate, intubation difficulty score, and the number of dental clicks, the outcomes from the Macintosh laryngoscope were better than those of the Truview and Glidescope. Conclusions: The AWS may have the potential for quicker, easier, and safer tracheal intubation in scenarios involving difficult airways for a novice airway manager.


Drowning is a common cause of death in young adults. The 2010 guidelines of the European Resuscitation Council call for in-water-resuscitation
There has been controversy about IWR amongst emergency and diving physicians for decades. The aim of the present study was assessing the efficacy of IWR.

Methods: In this randomized cross-over trial, nineteen lifeguards performed a rescue manoeuvre over a 100m distance in open water. All subjects performed the procedure four times in random order: with no ventilation (NV) and transportation only, mouth-to-mouth ventilation (MMV), bag-mask-ventilation (BMV) and laryngeal tube ventilation (LTV). Tidal volumes, ventilation rate and minute-volumes were recorded using a modified Laerdal Resusci Anne manikin. Furthermore, water aspiration and number of submersions of the test mannequin were assessed, as well as the physical effort of the lifeguard rescuers. One lifeguard subject did not complete MMV due to exhaustion and was excluded from analysis.

Results: NV was the fastest rescue manoeuvre (advantage ~40s). MMV and LTV were evaluated as efficient and relatively easy to perform by the lifeguards. While MMV (mean 199ml) and BMV (mean 481ml) were associated with a large amount of aspirated water, aspiration was significantly lower in LTV (mean 118ml). The efficacy of ventilation was consistently good in LTV (Vt=447ml), continuously poor in BMV (Vt=197) and declined substantially during MMV (Vt=1019ml initially and Vt=786ml at the end). The physical effort of the lifeguards was remarkably higher when performing IWR: 3.7 in NV, 6.7 in MMV, 6.4 in BMV and 4.8 in LTV as measured on the 0–10 visual analogue scale.

Conclusion: IWR in open water is time consuming and physically demanding. The IWR training of lifeguards should put more emphasis on a reduction of aspiration. The use of ventilation adjuncts like the laryngeal tube might ease IWR, reduce aspiration of water and increase the efficacy of ventilation during IWR.
standardized protocols available for a course of action in case of emergency, and there are no continuous registry data for in-hospital cardiac arrest and survival. Objective: Our aim was to improve survival and receive outcomes data, so we implemented a structured hospital-wide automated first-responder system in the hospital. Here our 5-year experience with 443 emergency calls is outlined. Methods: Throughout the hospital, 15 automated external defibrillator (AED) ‘access spots’ which can be easily reached within 30 s, were identified. AEDs were then installed at these locations (Lifepak 500 and Lifepak 1000, Medtronic equipped with a Biolog 3000i portable ECG monitor). At the same time, a training program was initiated in which the employees of the hospital participated once a year. Participants learned how to apply and activate an AED in case of cardiac arrest even before the designated Cardiac Arrest Team arrived at the scene. Results A witnessed cardiac arrest event was confirmed in 126 cases. In 56 of the 126 cases, the primary arrest rhythm was either ventricular tachycardia or ventricular fibrillation and the AED delivered a shock. In this group, spontaneous circulation was reached in 44 cases (79%) and 23 patients (41%) were discharged. In 44% (24 from 55 patients) of the cases, a shock was recommended by AED and delivered by the first responders before the rescue team arrived. Conclusions: The first-responder AED program successfully gave training lessons to the hospital staff. The training included how to initiate the cardiac arrest call, how to use the AED, and how to start immediate resuscitation. As a result, a higher survival rate after in-hospital cardiac arrest can be accomplished.


Our emergency medical service developed a telephone (phone)-assisted cardiopulmonary resuscitation (PACPR) procedure. Objectives: To describe this procedure and study the factors modulating its implementation. Methods: We conducted a single-center prospective study of telephone calls to our emergency medical communication center for cardiac arrest, for which PACPR was initiated. Results: Thirty-eight patients were included in the study. In six cases, cardiopulmonary resuscitation (CPR) had been started before the call. When PACPR was initiated, CPR was performed until the rescue team arrived in 27 cases. One-third (n = 9) of the bystanders in these cases knew first-aid interventions, and all of these bystanders continued CPR until the rescue team arrived. The absence of a familial relationship between bystander and patient facilitated the continuation of CPR (100% vs. 37% with family ties, p = 0.01). CPR was continued more often if the bystander immediately agreed to PACPR than when he or she did not agree at first (88% vs. 45%, respectively, p < 0.01). When an obstacle to performing CPR was encountered, CPR was then performed in 57% of cases vs. 100% of cases with no obstacle (p = 0.003). These obstacles were associated with either the bystander (panic, apprehension, feelings of inadequacy, physical inability, indirect witness, tiredness) or the victim (morphotype, physical position). The presence of an obstacle, compared to no obstacle, associated with the bystander lowered the CPR performance rate (58% vs. 94%, respectively, p = 0.01). The presence of an obstacle, compared to no obstacle, associated with the victim also lowered CPR performance rate (50% vs. 85%, respectively, p = 0.04). Conclusion: Our study demonstrates the feasibility of PACPR. The results may lead to a better understanding of facilitating factors and obstacles to telephone-assisted CPR, with the goal of improving its implementation. Good command of communication tools, identification of an appropriate bystander, and appropriate victim positioning are three fundamental factors of success.


This study was designed to assess changes in cardiopulmonary resuscitation (CPR) quality and rescuer fatigue when rescuers are provided with
a break during continuous chest compression CPR (CCC-CPR). The present prospective, randomized crossover study involved 63 emergency medical technician trainees. The subjects performed three different CCC-CPR methods on a manikin model. The first method was general CCC-CPR without a break (CCC), the second included a 10-s break after 200 chest compressions (10/200), and the third included a 10-s break after 100 chest compressions (10/100). All methods were performed for 10min. We counted the total number of compressions and those with appropriate depth every 1min during the 10min and measured mean compression depth from the start of chest compressions to 10min. The 10/100 method showed the deepest compression depth, followed by the 10/200 and CCC methods. The mean compression depth showed a significant difference after 5min had elapsed. The percentage of adequate compressions per min was calculated as the proportion of compressions with appropriate depth among total chest compressions. The percentage of adequate compressions declined over time for all methods. The 10/100 method showed the highest percentage of adequate compressions, followed by the 10/200 and CCC methods. When rescuers were provided a rest at a particular time during CCC-CPR, chest compression quality increased compared with CCC without rest. Therefore, we propose that a rescuer should be provided a rest during CCC-CPR, and specifically, we recommend a 10-s rest after 100 chest compressions.

Nishi T, Maeda T, Takase K, Kamikura T, Tanaka Y and Inaba H. Does the number of rescuers affect the survival rate from out-of-hospital cardiac arrests? Two or more rescuers are not always better than one. Resuscitation 2013; 84 (2): 154-61

An increased number of rescuers may improve the survival rate from out-of-hospital cardiac arrests (OHCAs). The majority of OHCAs occur at home and are handled by family members. Data from 5078 OHCAs that were witnessed by citizens and unwitnessed by citizens or emergency medical technicians from January 2004 to March 2010 were prospectively collected. The number of rescuers was identified in 4338 OHCAs and was classified into two (single rescuer (N=2468) and multiple rescuers (N=1870)) or three (single rescuer, two rescuers (N=887) and three or more rescuers (N=983)) groups. The backgrounds, characteristics and outcomes of OHCAs were compared between the two groups and among the three groups. When all OHCAs were collectively analysed, an increased number of rescuers was associated with better outcomes (one-year survival and one-year survival with favourable neurological outcomes were 3.1% and 1.9% for single rescuers, 4.1% and 2.0% for two rescuers, and 6.0% and 4.6% for three or more rescuers, respectively (p=0.0006 and p<0.0001)). A multiple logistic regression analysis showed that the presence of multiple rescuers is an independent factor that is associated with one-year survival (odds ratio (95% confidence interval): 1.539 (1.088, 2.183)). When only OHCAs that occurred at home were analysed (N=2902), the OHCAs that were handled by multiple rescuers were associated with higher incidences of bystander CPR but were not associated with better outcomes. In summary, an increased number of rescuers improves the outcomes of OHCAs. However, this beneficial effect is absent in OHCAs that occur at home.

Education, implementation and teams


Australian critical care nurses generally undertake assessment of resuscitation competencies on an annual or biannual basis. International resuscitation evidence and guidelines released in 2010 do not support this practice, instead advocating more frequent retraining. Aim: To review the evidence for annual assessment of resuscitation knowledge and skills, and for the efficacy of resuscitation training practices. Methods: A search of the Medline and CINAHL databases was conducted using the key search words/terms ‘resuscitation’ ‘advanced life support’ ‘advanced
cardiac life support’ ‘assessment’ ‘cardiac arrest’, ‘in-hospital cardiac arrest’, ‘competence’, ‘training’, ‘ALS’, ‘ACLS’ ‘course’ and ‘competency’. The search was limited to English language publications produced during the last 10 years. The International Liaison Committee On Resuscitation worksheets were reviewed for key references, as were the reference lists of articles from the initial search. Results: There is little evidence to support the current practice of annual resuscitation competency assessments. Theoretical knowledge has no correlation with resuscitation performance, and current practical assessment methods are problematic. Both knowledge and skills decline well before the 12-month mark. There is emerging support in the literature for frequent practice sessions using simulation technology. Conclusion: The current practice of annual assessments is not supported by evidence. Emerging evidence for regular resuscitation practice is not conclusive, but it is likely to produce better outcomes. Changing practice in Australia also represents an opportunity to generate data to inform practice further.

