
Objectives: Coronary angiography is often performed in survivors of out-of-hospital cardiac arrest, but little is known about the factors predictive of a positive coronary angiography. Our aim was to determine these factors. Methods: In this 7-year retrospective study (January 2000-December 2006) conducted by a French out-of-hospital emergency medical unit, data were collected according to Utstein style guidelines on all out-of-hospital cardiac arrest patients with suspected coronary disease who recovered spontaneous cardiac activity and underwent early coronary angiography. Coronary angiography was considered positive if a lesion resulting in more than a 50% reduction in luminal diameter was observed or if there was a thrombus at an occlusion site. Results: Among the 4621 patients from whom data were collected, 445 were successfully resuscitated and admitted to hospital. Of these, 133 were taken directly to the coronary angiography unit, 95 (71%) had at least one significant lesion, 71 (53%) underwent a percutaneous coronary intervention, and 30 survived [23%, 95% confidence interval (CI): 16-30]. According to multivariate analysis, the factors predictive of a positive coronary angiography were a history of diabetes [odds ratio (OR): 7.1, 95% CI: 1.4-36], ST segment depression on the out-of-hospital ECG (OR: 5.4, 95% CI: 1.1-27.8), a history of coronary disease (OR: 5.3, 95% CI: 1.4-20.1), cardiac arrest in a public place (OR: 3.7, 95% CI: 1.3-10.7), and ventricular fibrillation or ventricular tachycardia as initial rhythm (OR: 3.1, 95% CI: 1.1-8.6). Conclusion: Among the factors identified, diabetes and a history of coronary artery were strong predictors for a positive coronary angiography, whereas ST segment elevation was not as predictive as expected.


AIM: To assess the time to obtain reliable oxygen saturation readings by different pulse oximeters during neonatal resuscitation in the delivery room or NICU. METHODS: Prospective study comparing three different pulse oximeters: Masimo Radical-7 compared simultaneously with Ohmeda Biox 3700 or with Nellcor N395, in newborn infants who required resuscitation. Members of the research team placed the sensors for each of the pulse oximeters being compared simultaneously, one sensor on each foot of the same baby. Care provided routinely, without interference by the research team. The time elapsed until a reliable SpO2 was obtained was recorded using a digital chronometer. Statistical comparisons included chi-square and student’s T-test. RESULTS: Thirty-two infants were enrolled; median gestational age 32 weeks. Seventeen paired measurements were made with the Radical-7 and Biox 3700; mean time to a stable reading was 20.2+/-.7 sec for the Radical-7 and 74.2+/-.12 sec for the Biox 3700 (p=0.02). The Radical-7 and the N-395 were paired on 15 infants; the times to obtain a stable reading were 20.9+/-.4 sec and 67.3+/-.12 sec, respectively (p=0.03). CONCLUSION: The time to a reliable reading obtained simultaneously in neonatal critical situations differs by the type of the pulse oximeter used, being significantly faster with Masimo Signal Extraction Technology. This may permit for better adjustments of inspired oxygen, aiding in the prevention of damage caused by unnecessary exposure to high or low oxygen.

Objectives: This study sought to determine comprehensively the incidence of pediatric out-of-hospital cardiac arrest (OHCA) and its contribution to total pediatric mortality, the causes of pediatric OHCA, and the outcome of resuscitation of pediatric OHCA patients.

Background: There is a paucity of complete studies on incidence, causes, and outcomes of pediatric OHCA. Methods: In this prospective, population-based study, OHCA victims younger than age 21 years in 1 province of the Netherlands were registered through both emergency medical services and coroners over a period of 4.3 years. Death certificate data on total pediatric mortality, survival status, and neurological outcome at hospital discharge also were obtained. Results: With a total mortality of 923 during the study period and 233 victims of OHCA (including 221 who died and 12 who survived), OHCA caused 24% (221 of 923) of total pediatric mortality. Natural causes of OHCA amounted to 115 (49%) cases, with cardiac causes being most prevalent (n = 90, 39%). The incidence of pediatric OHCA was 9.0 per 100,000 pediatric person-years (95% confidence interval: 7.8 to 10.3), whereas the incidence of pediatric OHCA from cardiac causes was 3.2 (95% confidence interval: 2.5 to 3.9). Of 51 resuscitated patients, 12 (24%) survived; among survivors, 10 (83%) had a neurologically intact outcome.

Conclusions: Out-of-hospital cardiac arrest accounts for a significant proportion of pediatric mortality, and cardiac causes are the most prevalent causes of OHCA. The vast majority of OHCA survivors have a neurologically intact outcome.

Guideline 12: Paediatric ALS


Objective: To investigate if paper-based documentation in the authors' emergency medical service (EMS) satisfies scientific requirements.

Methods: From 1 July 2007 to 28 February 2008, data from all paper-based protocols of a physician-run EMS in Aachen, Germany, were transferred to a SQL database (n=4815). Database queries were conducted after personal data had been anonymised. Documentation ratios of 11 individual parameters were analysed at two points in time (T1, scene; T2, arrival in emergency department). The calculability of the Mainz Emergency Evaluation Score (MEES, embracing seven vital parameters) was investigated. The calculability of the Revised Trauma Score (RTS) was also determined for all trauma patients (n=408). Fisher’s exact test was used to compare differences in ratios at T1 versus T2. Results: The documentation ratios of vital parameters ranged from 99.33% (Glasgow Coma Scale, T1) to 40.31% (respiratory rate, T2). The calculability of the MEES was poor (all missions: 28.31%, T1; 22.40%, T2; p<0.001). In missions that required cardiopulmonary resuscitation (n=87), the MEES was calculable in 9.20% of patients at T1 and 29.89% at T2 (p<0.001). In trauma missions, the RTS was calculable in 37.26% at T1 and 27.70% at T2 (p=0.004). Conclusions: Documentation of vital parameters is carried out incompletely, and documentation of respiratory rate is particularly poor, making calculation of accepted emergency scores infeasible for a significant fraction of a given test population. The suitability of paper-based documentation is therefore limited. Electronic documentation that includes real-time plausibility checks might improve data quality. Further research is warranted.

**Objective:** Intranasal fentanyl's (INF) effectiveness is established using highly concentrated INF (HINF). Standard concentration INF (SINF) is more widely available. We aimed to illustrate the equivalence of SINF to HINF. **Methods:** Double-blinded randomized controlled trial was used within a children's hospital ED. Children aged 3–15 years with fractures were randomized to SINF or HINF. Outcome measures included pain scores at time zero and every 10 min until 30 min. Additional analgesic agents were noted. **Results:** Data in 189 children (91 HINF, 98 SINF) were obtained. Pre-analgesia median VAS was 80.0 mm (interquartile range [IQR] 60.0–95.5) in SINF, 77.5 mm (IQR 60.0–100) in HINF. At 10 min median VAS was 49.5 mm (IQR 26.5–68.5) and 43.0 mm (IQR 15.2–66.0), respectively, at 20 min 27.5 mm (IQR 18.5–56.5) and 35.0 mm (IQR 9.0–57.0) and at 30 min 20.0 mm (IQR 10.0–46.0) and 21.5 mm (IQR 4.75–51.0). Each agent demonstrated significant decrease in pain scores (median decrease 40 mm, P = 0.00). Additional analgesia was given in 67 (42 SINF, 25 HINF) (P = 0.028). The decrease in pain scores between children < and ≥50 kg in SINF was significant both overall (P = 0.005) and between 10 and 20 min (P = 0.003). There was no difference in HINF at any time by weight. **Conclusions:** The two concentrations of INF were equivalent in reducing pain, with a trend to increased oral additional agents in the more dilute solution. The widespread use of this readily available analgesic in the standard concentration can be supported, particularly in patients <50 kg.