Coventry C, Flabouris A, Sundararajan K and Cramey T. Rapid response team calls to patients with a pre-existing not for resuscitation order. Resuscitation 2013; Online first (31 January)

Compare and contrast rapid response team (RRT) calls to patients with, and those without, a pre-existing not for resuscitation (NFR) order. Retrospective medical record and database review of adult inpatients with a hospital stay greater than 24h. 198 (15.7%) of 1258 patients with a RRT call, had a pre-existing NFR order. Patients with, compared to those without a pre-existing NFR, were older (median years, 81 vs 70, p<0.01), similar gender (males, 56.6% vs 54.3%, p=0.55), the trigger be the worried criterion (48.5% vs 33.9%, p<0.01) and have had a prior RRT call (30.8% vs 18.0%, p<0.01). At time of RRT attendance, NFR patients had a higher respiratory rate (24 vs 20, p<0.01), lower SaO2 (93% vs 97%, p=0.02) and just as likely to receive a critical care (24.2% vs 25.8%, p=0.63) or ward type (88.9% vs 90.1%, p=0.61) intervention. NFR patients were less likely to be admitted to an ICU (2.0% vs 9.4%, p<0.01), more likely to be left on the ward (92.4% vs 80.3%, p<0.01), and be documented not for further RRT calls (2.5% vs 0.9%, p=0.06), but have a similar mortality (5.6% vs 3.5%, p=0.16), at time of RRT call. RRT calls to patients with pre-existing NFR orders are not uncommon. The worried criterion is more often the trigger, they have abnormal respiratory observations at time of call, a similar level of intervention, less likely to be admitted to the ICU and more likely to be documented not for further RRT calls.


Early recognition of deteriorating patients results in better patient outcomes. Modified early warning scores (MEWS) attempt to identify deteriorating patients early so timely interventions can occur thus reducing serious adverse events. We compared frequencies of vital sign recording 24 h post-ICU discharge and 24 h preceding unplanned ICU admission before and after a new observation chart using MEWS and an associated educational programme was implemented into an Australian Tertiary referral hospital in Brisbane. Design: Prospective before-and-after intervention study, using a convenience sample of ICU patients who have been discharged to the hospital wards, and in patients with an unplanned ICU admission, during November 2009 (before implementation; n = 69) and February 2010 (after implementation; n = 70). Main outcome measures Any change in a full set or individual vital sign frequency before-and-after the new MEWS observation chart and associated education programme was implemented. A full set of vital signs included Blood pressure (BP), heart rate (HR), temperature (T<sub>∞</sub>), oxygen
saturation (SaO2) respiratory rate (RR) and urine output (UO). Results: After the MEWS observation chart implementation, we identified a statistically significant increase (210%) in overall frequency of full vital sign set documentation during the first 24 h post-ICU discharge (95% CI 148, 288%, p value < 0.001). Frequency of all individual vital sign recordings increased after the MEWS observation chart was implemented. In particular, T recordings increased by 26% (95% CI 8, 46%, p value = 0.003). An increased frequency of full vital sign set recordings for unplanned ICU admissions were found (44%, 95% CI 2, 102%, p value = 0.035). The only statistically significant improvement in individual vital sign recordings was urine output, demonstrating a 27% increase (95% CI 3, 57%, p value = 0.029). Conclusions: The implementation of a new MEWS observation chart plus a supporting educational programme was associated with statistically significant increases in frequency of combined and individual vital sign set recordings during the first 24 h post-ICU discharge. There were no significant changes to frequency of individual vital sign recordings in unplanned admissions to ICU after the MEWS observation chart was implemented, except for urine output. Overall increases in the frequency of full vital sign sets were seen.

Hawkes CP, Walsh BH, Ryan CA and Dempsey EM. Smartphone technology enhances newborn intubation knowledge and performance amongst paediatric trainees. Resuscitation 2013; 84 (2): 223-6
Smartphones are widely used by physicians, but their effectiveness in improving teaching of clinical skills is not known. The aim of this study was to determine if pre procedural use of a smartphone neonatal intubation instructional application (NeoTube) improves trainee knowledge and enhances procedural skills performance in newborn intubation. Neonatal Resuscitation Program certified trainees in paediatrics and neonatology completed a knowledge based questionnaire on neonatal intubation, and were recorded intubating a term newborn manikin model. They then used the NeoTube iPhone application for 15min, before completing the questionnaire and intubation again. Video recordings were later reviewed by two independent assessors, blinded to whether it was pre or post NeoTube use. 20 paediatric trainees (12 fellows and 8 residents) participated in this study. Comparing pre and post-viewing of the application, Questionnaire Scores (median (range)) increased from 18.5 (8, 28) to 31 (24, 35) (P<0.001), with calculation scores increasing from 6 (0, 11) to 11 (6,12) (P<0.001), Skill Scores increased from 11 (9, 15) to 12.5 (9, 16) (P=0.016), and the duration of intubation attempt decreased from 39 to 31s (P=0.044) following utilisation of the application. There was a significant positive correlation with duration of specialist training for procedure performance post viewing, but not pre viewing of the application. Bedside use of smartphones can enhance both knowledge of newborn intubation and improves procedural performance, including reducing the time to successfully intubate. Smartphones may have a useful role in bringing procedural skills training closer to the bedside.

Technology-enhanced simulation is used frequently in emergency medicine (EM) training programs. Evidence for its effectiveness, however, remains unclear. The objective of this study was to evaluate the effectiveness of technology-enhanced simulation for training in EM and identify instructional design features associated with improved outcomes by conducting a systematic review. Methods The authors systematically searched MEDLINE, EMBASE, CINAHL, ERIC, PsychINFO, Scopus, key journals, and previous review bibliographies through May 2011. Original research articles in any language were selected if they compared simulation to no intervention or another educational activity for the purposes of training EM health professionals (including student and practicing physicians, midlevel providers, nurses, and prehospital providers). Reviewers evaluated study quality and abstracted information on learners, instructional design (curricular integration, feedback, repetitive practice, mastery learning), and outcomes. Results From a collection of 10,903 articles, 85 eligible studies enrolling 6,099 EM learners were
identified. Of these, 56 studies compared simulation to no intervention, 12 compared simulation with another form of instruction, and 19 compared two forms of simulation. Effect sizes were pooled using a random-effects model. Heterogeneity among these studies was large ($I^2 \geq 50\%$). Among studies comparing simulation to no intervention, pooled effect sizes were large (range = 1.13 to 1.48) for knowledge, time, and skills and small to moderate for behaviors with patients (0.62) and patient effects (0.43; all $p < 0.02$ except patient effects $p = 0.12$). Among comparisons between simulation and other forms of instruction, the pooled effect sizes were small ($\leq 0.33$) for knowledge, time, and process skills (all $p > 0.1$).

Qualitative comparisons of different simulation curricula are limited, although feedback, mastery learning, and higher fidelity were associated with improved learning outcomes. Conclusions: Technology-enhanced simulation for EM learners is associated with moderate or large favorable effects in comparison with no intervention and generally small and non-significant benefits in comparison with other instruction. Future research should investigate the features that lead to effective simulation-based instructional design.


The effect of family presence during cardiopulmonary resuscitation (CPR) on the family members themselves and the medical team remains controversial. METHODS: We enrolled 570 relatives of patients who were in cardiac arrest and were given CPR by 15 prehospital emergency medical service units. The units were randomly assigned either to systematically offer the family member the opportunity to observe CPR (intervention group) or to follow standard practice regarding family presence (control group). The primary end point was the proportion of relatives with post-traumatic stress disorder (PTSD)–related symptoms on day 90. Secondary end points included the presence of anxiety and depression symptoms and the effect of family presence on medical efforts at resuscitation, the well-being of the health care team, and the occurrence of medicolegal claims. RESULTS: In the intervention group, 211 of 266 relatives (79%) witnessed CPR, as compared with 131 of 304 relatives (43%) in the control group. In the intention-to-treat analysis, the frequency of PTSD-related symptoms was significantly higher in the control group than in the intervention group (adjusted odds ratio, 1.7; 95% confidence interval [CI], 1.2 to 2.5; P=0.004) and among family members who did not witness CPR than among those who did (adjusted odds ratio, 1.6; 95% CI, 1.1 to 2.5; P=0.02). Relatives who did not witness CPR had symptoms of anxiety and depression more frequently than those who did witness CPR. Family-witnessed CPR did not affect resuscitation characteristics, patient survival, or the level of emotional stress in the medical team and did not result in medicolegal claims. CONCLUSIONS: Family presence during CPR was associated with positive results on psychological variables and did not interfere with medical efforts, increase stress in the health care team, or result in medico-legal conflicts. (Funded by Programme Hospitalier de Recherche Clinique 2008 of the French Ministry of Health; ClinicalTrials.gov number, NCT01009606.)


The efficiency of cardiopulmonary resuscitation (CPR) training is dependent upon different influencing factors, such as the presented concepts, the participants' willingness to learn, and the interval between training sessions. However, the optimal interval for refreshing CPR training is less clear. Objective: We evaluated the perceived need of simulator-based CPR training for nurses and correlated it with their clinical experience. Methods: The 60 invited nurses were trained in simulator-based CPR. Knowledge about adult advanced life support was evaluated using a questionnaire after training, and participants rated their desired individual frequency of simulator-based training as well as the value of the
presented training using a six-point Likert scale. The same questions were asked again after 1 year. Results: All participants agreed about the usefulness of this type of simulator-based training. The average number of correct answers about typical facts in adult advanced life support showed an almost bell-shaped distribution, with the highest point at 6 - 15 years of clinical experience and the lowest points at < 5 and > 21 years. The desired training-frequency need was inversely correlated with clinical experience. Conclusions: There is a high interest in CPR training among nursing staff. Self-assessment about the training-frequency need was inversely correlated with clinical experience. However, the average number of correct answers on resuscitation questions decreased with clinical experience. Therefore, the training effectiveness seems to be extremely dependent on clinical experience, and therefore, training experienced senior nurses might be more challenging than training novice nurses.