**Objective:** To determine whether out-of-hospital administration of hypertonic fluids would improve survival after severe injury with hemorrhagic shock. **Background:** Hypertonic fluids have potential benefit in the resuscitation of severely injured patients because of rapid restoration of tissue perfusion, with a smaller volume, and modulation of the inflammatory response, to reduce subsequent organ injury. **Methods:** Multicenter, randomized, blinded clinical trial, May 2006 to August 2008, 114 emergency medical services agencies in North America within the Resuscitation Outcomes Consortium. Inclusion criteria: injured patients, age > 15 years with hypovolemic shock (systolic blood pressure < 70 mm Hg or systolic blood pressure 71-90 mm Hg with heart rate >108 beats per minute). Initial resuscitation fluid, 250 mL of either 7.5% saline per 6% dextran 70 (hypertonic saline/dextran, HSD), 7.5% saline (hypertonic saline, HS), or 0.9% saline (normal saline, NS) administered by out-of-hospital providers. Primary outcome was 28-day survival. On the recommendation of the data and safety monitoring board, the study was stopped early (23% of proposed sample size) for futility and potential safety concern. **Results:** A total of 853 treated patients were enrolled, among whom 62% were with blunt trauma, 38% with penetrating. There was no difference in 28-day survival: HSD: 74.5% (0.1; 95% confidence interval [CI], 7.5 to 7.8); HS: 73.0% (-1.4; 95% CI, -8.7 - 6.0); and NS: 74.4%, P = 0.91. There was a higher mortality for the post-randomization subgroup of patients who did not receive blood transfusions in the first 24 hours, who received hypertonic fluids compared to NS [28-day mortality: HSD: 10% (5.2; 95% CI, 0.4 - 10.1); HS: 12.2% (7.4; 95% CI, 2.5 - 12.2); and NS: 4.8%, P < 0.01]. **Conclusion:** Among injured patients with hypovolemic shock, initial resuscitation fluid treatment with either HS or HSD compared with NS, did not result in superior 28-day survival. However, interpretation of these findings is limited by the early stopping of the trial.
7. Cabanas JG, Brice JH, De Maio VJ, Myers B, Hinchey PR. 

Background: Emergency Medical Services (EMS) has started to embrace the early use of therapeutic hypothermia as standard treatment to improve neurological recovery in out-of hospital cardiac arrest (OHCA) survivors. Objective: We conducted a systematic review to provide an overall description of the current literature on the use of therapeutic hypothermia in OHCA and to identify possible gaps in the literature. Methods: Comprehensive searches of MEDLINE, PubMed, CINAHL, and ISI Web of Science from 1950 to March 2009, and EMBASE from 1988 to March 2009 were performed. Bibliographies of selected articles were hand searched. Two reviewers independently selected studies on the basis of three inclusion criteria. Two additional independent reviewers assessed selected studies for quality. Results: Of more than 800 screened citations, a total of 11 published studies were included in the systematic review. Three studies were conducted in the United States, three in Finland, and one each in Australia, France, Germany, Austria, and Norway. Four of the studies were pilot clinical trials that provided prehospital mild therapeutic hypothermia during active cardiopulmonary resuscitation. The remaining seven studies performed cooling after return of spontaneous circulation. Significant differences in research methodology and outcome measures were noted. Eight studies scored poor for quality. Conclusions: The use of mild therapeutic hypothermia is gaining acceptance within the EMS community. It seems that hypothermia can be efficiently induced in the prehospital environment. There is a need for more research in this area to understand the effectiveness and timing of early therapeutic hypothermia in the prehospital environment.

Guideline 11.8: Therapeutic hypothermia after cardiac arrest


Objective: Accurate identification of major trauma patients in the prehospital setting positively affects survival and resource utilization. Triage algorithms using predictive criteria of injury severity have been identified in paramedic-based prehospital systems. Our rescue system is based on prehospital paramedics and emergency physicians. The aim of this study was to evaluate the accuracy of the prehospital triage performed by physicians and to identify the predictive factors leading to errors of triage. Methods: Retrospective study of trauma patients triaged by physicians. Prehospital triage was analyzed using criteria defining major trauma victims (MTVs, Injury Severity Score >15, admission to ICU, need for immediate surgery and death within 48 h). Adequate triage was defined as MTVs oriented to the trauma centre or non-MTV (NMTV) oriented to regional hospitals. Results: One thousand six hundred and eighty-five patients (blunt trauma 96%) were included (558 MTV and 1127 NMTV). Triage was adequate in 1455 patients (86.4%). Overtriage occurred in 171 cases (10.1%) and under triage in 59 cases (3.5%). Sensitivity and specificity was 90 and 85%, respectively, whereas positive predictive value and negative predictive value were 75 and 94%, respectively. Using logistic regression analysis, significant (P<0.05) predictors of under triage were head or thorax injuries (odds ratio >2.5). Predictors of overtriage were paediatric age group, pedestrian or 2 wheel-vehicle road traffic accidents (odds ratio >2.0). Conclusion: Physicians using clinical judgement provide effective prehospital triage of trauma patients. Only a few factors predicting errors in triage process were identified in this study.