Out-of-hospital cardiac arrest (OHCA) has been reported to carry very varying morbidity and mortality. However, it remains unclear whether this is caused by intrinsic factors of the OHCA or due to the level of in-hospital care. The aim of this study is to compare 30-day and long-term mortality after OHCA at tertiary heart centres and non-tertiary university hospitals. Methods and results: Data from the Copenhagen OHCA registry from June 2002 through December 2010 included a total of 1218 consecutive patients treated by the same mobile emergency care unit (MECU) with either return of spontaneous circulation (ROSC) or on-going resuscitation (n=53) at hospital arrival. The MECU transported patients to the nearest hospital unless an ECG on scene suggested ST-segment elevation myocardial infarction, in which case patients were transported to the nearest tertiary centre for acute coronary angiography. Therefore, patients with ST-elevation myocardial infarction (n=198) were excluded from the analysis. 30-day mortality was 56% vs. 76% and long term (up to 8 years) mortality was 78% vs. 94% for tertiary and non-tertiary hospitals, respectively, both p<0.001. Multivariate analysis showed that admission to a non-tertiary hospital was independently associated with increased risk of death (HR=1.32, 95% CI: 1.09–1.59, p=0.004). Exclusion of patients with on-going resuscitation at admission resulted in HR = 1.34 (1.11–1.62), p=0.003. A matched pair propensity score analysis of 255 patients confirmed the results of the proportional hazard analysis (HR = 1.35, 95% CI: 1.11–1.65 p=0.003). Conclusion: Admission to tertiary centres is associated with lower mortality rates after OHCA compared with non-tertiary hospitals.


The introduction of a paediatric Medical Emergency Team (pMET) was accompanied by integration of weekly in situ simulation team training into routine clinical practice. On a rotational basis, all key ward staff participated in team training, which focused on recognition of the deteriorating child, teamwork and early consultant review of patients with evolving critical illness. This study aimed to evaluate the impact of regular team training on the hospital response to deteriorating in-patients and subsequent patient outcome. Prospective cohort study of all deteriorating in-patients of a tertiary paediatric hospital requiring admission to paediatric intensive care (PICU) the year before, and after, the introduction of pMET and concurrent team training. Deteriorating patients were: recognised more promptly (before/after pMET: median time 4/1.5h, p<0.001), more often reviewed by consultants (45%/76%, p=0.004), more often transferred to high dependency care (18%/37%, p=0.021) and more rapidly escalated to intensive care (median time 10.5/5h, p=0.024). These improved responses by ward staff extended beyond direct involvement of pMET. There was a trend towards fewer PICU admissions, reduced level of sickness at the time of PICU admission, reduced length of PICU stay.
and reduced PICU mortality. Introduction of pMET coincided with significantly reduced hospital mortality (p<0.001). These results indicate that lessons learnt by ward staff during regular in situ team training led to significantly improved recognition and management of deteriorating in-patients with evolving critical illness. Integration of in situ simulation team training in clinical care has potential applications beyond paediatrics.


We used the Utstein template, with special reference to patients having automated patient monitoring, and studied the factors that are associated with delayed medical emergency team (MET) activation and increased hospital mortality. Design and setting: A prospective observational study in a tertiary hospital with 45 of 769 general ward beds (5.9%) equipped with automated monitoring. Cohort: 569 MET reviews for 458 patients. Results: Basic MET review characteristics were comparable to literature. We found that 41% of the reviews concerned monitored ward patients. These patients’ vitals had been more frequently documented during the 6h period preceding MET activation compared to patients in normal ward areas (96% vs. 74%, p<0.001), but even when adjusted to the documentation frequency of vitals, afferent limb failure (ALF) occurred more often among monitored ward patients (81% vs. 53%, p<0.001). In MET population, factors associated with increased hospital mortality were non-elective hospital admission (OR 6.25, 95% CI 2.77–14.11), not-for-resuscitation order (3.34, 1.78–6.35), ICD XIV genitourinary diseases (2.42, 1.16–5.06), ICD II neoplasms (2.80, 1.59–4.91), age (1.02, 1.00–1.04), preceding length of hospital stay (1.04, 1.01–1.07), ALF (1.67, 1.02–2.72) and transfer to intensive care (1.85, 1.05–3.27). Conclusions: Documentation of vital signs before MET activation is suboptimal. Documentation frequency seems to increase if automated monitors are implemented, but our results suggest that benefits of intense monitoring are lost without appropriate and timely interventions, as afferent limb failure, delay to call MET when predefined criteria are fulfilled, was independently associated to increased hospital mortality.

Paediatric advanced life support


There is a paucity of data examining nationwide population-based incidences and outcomes of pediatric out-of-hospital cardiac arrest. The objective of this study is to describe the detailed characteristics of pediatric out-of-hospital cardiac arrest by scholastic age category and to evaluate the impact of bystander cardiopulmonary resuscitation and public access automated external defibrillators on the 1-month survival and favorable neurological status of pediatric out-of-hospital cardiac arrest patients. Design: A nationwide, population-based, observational study. Setting: Nationwide emergency medical system in Japan. Patients: Out-of-hospital cardiac arrest patients aged < 18 yr. Measurements and Main Results: We identified 7,624 pediatric out-of-hospital cardiac arrest patients (<18 yr old) from a nationwide population-based out-of-hospital cardiac arrest database in Japan from 2005 to 2008 and stratified them into five categories by scholastic age. The overall rates of 1-month survival and favorable neurological outcomes were 11.0% and 5.1%, respectively. Bystander cardiopulmonary resuscitation resulted in a significant improvement in both 1-month survival (odds ratio 2.81; 95% confidence interval 2.30, 3.44) and favorable neurological outcomes (odds
ratio 4.55; 95% confidence interval 3.35, 6.18). Performing public access automated external defibrillators had a significant effect on the 1-month survival rate (odds ratio 3.51; 95% confidence interval 1.81, 6.81) and favorable neurological outcomes (odds ratio 5.13; 95% confidence interval 2.64, 9.96). Conclusions: This study demonstrated that bystander cardiopulmonary resuscitation and public access automated external defibrillators had a significant impact on the outcomes of pediatric out-of-hospital cardiac arrest. The improved survival associated with bystander cardiopulmonary resuscitation and public access, automated external defibrillators are clinically important and are of major public health importance for school-aged out-of-hospital cardiac arrest patients.


The introduction of a paediatric Medical Emergency Team (pMET) was accompanied by integration of weekly in situ simulation team training into routine clinical practice. On a rotational basis, all key ward staff participated in team training, which focused on recognition of the deteriorating child, teamwork and early consultant review of patients with evolving critical illness. This study aimed to evaluate the impact of regular team training on the hospital response to deteriorating in-patients and subsequent patient outcome. Methods: Prospective cohort study of all deteriorating in-patients of a tertiary paediatric hospital requiring admission to paediatric intensive care (PICU) the year before, and after, the introduction of pMET and concurrent team training. Results: Deteriorating patients were: recognised more promptly (before/after pMET: median time 4/1.5h, p<0.001), more often reviewed by consultants (45%/76%, p=0.004), more often transferred to high dependency care (18%/37%, p=0.021) and more rapidly escalated to intensive care (median time 10.5/5h, p=0.024). These improved responses by ward staff extended beyond direct involvement of pMET. There was a trend towards fewer PICU admissions, reduced level of sickness at the time of PICU admission, reduced length of PICU stay and reduced PICU mortality. Introduction of pMET coincided with significantly reduced hospital mortality (p<0.001). Conclusions: These results indicate that lessons learnt by ward staff during regular in situ team training led to significantly improved recognition and management of deteriorating in-patients with evolving critical illness. Integration of in situ simulation team training in clinical care has potential applications beyond paediatrics.


Objectives: Commonly used acute asthma scoring systems assess severity of symptoms, whereas other clinical models aim to predict hospitalization; all rely on a measure of response to treatment and use the same criteria across age ranges. This may not reflect a child's changing physiology and response to illness as he or she grows older. This study aimed to find age-specific objective predictors of hospitalization readily known at triage. The goal is to identify rapidly those who will likely need admission regardless of treatment administered or response to aggressive treatment in the emergency department (ED). Methods: Children between 1 and 18 years of age with a final primary ED International Classification of Diseases, Ninth Revision, diagnosis of asthma or asthma-related spectrum of disease were studied using data from the National Hospital Ambulatory Medical Care Survey. The primary outcome was hospital admission (observation unit, ward, monitored, or pediatric intensive care unit). Triage vital signs, mode of arrival, recent visits, emergency severity index score, as well as demographic and socioeconomic factors were incorporated into age-specific forward-selection multiple logistic regression models. Results: In 2,454,983 ED visits for asthma or reactive airway disease among children 1 to 18 years of age, patterns of vital sign predictors for admission varied by age group. Across all ages, diastolic hypotension at triage was an early, consistent, independent predictor of admission, especially in 1- to 3-year-olds (odds ratio, 6.27; 95% confidence interval, 6.01, 6.54) and 3- to 6-year-olds (odds ratio, 17.95; 95% confidence interval, 16.80, 19.17). Conclusions: Age-specific
assessment is important in the evaluation of acute asthma or reactive airway exacerbation. Diastolic hypertension may serve as an early warning indicator of severity of disease and need for hospitalization. Variability by age group in vital sign predictor for admission calls for further development or refinement of age-specific asthma assessment tools.


This prospective, randomized trial was conducted to establish whether the pediatric laryngeal mask airway (LMA) could be used without any concerns for abnormally high intra-cuff pressure when a cuff of the LMA was inflated with half the maximum recommended inflation volume or the resting volume before insertion. Basic procedures: Eighty children 0 to 9 years of age and weighing of 5 to 30 kg scheduled for general anesthesia were included. Before insertion, the cuff of the LMA was filled with half the maximum recommended inflation volume in the Half volume group, or the resting volume by opening the pilot balloon valve to atmospheric pressure in the Resting volume group. After insertion of the LMA, intra-cuff pressure, oro-pharyngeal leak pressure, and leakage volume were investigated. Major findings The Half volume group showed lower mean intra-cuff pressure than the Resting volume group (49.6 ± 12.1 cm H2O vs 58.1 ± 13.8 cm H2O, P = .005). There was no difference in oro-pharyngeal leak pressure (22.1 ± 5.8 vs 21.7 ± 5.1 cm H2O, P = .757) or leakage volume between the Half volume group and the Resting volume group (0.13 ± 0.13 ml/kg vs 0.11 ± 0.12 ml/kg, P = .494) under spontaneous respiration. Conclusions: Both methods of the LMA cuff inflation before insertion provided an acceptable range of intra-cuff pressure with adequate pharyngeal sealing without any intervention after insertion.


Hospitalized children with cardiovascular disease may be at increased risk of cardiac arrest; however, little data exist regarding prevalence, risk factors, or outcomes of cardiopulmonary resuscitation in these patients. We sought to characterize national estimates of cardiopulmonary resuscitation and death after cardiopulmonary resuscitation for hospitalized children with cardiovascular disease. Setting: A total of 3,739 hospitals in 38 states participating in Kids Inpatient Database. Design: Retrospective analysis of the 2000, 2003, and 2006 Healthcare Cost and Utilization Project Kids Inpatient Database was performed. Sample weighting was employed to produce national estimates. Measurements and Main Results: Cardiovascular disease was identified in 2.2% of the estimated 22,175,468 (95% confidence interval 21,391,343, 22,959,592) hospitalizations. Cardiopulmonary resuscitation occurred in 0.74% (3,698; 95% confidence interval 3,205, 191) of hospitalizations of children with cardiovascular disease, compared with 0.05% (11,726; 95% confidence interval 10,647, 12,805) without cardiovascular disease (odds ratio 13.8, 95% confidence interval 12.1, 15.0). The highest frequency of cardiopulmonary resuscitation occurred with myocarditis (3.0% of admissions), heart failure (2.0%), and coronary pathology (2.0%). Compared with other forms of cardiovascular disease identified in this study, single-ventricle patients were the only subgroup who exhibited a higher mortality after cardiopulmonary resuscitation (mortality 65% vs. 55%; odds ratio 1.7 [95% confidence interval 1.2, 2.6]), while those who had undergone cardiac surgery exhibited a lower mortality rate (mortality 48% vs. 57%; odds ratio 0.6 [95% confidence interval 0.5, 0.8]). Conclusions: Cardiopulmonary resuscitation occurs in approximately 7 per 1,000 hospitalizations of children with cardiovascular disease, a rate greater than ten-fold that observed in hospitalizations of children without cardiovascular disease. Single-ventricle patients demonstrated increased mortality after cardiopulmonary resuscitation, while recent cardiac surgery was associated with...
a reduced odds of death after cardiopulmonary resuscitation. Further studies are needed to confirm these findings and develop techniques to prevent cardiac arrest in this high-risk population.


Single mode, pressure reduction (PR) crib mattresses are increasingly employed in hospitals to prevent skin injury and infection. However, single mode PR mattresses risk large mattress deflection during CPR chest compressions, potentially leading to inadequate chest compressions.

Hypothesis: New, dual mode PR crib mattress technology provides less mattress deflection during chest compressions (CCs) with similar PR characteristics for prevention of skin injury. Methods: Epochs of 50 high-quality CCs (target sternum–spine compression depth ≥ 38mm) guided by real-time force/deflection sensor (FDS) feedback were delivered to CPR manikin with realistic CC characteristics on two PR crib mattresses for four conditions: (1) single mode + backboard; (2) dual mode + backboard; (3) single mode−no backboard; and (4) dual mode−no backboard. Mattress displacement was measured using surface reference accelerometers. Mattress displacement ≥ 5mm was prospectively defined as minimal clinically important difference. PR qualities of both mattresses were assessed by tissue interface pressure mapping.

Results: During simulated high quality CC, single mode had significantly more mattress displacement compared to dual mode (mean difference 16.5±1.4mm, p<0.0001) with backboard. This difference was greater when no backboard was used (mean difference 31.7±1.5mm, p<0.0001). Both single mode and dual mode met PR industry guidelines (mean surface pressure <50mmHg). Conclusions: Chest compressions delivered on dual mode pressure reduction crib mattresses resulted in substantially smaller mattress deflection compared to single mode pressure reduction mattresses. Skin pressure reduction qualities of dual mode pressure reduction crib mattress were maintained. We recommend that backboards continue to be used in order to mitigate mattress deflection during CPR on soft mattresses.


To evaluate the association between cardiopulmonary resuscitation (CPR) quality and hemodynamic measurements during in-hospital pediatric cardiac arrest. We hypothesized that AHA recommended CPR rate and depth targets would be associated with systolic blood pressures ≥ 80mmHg and diastolic blood pressures ≥ 30mmHg. Methods: In children and adolescents <18 years of age who suffered a cardiac arrest with an invasive arterial catheter in place, a CPR monitoring defibrillator collected CPR data which was synchronized to arterial blood pressure (BP) tracings. Chest compression (CC) depths were corrected for mattress deflection. Generalized least squares regression estimated the association between BP and CPR quality, treated as continuous variables. Mixed-effects logistic regression estimated the association between systolic BP ≥80mmHg/diastolic BP ≥30mmHg and the AHA targets of depth ≥38mm and/or rate ≥100/min. Results: Nine arrests resulted in 4156 CCs. The median mattress corrected depth was 32mm (IQR 28–38); median rate was 111 CC/min (IQR 103–120). AHA depth was achieved in 1090/4156 (26.2%) CCs; rate in 3441 (83.7%). Systolic BP ≥80mmHg/diastolic BP ≥30mmHg and the AHA targets of depth ≥38mm and/or rate ≥100/min. Results: Nine arrests resulted in 4156 CCs. The median mattress corrected depth was 32mm (IQR 28–38); median rate was 111 CC/min (IQR 103–120). AHA depth was achieved in 1090/4156 (26.2%) CCs; rate in 3441 (83.7%). Systolic BP ≥80mmHg/diastolic BP ≥30mmHg was attained in 2516/4156 (60.5%) compressions; diastolic ≥30mmHg in 2561/4156 (61.6%). A rate ≥100/min was associated with systolic BP ≥80mmHg (OR 1.32; CI 95% 1.04, 1.66; p=0.02) and diastolic BP ≥30mmHg in 2561/4156 (61.6%). A rate ≥100/min was associated with systolic BP ≥80mmHg (OR 1.32; CI 95% 1.04, 1.66; p=0.02) and diastolic BP ≥30mmHg (OR 2.15; CI 95% 1.65, 2.80; p<0.001). Exceeding both (rate ≥100/min and depth≥38mm) was associated with systolic BP ≥80mmHg (OR 2.02; CI 95% 1.45, 2.82; p=0.001) and diastolic BP ≥30mmHg (OR 1.48; CI 95% 1.01, 2.15; p=0.042). Conclusions: AHA quality targets (rate ≥100/min and depth ≥38mm) were associated with systolic BPs ≥80mmHg and diastolic BPs ≥30mmHg during CPR in children.

Weight estimations in children, which are required when actual weight cannot be measured, are often very inaccurate because of variations in body habitus not accounted for in the estimating methodology. This study was conducted to evaluate the accuracy of the PAWPER tape, a new two-step weight-estimation tape device which employs a length-based habitus-modified weight estimation system. This was a prospective study in the Emergency Departments of two hospitals in Johannesburg, South Africa on a population of children aged from 1 month to 12 years. Each child had their weight estimated by both the Broselow tape and the PAWPER tape. These weight estimates were then compared against measured weight to determine the bias and precision of the estimation techniques. The PAWPER tape performed well, and better than the Broselow tape in every analysis performed. The mean percentage error was 3.8% vs 0% and the root mean squared percentage error was 9.1% vs 4.5% for the Broselow tape and PAWPER tape, respectively (p < 0.0001). The Broselow tape predicted weight to within 10% of actual weight in 63.6% of children and the PAWPER tape in 89.2% (p < 0.0001). The difference between the performances of the Broselow tape and PAWPER tape was most pronounced in children >20kg, and in children above or below average weight-for-length. The PAWPER tape has been shown to be a simple and reliable method of weight estimation in children and infants. The inclusion of an appraisal of body habitus in the methodology considerably improved the accuracy of weight estimation.

Acute coronary syndromes


Cardiovascular observational registries characterise patients and describe the manner and use of therapeutic strategies. They facilitate analyses on the quality of care among participating institutions and document variations in clinical practice, which can be benchmarked against best practice recommendations. The Cooperative National Registry of Acute Coronary care, Guideline Adherence and Clinical Events (CONCORDANCE) is an Australian observational registry that describes management and outcomes in patients with acute coronary syndromes (ACS) and feeds back both performance and outcome measures to participating hospitals. Methods: The CONCORDANCE registry has been designed within a comparative effectiveness research (CER) framework to collect and report data from hospitals located in geographically diverse regions of Australia. Information including patient demographics, presenting characteristics, past medical history, in-hospital management and outcomes at six months and two years are entered into a web-based database using an electronic clinical record form (eCRF). Individual hospital information is returned to the sites in a real time confidential report detailing information on key performance Indicator (KPI) process measures and outcomes benchmarked against the aggregated study cohort. Governance rules ensure data security and protect patient and clinician confidentiality. Consistent with a CER framework, additional characteristics of the registry include: (a) the capacity to evaluate associations
between the inter and intra hospital systems and the provision of evidence based care and outcomes, (b) ongoing data collection from representative hospitals which allow spatial and temporal analysis of change in practice and the application of treatment modalities in the real world setting and (c) the provision of a data spine for quality improvement strategies and practical clinical trials. Conclusion: The CONCORDANCE registry is a clinician-driven initiative describing clinical care for ACS patients admitted to Australian hospitals. The registry generates high quality data which is fed back to clinicians, and key stakeholders in ACS care. Using a CER approach, the registry describes the translation of randomised trial evidence into practice, and provides insights into strategies that could improve care and ultimately patient outcomes.


In patients with ST-elevation myocardial infarction treated with fibrinolysis, routine early percutaneous coronary intervention (r-PCI) improves clinical outcomes at 30 days compared with a more standard approach of performing early PCI only for failed fibrinolysis (s-PCI). Methods: We report prespecified secondary clinical outcomes and cost implications of r-PCI compared with s-PCI from the Canadian TRANSFER-AMI trial. Average cost per patient in each arm was calculated based on a microcosting approach. Bootstrap method (5,000 samples) was used to calculate standard errors and 95% CI. Results: At 1 year, rates of death or reinfarction (10.3% vs 11.6%, P = .50), hospital readmission (15.4% vs 16.5%, P = .64) and subsequent revascularization after index hospitalization (6.9% vs 8.7%, P = .30) were similar between the r-PCI and s-PCI arms. The difference in cost per patient between r-PCI and s-PCI was CAD $1,003 (95% CI, $4247 to $2,211). Since a greater proportion of patients were transported by air (vs land) in the r-PCI arm (9.4% vs 3%), and the ratio of abciximab to eptifibatide use was higher in the r-PCI arm compared with s-PCI (2:1 vs 4:5), we undertook additional post hoc cost scenario analyses. In a scenario where patients are transported by land only and eptifibatide is used as the sole GPIIb/IIIa inhibitor, the difference in cost per patient between r-PCI and s-PCI was estimated to be CAD $108 (95% CI $1,114 to $1,344). Conclusions: At 1 year, there is no difference in the clinical composite outcome of death or reinfarction between r-PCI and s-PCI strategies. Greater cost with r-PCI, although statistically insignificant, is economically important.