Introduction: Serious pulmonary and cardiac failure may be treated with extracorporeal membrane oxygenation (ECMO) when the conventional treatment fails. Improvements in extracorporeal circulation devices have allowed us to set up two specialized mobile units: a mobile cardiac assistance unit (MCAU) and a mobile respiratory assistance unit (MRAU). Their role is to provide ECMO at patient's bedside, and then to ensure inter-hospital transport (IHT). The aim of this study was to evaluate our experiences with the transportation of patients on ECMO. Methods: We performed two prospective observational studies, the first on IHT requiring MCAU during 3 years and the second on IHT requiring MRAU during 6 months. Results: Thirty-two patients needed MCAU. The median age is 40 years. The median distance travelled is 45 km. The median time of arrival at patient bedside is 49 min. Causes of cardiac shock were: myocarditis (28.1%), acute heart failure of unknown aetiology (21.9%), drug-induced cardiovascular failure (18.8%), post-infarction cardiac failure (12.5%), post-cardiac surgery (12.5%) and refractory cardiac arrest (6.2%). Thirty days mortality was 40%. Eleven patients needed MRAU. The median age was 33 years. The median distance travelled is 40 km; the median time of arrival at patient bedside is 47 min. All patients had severe acute respiratory distress syndrome complicating severe H1N1 virus infection. Thirty days mortality was 65%. In both the cases, all transportations were uneventful. Conclusion: This study shows that mobile ECMO system can be successfully and quickly established at patient's bedside, and that transportation of patients on ECMO can be performed safely and without technical difficulties.


Background: The Institute of Medicine calls for the use of clinical guidelines and practice parameters to promote best practices, and improve patient outcomes. In 2006, The Trauma Association of Canada Pediatric Committee set out to create an evidence-based, national pediatric cervical spine (c-spine) clearance guideline based on the literature, existing algorithms from each pediatric trauma center and from expert opinion from across Canada. Methods: A review of the literature took place in September 2006 using the PubMed database. Search criteria were 'cervical spine', 'c-spine', 'clearance' and 'trauma'. Limits that were applied were Languages: English, Humans, Type of Article: Meta-Analysis, Practice Guidelines, Randomized Control Trial, Review, and Ages: all child 0-18 years. These search criteria were repeated in December 2007, April 2009, and October 2009. A total of 248 articles were identified. Existing guidelines were identified and their practices examined as models of care. Two draft guidelines were created for discussion: one for the pediatric patient with a reliable clinical examination and the other for the pediatric patient with an unreliable clinical examination. Via email, telephone, and two national videoconferences, the content of the guidelines was reviewed, discussed, and amended. The final article was prepared and circulated for author input until consensus was reached. Results: A consensus was reached on two pathways to evaluate the pediatric cervical spine: a patient with a reliable clinical examination and a patient with an unreliable examination. Conclusion: Presented herein are the consensus Trauma Association of Canada, National Pediatric Cervical Spine Evaluation Pathways for the patient with a reliable clinical examination, and the patient with and unreliable clinical examination.