If percutaneous coronary intervention (PCI) is required in patients taking oral anticoagulants, antiplatelet therapy with aspirin and clopidogrel is indicated, but such triple therapy increases the risk of serious bleeding. We investigated the safety and efficacy of clopidogrel alone compared with clopidogrel plus aspirin. Methods: We did an open-label, multicentre, randomised, controlled trial in 15 centres in Belgium and the Netherlands. From November, 2008, to November, 2011, adults receiving oral anticoagulants and undergoing PCI were assigned clopidogrel alone (double therapy) or clopidogrel plus aspirin (triple therapy). The primary outcome was any bleeding episode within 1 year of PCI, assessed by intention to treat. Findings: 573 patients were enrolled and 1-year data were available for 279 (98·2%) patients assigned double therapy and 284 (98·3%) assigned triple therapy. Mean ages were 70·3 (SD 7·0) years and 69·5 (8·0) years, respectively. Bleeding episodes were seen in 54 (19·4%) patients receiving double therapy and in 126 (44·4%) receiving triple therapy (hazard ratio [HR] 0·36, 95% CI 0·26–0·50, p<0·0001). In the double-therapy group, six (2·2%) patients had multiple bleeding events, compared with 34 (12·0%) in the triple-therapy group. 11 (3·9%)
patients receiving double therapy required at least one blood transfusion, compared with 27 (9.5%) patients in the triple-therapy group (odds ratio from Kaplan-Meier curve 0.39, 95% CI 0.17–0.84, p=0.01). Interpretation: Use of clopiogrel without aspirin was associated with a significant reduction in bleeding complications and no increase in the rate of thrombotic events.

Determining which patients presenting to the Emergency Department (ED) require further work-up for acute coronary syndrome (ACS) can be difficult. The utility of routine observation for cardiac testing in low-risk young adult patients has been questioned. Study Objectives: We investigated the rate of positive findings yielded by routine cardiac observation unit work-up in patients aged 40 years or younger. Methods: This was a retrospective observational cohort study of patients aged 18-40 years who were evaluated for ACS in an ED-based observation unit. Data were collected by trained abstractors from electronic medical records. Results: A total of 362 patients met inclusion criteria. Of those, 239 received stress testing, yielding five positive and nine indeterminate results. One other patient had acute troponin elevation while under observation. The positive stress test patients and troponin-elevated patient underwent cardiac angiography. Only one positive stress test patient showed significant coronary stenosis and received coronary interventions. In follow-up data, one patient had an adverse cardiac outcome within 1 year of index visit, but no coronary interventions. Thus, only 3 patients had adverse cardiac events, with only one patient warranting intervention discovered by observation unit stress testing and a second via serial cardiac markers. Conclusion: Routine observation of symptomatic young adults for ACS had low yield. Observation identified one patient with acute cardiac marker elevation and further stress testing identified only one patient with intervenable ACS, despite a high false-positive rate. This suggests that observation and stress testing should not be routinely performed in this demographic absent other high-risk features.

The ultimate treatment goal for ST-segment elevation myocardial infarction (STEMI) is rapid reperfusion via primary percutaneous intervention (PCI). North Carolina has adopted a statewide STEMI referral strategy that advises paramedics to bypass local hospitals and transport STEMI patients directly to a PCI-capable hospital, even if a non-PCI-capable hospital is closer. Methods and Results: We assessed the adherence of emergency medical services to this STEMI protocol, as well as subsequent associations with patient treatment times and outcomes by linking data from the Acute Coronary Treatment and Intervention Outcomes Network Registry - Get With the Guidelines and a statewide emergency medical services data system from June 2008 to September 2010 for all patients with STEMI. Patients were divided into those (1) transported directly to a PCI hospital, thereby bypassing a closer non-PCI hospital and (2) first taken to a closer non-PCI center and later transferred to a PCI hospital. Among 6010 patients with STEMI, 1288 were eligible and included in our study cohort. Of these, 826 (64%) were transported directly to a PCI facility, whereas 462 (36%) were first taken to a non-PCI hospital and later transferred. In a multivariable model, increase in differential driving time and cardiac arrest were associated with a lesser likelihood of being taken directly to a PCI center, whereas a history of PCI was associated with a higher likelihood of being taken directly to a PCI center. Patients sent directly to a PCI center were more likely to have times between first medical contact and PCI within guideline recommendations. Conclusions: We found that patients who were sent directly to a PCI center had significantly shorter time to reperfusion.
Goel K, Pinto DS and Gibson CM. Association of time to reperfusion with left ventricular function and heart failure in patients with acute myocardial infarction treated with primary percutaneous coronary intervention: A systematic review. Am Heart J 2013; Online first (14 February)

Shorter time to reperfusion is associated with a significant reduction in mortality; however, its association with heart failure (HF) is not clearly documented. We conducted a systematic review to examine the association between time to reperfusion and incident HF and/or left ventricular dysfunction. Methods: MEDLINE/OVID, EMBASE, Cochrane Library, and Web of Science databases were searched from January 1974 to May 2012 for studies that reported the association between time to reperfusion and incident HF or left ventricular ejection fraction (LVEF) in patients undergoing primary percutaneous coronary intervention. Results Of 362 non-duplicate abstracts, 71 studies were selected for full-text review. Thirty-three studies were included in the final review, of which 16 were single-center studies, 7 were population-based studies, 7 were sub-analyses from randomized controlled trials, and 3 were based on national samples. The pooled data demonstrate that every 1-hour delay in time to reperfusion is associated with a 4% to 12% increased risk of new-onset HF and a 4% relative increase in the risk of incident HF during follow-up. Early reperfusion was associated with a 2% to 8% greater LVEF before discharge and a 3% to 12% larger improvement in absolute LVEF at follow-up compared with the index admission. Conclusions: This systematic review presents evidence that longer time to reperfusion is not only associated with worsened left ventricular systolic function and new-onset HF at the time of index admission, but also with increased risk of HF and reduced improvement in left ventricular systolic function during follow-up.

Landman AB, Spatz ES, Cherlin EJ, Krumholz HM, Bradley EH and Curry LA. Hospital Collaboration With Emergency Medical Services in the Care of Patients With Acute Myocardial Infarction: Perspectives From Key Hospital Staff. Ann Emerg Med 2013; 61 (2): 185-95

Study objective: Evidence suggests that active collaboration between hospitals and emergency medical services (EMS) is significantly associated with lower acute myocardial infarction mortality rates; however, the nature of such collaborations is not well understood. We seek to characterize views of key hospital staff about collaboration with EMS in the care of patients hospitalized with acute myocardial infarction. Methods: We performed an exploratory analysis of qualitative data previously collected from site visits and detailed interviews with 11 US hospitals that ranked in the top or bottom 5% of performance on 30-day risk-standardized acute myocardial infarction mortality rates, using Centers for Medicare & Medicaid Services data from 2005 to 2007. We selected all codes from the previous analysis in which EMS was most likely to have been discussed. A multidisciplinary team analyzed the data with the constant comparative method to generate recurrent themes. Results: Both higher- and lower-performing hospitals reported that EMS is critical to the provision of timely care for patients with acute myocardial infarction. However, close collaborative relationships with EMS were more apparent in the higher-performing hospitals, which demonstrated specific investment in and attention to EMS through respect for EMS as valued professionals and colleagues, strong communication and coordination with EMS and active engagement of EMS in hospital acute myocardial infarction quality improvement efforts. Conclusion: Hospital staff from higher-performing hospitals described broad, multifaceted strategies to support collaboration with EMS in providing acute myocardial infarction care. The association of these strategies with hospital performance should be tested quantitatively in a larger representative study.


Current models incompletely risk-stratify patients with acute chest pain. In this study, N-terminal pro-B-type natriuretic peptide and cystatin C were incorporated into a contemporary chest pain triage algorithm in a clinically stratified population to improve acute coronary syndrome
discrimination. Adult patients with chest pain presenting without myocardial infarction (n = 382) were prospectively enrolled from 2008 to 2009. After clinical risk stratification, N-terminal pro-B-type natriuretic peptide and cystatin C were measured and standard care was performed. The primary end point was the result of a clinical stress test. The secondary end point was any major adverse cardiac event at 6 months. Associations were determined through multivariate stratified analyses. In the low-risk group, 76 of 78 patients with normal levels of the 2 biomarkers had normal stress test results (negative predictive value 97%). Normal biomarkers predicted normal stress test results with an odds ratio of 10.56 (p = 0.006). In contrast, 26 of 33 intermediate-risk patients with normal levels of the 2 biomarkers had normal stress test results (negative predictive value 79%). Biomarkers and stress test results were not associated in the intermediate-risk group (odds ratio 2.48, p = 0.09). There were 42 major adverse cardiac events in the overall cohort. No major adverse cardiac events occurred at 6 months in the low-risk subgroup that underwent stress testing. In conclusion, N-terminal pro-B-type natriuretic peptide and cystatin C levels predict the results of stress tests in low-risk patients with chest pain but should not be substituted for stress testing in intermediate-risk patients. There is potential for their use in the early discharge of low-risk patients after clinical risk stratification.