*Guideline 9.1.6: Spinal injuries*

Controversy exists around CPR in the elderly. The characteristics and outcomes of out-of-hospital cardiac arrest (OHCA) in this age group were studied in Melbourne, Australia. The Victorian Ambulance Cardiac Arrest Registry (VACAR) was searched for all OHCAs not witnessed by Emergency Medical Services (EMS) occurring in those aged 65 years and older. Between 2000 and 2009 there were 30,006 OHCAs of which 9703 (32%) were in people 65-79 years of age, 6430 (21%) in octogenarians, 1530 (5%) in nonagenarian and 40 (0.1%) in centenarians. Rates of attempted resuscitation decreased with advancing age: 48% for those aged 65-79 years, 39% for octogenarians, 31% for nonagenarians and 17% for centenarians. Similarly rates of survival to hospital discharge decreased with age: 8% for those aged 65-79 years, 4% for octogenarians, 2% for nonagenarians; for 65-79 year olds, octogenarians and nonagenarians survival if in VF/VT was: 17%, 10% and 4%; asystole: 1%, 1% and 0.5%; and PEA: 6%, 3% and 3%, respectively. Multivariable logistic regression shows that between 2000 and 2009 rates of transportation with return of spontaneous circulation have improved for both shockable and non-shockable rhythms [OR 95% CI 1.07(1.04-1.10) and 1.16(1.12-1.20), respectively] but survival to hospital discharge has improved in the shockable rhythm group only [OR 1.12(1.07-1.16)]. Outcomes for OHCA with shockable rhythm have improved over the last 10 years for people aged 65 years and over. Quality of life studies should be performed to help inform the community and EMS on appropriate resuscitative efforts.


Aims: Return of spontaneous circulation (ROSC) following cardiopulmonary resuscitation from cardiac arrest (CA) depends on numerous variables. The aim of this study was to develop a score to predict the initial resuscitation outcome; the RACA (ROSC after cardiac arrest) score.

Methods and results: Based on 5471 prospectively registered out-of-hospital CAs patients between 1998 and 2008 within the German Resuscitation Registry, calculation of the RACA score was performed by multivariate logistic regression analysis with ROSC as the outcome variable. The probability of ROSC was defined as 1/(1 + X), where X is the weighted sum of independent factors. Additional 2218 patients documented between 2009 and 2010 were used for validation of the RACA score. The following independent variables were found to have a significant positive (+) or negative (-) impact on the probability of ROSC: male gender (-0.2); age >80 years (-0.2); witnessing by lay people (+0.6) and by professionals (+0.5); asystole (-1.1); location at doctor’s office (+1.2), medical institution (+0.5), public place (+0.3) and nursing home (-0.3); presumable aetiology of hypoxia (+0.7), intoxication (+0.5) and trauma (-0.6); and time until professionals arrival (-0.04 per minute). In a validation cohort, observed ROSC (43.8%) did not differ from predicted ROSC (43.7%). Conclusion: The RACA score represents a simple tool and enables comparison between observed and predicted ROSC rates based on readily available variables after CA. Thereby, the RACA score may contribute to preclinical quality assessment and may help analysing the effects of different post-resuscitation strategies.

Background: Lactate is associated with morbidity and mortality; however, the value of prehospital lactate (pLA) is unknown. Our objective was to determine whether prehospital lactate (pLA) improves identification of mortality and morbidity independent of vital signs. Methods: We measured pLA in 1,168 patients transported by rotorcraft to a Level I trauma center over 18 months. The primary outcome was in-hospital mortality; secondary outcomes were emergent surgery and multiple organ dysfunction syndrome (MODS). Covariates include age, sex, prehospital vital signs, and mental status. We created multivariable logistic regression models and tested them for interaction terms and goodness of fit. Cutoff values were established for reporting operating characteristics using shock (defined as shock index >0.8, heart rate >110, and systolic blood pressure <100), tachypnea (RR ≥30), and altered sensorium (Glasgow Coma Scale score <15). Results: In-hospital mortality was 5.6%, 7.4% required surgery and 5.7% developed MODS. Median lactate was 2.4 mmol/L. Lactate was associated with mortality (odds ratio [OR], 1.23; p < 0.0001), surgery (OR, 1.13; p < 0.001), and MODS (OR, 1.14; p < 0.0001). Inclusion of pLA into a logistic model significantly improved the area under the receiver operator curves from 0.85 to 0.89 for death (p < 0.001), 0.68 to 0.71 for surgery (p = 0.02), and 0.78 to 0.81 for MODS (p = 0.002). When a threshold lactate value of >2 mmol/L was added to a predictive model of shock, respiratory distress, or altered sensorium, it improved sensitivity from 88% to 97% for death, 64% to 86% for surgery, and 94% to 99% for MODS. Conclusion: The pLA measurements improve prediction of mortality, surgery, and MODS. Lactate may improve the identification of patients who require monitoring, resources, and resuscitation.