A chest pain unit (CPU) for management of patients with chest pain at low to intermediate risk for acute coronary syndrome (ACS) appears safe and cost-effective. We report our experience with a CPU from March 2005 to July 2009. Methods: Prospective audit of patients presenting with chest pain suggestive of ACS but no high risk features and managed using a CPU, which included: serial cardiac troponins and electrocardiography and exercise tolerance test (ETT) if indicated. Outcomes assessed included three-month readmission rate and one year mortality. Results: 2358 patients were managed according to the CPU. Mean age 56 years (17 - 96 years), 59% men and median stay of 22 h (IQR 17, 26 h). 1933 (82%) were diagnosed as non-cardiac chest pain. 1741 (74%) patients had an ETT. Median time from triage to ETT was 21 h (IQR 16, 24 h). 64 (2.7%) were readmitted within three months. The majority of readmissions, 39 (61%) were for a non-cardiac cause. Twenty patients (1%) were readmitted with ACS. There was no cardiac death after one year of being discharged as non-cardiac chest pain. Conclusions: This study confirms that a CPU with high usage of pre-discharge ETT is a safe and effective way of excluding ACS in patients without high risk features in a New Zealand setting.


Multiple strategies have been implemented to reduce door-to-balloon times. The purpose of this study was to compare door-to-balloon times between ST-elevation myocardial infarction (STEMI) patients who arrived at the emergency department by ambulance with a pre-hospital electrocardiogram (ECG), to those who self-transported and had an ECG on ED arrival. Methods: This retrospective, comparative study evaluated differences in door-to-balloon times from October 2006 to December 2009 between STEMI patients that had a 12-lead ECG done in the ambulance prior to ED arrival and patients who self-transported and had an ECG on ED arrival. Results Of the 367 patients, 62% (n=228) arrived by ambulance and 38% (n=139) self-transported to the emergency department. Door-to-balloon times were 30 minutes less (P < 0.001) than patients who were self-transported. Discussion: Door-to-balloon times can be reduced when chest pain patients are transported to the
emergency department by ambulance. The paramedics are equipped to perform an ECG, thereby making a preliminary diagnosis of STEMI. The emergency department can then prepare for potential angioplasty or percutaneous coronary intervention. An opportunity exists for emergency nurses to educate the public about the importance of calling 911 for chest pain.


Primary percutaneous coronary intervention (PCI) is the treatment of choice for patients presenting with acute ST-segment elevation myocardial infarction (STEMI). However, if catheterization facilities are not immediately available, the effectiveness of PCI can be affected by delays in transfer. Evidence suggests that antiplatelet therapy administered early, preferably in the ambulance during transfer, may provide better and earlier perfusion. Ticagrelor, a direct platelet P2Y12 receptor inhibitor, is indicated for the management of patients with acute coronary syndromes. The ATLANTIC study (NCT01347580; EudraCT 2011-000214-19) is a 30-day international, randomized, parallel-group, placebo-controlled study in male and female patients (aged >18 years) who are diagnosed as having STEMI, with intended primary PCI. In total, 1770 patients will be randomized immediately after diagnosis to prehospital administration of ticagrelor 180 mg followed by matching placebo administered in hospital, or prehospital administration of placebo followed by ticagrelor 180 mg administered in hospital. All patients will then receive ticagrelor 90 mg twice daily for 30 days. The coprimary end point is the percentage of patients reaching thrombolysis in myocardial infarction flow grade 3 in the infarct-related artery at initial angiography or achieving > 70% ST-segment elevation resolution pre-PCI. The primary safety end point is major, life-threatening, or minor bleeding after ticagrelor administration. The results of this study may have an impact on future recommendations for treatment for patients with STEMI.


This study examined revascularization rates after acute myocardial infarction (AMI) for Aboriginal and non-Aboriginal patients sequentially controlling for admitting hospital and risk factors. Methods and Results—Hospital data from the state of New South Wales, Australia (July 2000 through December 2008) were linked to mortality data (July 2000 through December 2009). The study sample were all people aged 25 to 84 years admitted to public hospitals with a diagnosis of AMI (n=59,282). Single level and multilevel Cox regression was used to estimate rates of revascularization within 30 days of admission. A third (32.9%) of Aboriginal AMI patients had a revascularization within 30 days compared with 39.7% non-Aboriginal patients. Aboriginal patients had a revascularization rate 37% lower than non-Aboriginal patients of the same age, sex, year of admission, and AMI type (adjusted hazard ratio, 0.63; 95% confidence interval, 0.57–0.70). Within the same hospital, however, Aboriginal patients had a revascularization rate 18% lower (adjusted hazard ratio, 0.82; 95% confidence interval, 0.74–0.91). Accounting for comorbidities, substance use and private health insurance further explained the disparity (adjusted hazard ratio, 0.96; 95% confidence interval, 0.87–1.07). Hospitals varied markedly in procedure rates, and this variation was associated with hospital size, remoteness, and catheterization laboratory facilities. Conclusions—Aboriginal Australians were less likely to have revascularization procedures after AMI than non-Aboriginal Australians, and this was largely explained by lower revascularization rates at the hospital of first admission for all patients admitted to smaller regional and rural hospitals, a higher comorbidity burden for Aboriginal people, and to a lesser extent a lower rate of private health insurance among Aboriginal
Prompt percutaneous coronary intervention is associated with improved survival in patients presenting with cardiac arrest. Few studies, however, have focused on patients with cardiac arrest not selected for coronary angiography. The aim of the present study was to evaluate the clinical characteristics and outcomes of patients with cardiac arrest denied emergent angiography. Patients with cardiac arrest were identified within a registry that included all catheterization laboratory activations from 2008 to 2012. Logistic regression and proportional-hazards models were created to assess the clinical characteristics and mortality associated with denying emergent angiography. Among 664 patients referred for catheterization, 110 (17%) had cardiac arrest, and 26 of these patients did not undergo emergent angiography. Most subjects (69%) were turned down for angiography for clinical reasons and a minority for perceived futility (27%). After multivariate adjustment, pulseless electrical activity as the initial arrest rhythm (adjusted odds ratio [AOR] 13.27, 95% confidence interval [CI] 1.76 to 100.12), < 1.0 mm of ST-segment elevation (AOR 10.26, 95% CI 1.68 to 62.73), female gender (AOR 4.45, 95% CI 1.04 to 19.08), and advancing age (AOR 1.10 per year, 95% CI 1.04 to 1.16) were associated with increased odds of withholding angiography. The mortality rate was markedly higher for patients who were denied emergent angiography (hazard ratio 3.64, 95% CI 2.05 to 6.49), even after adjustment for medical acuity (hazard ratio 2.29, 95% CI 1.19 to 4.41). In conclusion, older subjects, women, and patients without ST-segment elevation were more commonly denied emergent angiography after cardiac arrest. Patients denied emergent angiography had increased mortality that persisted after adjustment for illness severity.

Neonatal resuscitation


Objective: Children treated with neonatal extracorporeal membrane oxygenation may show physical and mental morbidity at a later age. We compared the health-related quality of life of these children with normative data. Design: Prospective longitudinal follow-up study. Setting: Outpatient clinic of a level III university hospital. Patients: Ninety-five 5-yr-old children who had received neonatal extracorporeal membrane oxygenation support between January 1999 and December 2005. Interventions: None. Measurements and Main Results: The pediatric quality of life inventory was administered at 5 yrs of age. The mothers (n = 74) as proxy-reporters assigned significantly lower health-related quality of life scores for their children than did the parents in the healthy reference group for the total functioning scale of the pediatric quality of life inventory (mean difference: 8.1; p < 0.001). Mothers' scores for 31 children (42%) were indicative of impaired health-related quality of life (−1 SD below the reference norm). The children (n = 78) themselves scored significantly lower than did their healthy peers on total functioning (mean difference: 11.0; p < 0.001). Thirty-two children (41%) indicated an impaired health-related quality of life themselves. For the mother proxy-reports, the duration of extracorporeal membrane oxygenation support (R2 = 0.009; p = 0.010) and the presence of chronic lung disease (R2 = 0.133; p = 0.002) were negatively related to total functioning. Children with a disabled health status for neuromotor functioning, maximum exercise capacity, behavior, and cognitive functioning at 5 yrs of age had a higher odds ratio of also having a lower health-related quality of life. Health status had no influence on reported emotional functioning. Conclusions: Overall, children treated with extracorporeal membrane
oxygenation in the neonatal period reported low health-related quality of life at 5 yrs of age. Because only emotional health-related quality of life was not associated with health status, the pediatric quality of life inventory might be a measure of health status rather than of health-related quality of life. In contrast with conclusions from others, we found that 5-yr-old children might be too young to rate their own health-related quality of life.

General papers

Twitter has over 500 million subscribers but little is known about how it is used to communicate health information. We sought to characterize how Twitter users seek and share information related to cardiac arrest, a time-sensitive cardiovascular condition where initial treatment often relies on public knowledge and response. Tweets published April - May 2011 with keywords cardiac arrest, CPR, AED, resuscitation, heart arrest, sudden death and defib were identified. Tweets were characterized by content, dissemination, and temporal trends. Tweet authors were further characterized by: self-identified background, tweet volume, and followers. Of 62,163 tweets (15,324, 25%) included resuscitation/cardiac arrest-specific information. These tweets referenced specific cardiac arrest events (1130, 7%), CPR performance or AED use (6896, 44%), resuscitation-related education, research, or news media (7449, 48%), or specific questions about cardiac arrest/resuscitation (270, 2%). Regarding dissemination (1980, 13%) of messages were retweeted. Resuscitation specific tweets primarily occurred on weekdays. Most users (10,282, 93%) contributed three or fewer tweets during the study time frame. Users with more than 15 resuscitation-specific tweets in the study time frame had a mean 1787 followers and most self-identified as having a healthcare affiliation. Despite a large volume of tweets, Twitter can be filtered to identify public knowledge and information seeking and sharing about cardiac arrest. To better engage via social media, healthcare providers can distil tweets by user, content, temporal trends, and message dissemination. Further understanding of information shared by the public in this forum could suggest new approaches for improving resuscitation related education.

The objective was to test the efficacy and safety of 2 mg of intravenous (IV) hydromorphone (Dilaudid) against “usual care” in emergency department (ED) patients with acute severe pain. Methods: This was a randomized clinical trial. Patients allocated to 2 mg of IV hydromorphone received their medication in a single dose. Those randomized to usual care received any IV opioid, with type, dose, and frequency chosen by the ED attending. All patients received 2 L/min. nasal cannula oxygen. The primary outcome was the difference in the proportion of patients who achieved clinically satisfactory analgesia by 30 minutes. This was defined as the patient declining additional analgesia when asked the question, “Do you want more pain medicine?” A 10% absolute difference was chosen a priori as the minimum difference considered clinically significant. Results Of 175 subjects randomized to each group, 164 in the 2 mg hydromorphone group and 161 in the usual care group had sufficient data for analysis. Additional pain medication was declined by 77.4% of patients in the 2 mg hydromorphone group at 30 minutes, compared to 65.8% in the usual care group. This difference of 11.6% was statistically and clinically significant (95% confidence interval [CI] = 1.8% to 21.1%). Safety profiles were similar and no patient required naloxone. There was more pruritus in the hydromorphone group (18.3% vs. 8.7%; difference = 9.6%,
95% CI = 2.6% to 16.6%). Conclusions: Using a simple dichotomous patient-centered endpoint in which a difference of 10% in proportion obtaining adequate analgesia was considered clinically significant, 2 mg of hydromorphone in a single IV dose is clinically and statistically more efficacious when compared to usual care for acute pain management in the ED.


Triage nurse initiated X-rays (NIXRs) are safe and effective; however, little is known about the ability of other RNs, particularly those without postgraduate qualifications in emergency nursing, to order NIXRs. The aim of this study was to evaluate an innovative NIXR education programme for emergency nurses. Method: The education programme was multi-faceted, delivered using Team-Based Learning (TBL) and augmented by a decision support checklist. Using a prospective exploratory design, 276 NIXR requests from June to December 2011 were audited. Three groups were compared: (i) RNs with and without postgraduate qualifications irrespective of how they were educated in NIXR, (ii) RNs with and without postgraduate qualifications who undertook the NIXR education programme, and (iii) RNs who did and did not undertake the NIXR programme irrespective of postgraduate qualifications. Results: There were 130 NIXRs by 28 RNs with postgraduate qualifications and 146 NIXRs by 12 RNs without postgraduate qualifications. Analysis of all RNs showed RNs without postgraduate qualifications had higher incidence of appropriate NIXRs (83.6% vs 66.2%, p = 0.003) however when controlled for the NIXR education programme, statistical significance was lost (83.6% vs 67.5%, p = 0.017). RNs who undertook the NIXR education programme had superior documentation of patient assessment findings and higher incidence of appropriate X-ray requests than RNs who did not undertake the NIXR education programme (80.4% vs 65.2%, p = 0.042). Conclusions: With appropriate educational preparation, RNs without postgraduate qualifications in emergency nursing can safely engage in NIXR. Structured education using TBL and a decision support checklist produces superior assessment and X-ray requests when compared to ad hoc education and role moulding.


Stroke is the second common cause of death and the primary cause of early invalidity worldwide. Different from other diseases is the time sensitivity related to stroke. In case of an ischemic event occluding a brain artery, 2 000 000 neurons die every minute. Stroke diagnosis and treatment should be initiated at the earliest time point possible, preferably at the site or during patient transport. Portable ultrasound has been used for prehospital diagnosis for applications other than stroke, and its acceptance as a valuable diagnostic tool ‘in the field’ is growing. The intrahospital use of transcranial ultrasound for stroke diagnosis has been described extensively in the literature. Beyond its diagnostic use, first clinical trials as well as numerous preclinical work demonstrate that ultrasound can be used to accelerate clot lysis (sonothrombolysis) in presence as well as in absence of tissue plasminogen activator. Hence, the use of trans-cranial ultrasound for diagnosis and possibly treatment of stroke bares the potential to add to current stroke care paradigms significantly. The purpose of this concept article is to describe the opportunities presented by recent advances in transcranial ultrasound to diagnose and potentially treat large vessel embolic stroke in the prehospital environment.

Jones D, Mitchell I, Hillman K and Story D. *Defining clinical deterioration.* Resuscitation 2013; Online first (4 February)

To review literature reporting adverse events and physiological instability in order to develop frameworks that describe and define clinical
deterioration in hospitalised patients. Literature review of publications from 1960 to August 2012. Conception and refinement of models to describe clinical deterioration based on prevailing themes that developed chronologically in adverse event literature. We propose four frameworks or models that define clinical deterioration and discuss the utility of each. Early attempts used retrospective chart review and focussed on the end result of deterioration (adverse events) and iatrogenesis. Subsequent models were also retrospective, but used discrete complications (e.g. sepsis, cardiac arrest) to define deterioration, had a more clinical focus, and identified the concept of antecedent physiological instability. Current models for defining clinical deterioration are based on the presence of abnormalities in vital signs and other clinical observations and attempt to prospectively assist clinicians in predicting subsequent risk. However, use of deranged vital signs in isolation does not consider important patient-, disease-, or system-related factors that are known to adversely affect the outcome of hospitalised patients. These include pre-morbid function, frailty, extent and severity of co-morbidity, nature of presenting illness, delays in responding to deterioration and institution of treatment, and patient response to therapy. There is a need to develop multiple-variable models for deteriorating ward patients similar to those used in intensive care units. Such models may assist clinician education, prospective and real-time patient risk stratification, and guide quality improvement initiatives that prevent and improve response to clinical deterioration.

The purpose was to determine the proportion of alcohol-positive (AlcPos) trauma patients in different age groups and any association with mortality using the National Trauma Data Bank. Methods: Several variables were extracted from the National Trauma Data Bank (version 6.2) using MS Access 2007: age, alcohol presence, Injury Severity Score (ISS), and discharge status (alive vs dead). Age groups for logistic regression were arbitrarily defined as follows: 0 to 10, 11 to 20, 21 to 39, 40 to 64, and older than 64 years. Results Approximately 47% of all trauma survivors were tested for alcohol (621,174 of a total of 1,311,137), and 28% of those were AlcPos (176,107/621,174). The proportion of AlcPos patients gradually increased to maximum at 22 years, when 46% (6797/14,732) tested were AlcPos. The proportion AlcPos gradually declined to 35% by age 50 years, then to 15% (2516/16,244) by age 66 to 70 years. The ISSs were significantly higher in AlcPos patients in all age groups (P< .01). Mortality rates were higher in AlcPos children (up to age 20 years) and in adults older than 40 years. The AlcPos patients who were 21 to 39 years old had lower mortality compared with alcohol-negative patients. Logistic regression analysis (controlling for ISSs) revealed that being AlcPos did not play a role in mortality until age 21 to 39 years (AlcPos lower mortality) and in age 40 to 64 years and older than 65 years (AlcPos higher mortality). Conclusions: Trauma patients of all ages may be AlcPos. Being AlcPos is a marker for greater injury in all age groups. After controlling for ISSs, trauma patients 40 years and older who were AlcPos have increased mortality. This study suggests a role for alcohol testing in all age groups.

Study objective: We determine the association between emergency medical services (EMS) out-of-hospital times and mortality in trauma patients presenting to an urban Level I trauma center. Methods: We conducted a secondary analysis of a prospective cohort registry of trauma patients presenting to a Level I trauma center during a 14-year period (1996 to 2009). Inclusion criteria were patients sustaining traumatic injury who
presented to an urban Level I trauma center. Exclusion criteria were extrication, missing or erroneous out-of-hospital times, and intervals exceeding 5 hours. The primary outcome was inhospital mortality. EMS out-of-hospital intervals (scene time and transport time) were evaluated with multivariate logistic regression. Results There were 19,167 trauma patients available for analysis, with 865 (4.5%) deaths; 16,170 (84%) injuries were blunt, with 596 (3.7%) deaths, and 2,997 (16%) were penetrating, with 269 (9%) deaths. Mean age and sex for blunt and penetrating trauma were 34.5 years (68% men) and 28.1 years (90% men), respectively. Of those with Injury Severity Score less than or equal to 15, 0.4% died, and 26.1% of those with a score greater than 15 died. We analyzed the relationship of scene time and transport time with mortality among patients with Injury Severity Score greater than 15, controlling for age, sex, Injury Severity Score, and Revised Trauma Score. On multivariate regression of patients with penetrating trauma, we observed that a scene time greater than 20 minutes was associated with higher odds of mortality than scene time less than or equal to 1 minutes (odds ratio [OR] 2.90; 95% confidence interval [CI] 1.09 to 7.74). Scene time of 10 to 19 minutes was not significantly associated with mortality (OR 1.19; 95% CI 0.66 to 2.16). Longer transport times were likewise not associated with increased odds of mortality in penetrating trauma cases; OR for transport time greater than or equal to 20 minutes was 0.40 (95% CI 0.14 to 1.19), and OR for transport time 10 to 19 minutes was 0.64 (95% CI 0.35 to 1.15). For patients with blunt trauma, we did not observe any association between scene or transport times and increased odds of mortality. Conclusion: In this analysis of patients presenting to an urban Level I trauma center during a 14-year period, we observed increased odds of mortality among patients with penetrating trauma if scene time was greater than 20 minutes. We did not observe associations between increased odds of mortality and out-of-hospital times in blunt trauma victims. These findings should be validated in an external data set.

Nelson MJ, Delorio NM, Schmidt TA, Zive DM, Griffiths D and Newgard CD. Why persons choose to opt out of an exception from informed consent cardiac arrest trial. Resuscitation 2013; Online first (11 February)
We sought to characterize persons who requested to opt out of an exception from informed consent (EFIC) cardiac arrest trial and their reasons for opting out. At one site of a multi-site, out-of-hospital, cardiac arrest EFIC trial (September 2007 - June 2009), persons who did not want to participate in the study could request an opt-out 'NO STUDY' bracelet to prevent trial enrollment. We surveyed all persons who requested a bracelet by phone interview, web or mail. Opt-out bracelets were advertised in all public communication about the study, including community consultation and public disclosure efforts. Survey questions included demographics, Likert scale items about attitudes toward the trial and research in general, plus open-ended questions. We used descriptive statistics for standardized questions and qualitative analysis to identify common themes from open-ended questions. Sixty bracelets were requested by 50 individuals. Surveys were completed by 46 persons (92% response rate). Seventy percent of respondents agreed emergency research is important, but 87% objected to any research without consent. In the qualitative analysis, 5 overlapping themes emerged: questioning the ethics of EFIC research; concerns about how the study would impact end-of-life preferences; subjective emotions including sarcasm, anger, and allusions to past unethical research; negative reference to unrelated public health controversies; and objections to the study protocol based on misinformation. A primary reason for opting out from this EFIC trial was opposition to all research without informed consent, despite stated support for emergency research. Understanding the demographics and beliefs of persons opting out may aid researchers planning EFIC studies and help provide clarity in future EFIC-related community education efforts.