Background: The true incidence of sudden cardiac death (SCD) in US athletes is unknown. Current estimates are based largely on case identification through public media reports and estimated participation rates. The purpose of this study was to more precisely estimate the incidence of sudden cardiac death (SCD) in National Collegiate Athletic Association (NCAA) student-athletes and assess the accuracy of traditional methods for collecting data on SCD. Methods and Results: From January 2004 through December 2008, all cases of sudden death in NCAA student-athletes were identified by use of an NCAA database, weekly systematic search of public media reports, and catastrophic insurance claims. During the 5-year period, there were 273 deaths and a total of 1,969,663 athlete participant-years. Of these 273 deaths, 187 (68%) were due to nonmedical or traumatic causes, 80 (29%) to medical causes, and 6 (2%) to unknown causes. Cardiovascular-related sudden death was the leading cause of death in 45 (56%) of 80 medical cases, and represented 75% of sudden deaths during exertion. The incidence of SCD was 1:43,770 participants per year. Among NCAA Division I male basketball players, the rate of SCD was 1:3100 per year. Thirty-nine (87%) of the 45 cardiac cases were identified in the NCAA database, only 25 (56%) by use of public media reports, and 9 (20%) from catastrophic claims data. Conclusions: SCD is the leading medical cause of death and death during exercise in NCAA student-athletes. Current methods of data collection underestimate the risk of SCD. Accurate assessment of SCD incidence is necessary to shape appropriate health policy decisions and develop effective strategies for prevention.

**Objective:** To evaluate and compare the efficacy and safety of bronchodilators and steroids, alone or combined, for the acute management of bronchiolitis in children aged less than 2 years. **Design:** Systematic review and meta-analysis. **Data sources:** Medline, Embase, Central, Scopus, PubMed, LILACS, IranMedEx, conference proceedings, and trial registers. **Inclusion criteria:** Randomised controlled trials of children aged 24 months or less with a first episode of bronchiolitis with wheezing comparing any bronchodilator or steroid, alone or combined, with placebo or another intervention (other bronchodilator, other steroid, standard care). **Review methods:** Two reviewers assessed studies for inclusion and risk of bias and extracted data. Primary outcomes were selected by clinicians a priori based on clinical relevance: rate of admission for outpatients (day 1 and up to day 7) and length of stay for inpatients. Direct meta-analyses were carried out using random effects models. A mixed treatment comparison using a Bayesian network model was used to compare all interventions simultaneously. **Results:** 48 trials (4897 patients, 13 comparisons) were included. Risk of bias was low in 17% (n=8), unclear in 52% (n=25), and high in 31% (n=15). Only adrenaline (epinephrine) reduced admissions on day 1 (compared with placebo: pooled risk ratio 0.67, 95% confidence interval 0.50 to 0.89; number needed to treat 15, 95% confidence interval 10 to 45 for a baseline risk of 20%; 920 patients). Unadjusted results from a single large trial with low risk of bias showed that combined dexamethasone and adrenaline reduced admissions on day 7 (risk ratio 0.65, 0.44 to 0.95; number needed to treat 11, 7 to 76 for a baseline risk of 26%; 400 patients). A mixed treatment comparison supported adrenaline alone or combined with steroids as the preferred treatments for outpatients (probability of being the best treatment based on admissions at day 1 were 45% and 39%, respectively). The incidence of reported harms did not differ. None of the interventions examined showed clear efficacy for length of stay among inpatients. **Conclusions:** Evidence shows the effectiveness and superiority of adrenaline for outcomes of most clinical relevance among outpatients with acute bronchiolitis, and evidence from a single precise trial for combined adrenaline and dexamethasone.