Ondansetron is frequently used to treat nausea and vomiting during pregnancy, but the safety of this drug for the fetus has not been well studied.

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METHODS: We investigated the risk of adverse fetal outcomes associated with ondansetron administered during pregnancy. From a historical cohort of 608,385 pregnancies in Denmark, women who were exposed to ondansetron and those who were not exposed were included, in a 1:4 ratio, in propensity-score–matched analyses of spontaneous abortion (1849 exposed women vs. 7396 unexposed women), stillbirth (1915 vs. 7660), any major birth defect (1233 vs. 4932), preterm delivery (1792 vs. 7168), and birth of infants at low birth weight and small for gestational age (1784 vs. 7136). In addition, estimates were adjusted for hospitalization for nausea and vomiting during pregnancy (as a proxy for severity) and the use of other antiemetics. RESULTS: Receipt of ondansetron was not associated with a significantly increased risk of spontaneous abortion, which occurred in 1.1% of exposed women and 3.7% of unexposed women during gestational weeks 7 to 12 (hazard ratio, 0.49; 95% confidence interval [CI], 0.27 to 0.91) and in 1.0% and 2.1%, respectively, during weeks 13 to 22 (hazard ratio, 0.60; 95% CI, 0.29 to 1.21). Ondansetron also conferred no significantly increased risk of stillbirth (0.3% for exposed women and 0.4% for unexposed women; hazard ratio, 0.42; 95% CI, 0.10 to 1.73), any major birth defect (2.9% and 2.9%, respectively; prevalence odds ratio, 1.12; 95% CI, 0.69 to 1.82), preterm delivery (6.2% and 5.2%; prevalence odds ratio, 0.90; 95% CI, 0.66 to 1.25), delivery of a low-birth-weight infant (4.1% and 3.7%; prevalence odds ratio, 0.76; 95% CI, 0.51 to 1.13), or delivery of a small-for-gestational-age infant (10.4% and 9.2%; prevalence odds ratio, 1.13; 95% CI, 0.89 to 1.44). CONCLUSIONS: Ondansetron taken during pregnancy was not associated with a significantly increased risk of adverse fetal outcomes. (Funded by the Danish Medical Research Council.)


Pneumothorax has traditionally been treated in the Emergency Department by tube thoracostomy. However, this is an invasive procedure with high risk of complication and prolonged hospitalization. Discussion In select settings, there are alternative forms of management of pneumothorax that carry lower risks and may reduce hospital stay. This article reviews the settings in which less invasive treatment, including observation alone, may be indicated. This article also reviews the techniques for simple aspiration and small-bore catheter insertion (by either Seldinger or catheter-over-wire technique) with Heimlich valve, as well as the indications, contraindications, and potential risks and benefits of each. Conclusions: The practices of observation, simple aspiration, and small-bore catheter insertion with Heimlich valve for selected patients may decrease complications, time, and costs by avoiding invasive procedures and hospital admissions.


Cervical spine injury (CSI) studies have identified different factors contributing to CSI, but none compares the incidence and pattern of injury of patients arriving at the Emergency Department (ED) by private vehicle (PV). Objective: We compared the characteristics and injury patterns in CSI patients who were transported to the ED via Emergency Medical Services (EMS) versus PV. Methods: We conducted a three-hospital retrospective review of patients with CSI from January 1, 2000 to December 31, 2007. We excluded transfers and follow-up visits. Using a standardized data collection form, we reviewed demographics, mode of transport, mechanism of injury, imaging results, injury type and level, and neurologic deficits. Means and proportions were compared using t-tests and chi-squared as appropriate. Results: Of 1174 charts identified, 718
met all study criteria; 671 arrived by EMS and 47 by PV. There was no difference between groups in age or gender. Ground-level fall was more likely in PV patients (32%, 95% confidence interval [CI] 20–46% vs. 6%, 95% CI 4–9%), whereas motor vehicle collision was less likely (32%, 95% CI 20–46% vs. 67%, 95% CI 63–70%). PV patients more often sustained a stable injury (66%, 95% CI 52–78% vs. 40%, 95% CI 36–44%), and were more often triaged to a lower-acuity area (25%, 95% CI 15–40% vs. 4%, 95% CI 3–6%). The incidence of neurologic deficit was similar (32%, 95% CI 20–46% vs. 24%, 95% CI 21–28%), though more PV patients had spinal cord injury without radiographic abnormality (21%, 95% CI 12–35% vs. 5%, 95% CI 4–7%). Conclusion: A small proportion of patients with CSI present to the ED by PV. Although most had stable injuries, a surprising number had unstable injuries with neurologic deficits, and were triaged to lower-acuity areas in the ED.

Williams TA, Finn J, Celenza A, Teng TH and Jacobs IG. Paramedic Identification of Acute Pulmonary Edema in a Metropolitan Ambulance Service. Prehosp Emerg Care 2013; Online first (15 March)

Acute pulmonary edema (APE) is a common cause of acute dyspnea. In the prehospital setting, it is often difficult to differentiate APE from other causes of shortness of breath (SOB). Radiography and echocardiography aid in the identification of APE but are often not available. There is little information on how accurately ambulance paramedics identify patients with APE. Objectives. This study aimed to 1) describe the prehospital clinical presentation and management of patients with a clinical diagnosis of APE and 2) compare the accuracy of coding of APE by paramedics against the emergency department (ED) medical discharge diagnosis. Methods. This study included a retrospective cohort of all patients who had episodes identified as APE by ambulance paramedics and were transported to a metropolitan hospital ED in 2011. Two databases were used: an ambulance database and the Emergency Department Information System. The ED medical discharge diagnosis (using International Statistical Classification of Diseases and Related Problems, 10th Revision, Australian Modification [ICD-10-AM] codes) was used as the comparator with paramedic-assigned problem codes for APE. The outcomes for the study were the positive predictive value, i.e., the proportion of patients identified as having APE in the ambulance database who also had an ED discharge diagnosis of APE, and the sensitivity of paramedic identification of APE, i.e., the proportion of patients with an ED discharge diagnosis of APE that were correctly identified as APE by the ambulance paramedics. Results. Four hundred ninety-five patients were transported to an ED with APE identified by the paramedics as the primary problem code. Shortness of breath, crepitations, high systolic blood pressure, and chest pain were the most common presenting signs and symptoms. Pink frothy sputum was rare (3% of patient episodes of APE). One hundred eighty-six patients received an ED discharge diagnosis of APE, i.e., a positive predictive value of 41%. Of 631 ED presentations with APE, paramedics identified 186, i.e., a sensitivity of 29%. Conclusion. Acute pulmonary edema is difficult to identify in the prehospital setting because of the variability in the signs and symptoms associated with this condition. Improved identification of APE is essential in the initiation of appropriate and timely care. Ambulance paramedics need to be aware of such variability when considering patients who may be suffering from APE. Key words: pulmonary edema; acute pulmonary edema; emergency medical services; ambulance; paramedics.


The objective of this study is to describe emergency medicine (EM) publications in terms of methodology, approval by institutional review board, method of consent, external validity, and setting (eg, prehospital or emergency department). Methods The 12 top-ranked emergency journals were selected. We manually reviewed the last 30 original articles in each EM journal, to represent more than 2 months of publications for all EM journals (range, 2-6 months). Only clinical original articles on human subjects were included. To ensure accurate data transcription, each article
was read at least twice by 2 different reviewers and graded by written criteria using an extraction standard chart. Results: Over the articles reviewed, 330 were analyzed. One hundred eighty-nine (57.3%) were prospective studies; 29 (8.8%) were randomized studies. Two hundred twenty-six studies (68.5%) mentioned an institutional review board approval or a waiver of authorization, and an informed consent was not mentioned in 227 (68.8%) of studies. Fifty-nine (17.9%) were conducted in a prehospital setting. Two hundred thirty-eight (72.1%) of these studies were at single-center institutions; the United States contributed 158 (47.9%) of the total publications. Conclusion: This study describes publications in the field of EM. Randomized studies represent 9% of publications, most studies are cross-sectional, and more than half have a retrospective design. We found that, in one-third of the studies, an institutional review board review was not mentioned and informed consent was not specified in two-thirds of the studies. Emergency medicine research volume, quality, and grants activity must increase in order for EM to progress within academic medicine.


Failure to promptly recognize and treat anaphylaxis can result in death. Understanding the incidence, etiology, and management is imperative. A previous pediatric study identified latex as the most common anaphylaxis allergen. We aim to describe the incidence, etiology, and management of anaphylaxis prelatex and postlatex-precaution implementation. Methods: Retrospective review of inpatient and emergency department (ED) records of pediatric anaphylaxis patients seen at 1 institution between 1986 and 1990 or 2002 and 2006 was performed. Patients with 2 systemic symptoms (gastrointestinal, respiratory, hypotension/syncope, oropharyngeal, altered mental status) or 1 systemic symptom plus 1 cutaneous symptom (urticaria, edema, or flushing) were included. Results: Fifty-three episodes were included from 1986 to 1990. A total of 117 episodes were included from 2002 to 2006. Approximately 80% of cases presented to the ED. From 1986 to 1990, we noted 30.5 cases per 100,000 ED visits versus 38 cases per 100,000 ED visits from 2002 to 2006. Food allergens were most common in both groups (43%). Latex accounted for only 1.9% of cases in 1986 to 1990 versus 1.7% postlatex precautions. Prehospital epinephrine use was poor. Patients in 2002 to 2006 were more likely to receive steroids, H2-blockers, epinephrine autoinjectors, and allergist referrals but less likely to receive epinephrine. Conclusions: The etiology of pediatric anaphylaxis has not significantly changed over time but seems to differ across regions because latex was not a significant allergen at this institution in either period. The incidence of anaphylaxis has increased slightly. Anaphylaxis remains underdiagnosed and undertreated. Improved education of patients/caregivers and health care providers is needed.