Atrial fibrillation (AF) is a common finding in patients with myocardial infarction (MI). Atrial fibrillation is not generally perceived by clinicians as a critical event during the acute phase of MI; however, its prognostic influence in MI remains controversial. Furthermore, contradictory data exist concerning the risk of death according to AF timing. **This article, a systematic review and first meta-analysis, aims to quantify the mortality risk associated with AF in MI patients and its timing.** **Methods and Results:** A comprehensive search of several electronic databases (1970 to 2010; adults, any language) identified MI studies that evaluated mortality related to AF. Evidence was reviewed by two blinded reviewers with a formal assessment of the methodological quality of the studies. Adjusted odds ratios were pooled across studies using the random-effects model. The I2 statistic was used to assess heterogeneity. In the 43 included studies (278 854 subjects), the mortality odds ratio associated with AF was 1.46 (95% confidence interval, 1.35 to 1.58; I2=76%; 23 studies). This worse prognosis persisted regardless of the timing of AF; the odds ratio of mortality for new AF with no prior history of AF was 1.37 (95% confidence interval, 1.26 to 1.49), I2=28%, 9 studies), and for prior AF was 1.28 (95% confidence interval, 1.16 to 1.40; I2=24%; 4 studies). The sensitivity analysis of new AF studies adjusting for confounding factors did not show a decrease in risk of death. **Conclusions:** Atrial fibrillation is associated with increased risk of mortality in MI.
patients. New AF with no history of AF before MI remained associated with an increased risk of mortality even after adjustment for several important AF risk factors. These subsequent increases in mortality suggest that AF can no longer be considered a non-severe event during MI.

**Guideline 14.1: ACS: Presentation with ACS**


Background: Although head computed tomographic angiography (CTA) is a sensitive tool for the evaluation of neurological symptoms in the emergency department (ED), little is known about which clinical signs predict significant CTA findings. **Objectives:** To identify clinical factors that predict significant findings on head CTA in patients presenting to the ED with neurological complaints. Methods: Retrospective chart review of consecutive adult patients undergoing head CTA over a 6-month period in an urban, tertiary care ED with an annual volume of 76,000. Significant head CTA findings were defined as clinically significant neurological abnormalities undetected by previous imaging studies. Demographics, chief complaint, results of the neurological examinations (NE), and head non-contrast computed tomography (CT) results were used as predictors of significant head CTA. All predictors with a univariate p < 0.2 using Pearson’s chi-squared were entered stepwise into a multivariable logistic regression including odds ratios (OR), with inclusion restricted to p < 0.05. Results: Chart review yielded 456 cases; 215 (47%) were male. Mean age was 62 (SD 20) years. There were 189 patients (41%) with abnormal CTAs. **Multivariable logistic regression** indicated five variables that predicted a clinically significant CTA: abnormal CT (OR 3.72), chief complaint of subarachnoid hemorrhage-type headache (OR 2.30), and motor deficit (OR 2.23), visual deficit (OR 2.23), and other focal deficit (OR 2.18) on NE. A chief complaint of trauma (OR 0.23) predicted a normal CTA. Conclusions: Specific historical and focal neurological findings are useful for predicting clinically significant findings on head CTA.

**Guideline 9.1.4: Head injury**


Aim: Troponin assays have high diagnostic value for myocardial infarction (MI), but sensitivity has been weak early after chest pain onset. New, so-called ‘sensitive’ troponin assays have recently been introduced. Two studies report high sensitivity for assays taken at ED presentation, but studied selected populations. Our aim was to evaluate the diagnostic performance for MI of a sensitive troponin assay measured at ED presentation in an unselected chest pain population without ECG evidence of ischaemia. Methods: This is a sub-study of a prospective cohort study of adult patients with potentially cardiac chest pain who underwent evaluation for acute coronary syndrome. Patients with clear ECG evidence of acute ischaemia or an alternative diagnosis were excluded. Data collected included demographic, clinical, ECG, biomarker and outcome data. A ‘positive’ troponin was defined as >99th percentile of the assay used. MI diagnosis was as judged by the treating cardiologist. The outcomes of interest were sensitivity, specificity and likelihood ratios (LR) for positive troponin assay taken at ED presentation. Data were analysed by clinical performance analysis. Results: Totally 952 were studied. Median age was 61 years; 56.4% were male and median TIMI score was 2. There were 129 MI (13.6, 95% CI 11.5–15.9). Sensitivity of TnI at ED presentation was 76.7% (95% CI 68.5–83.7%), specificity
93.6% (95% CI 91.7–95.1%), with LR positive 11.92 and LR negative 0.25. Conclusion: Sensitive TnI assay at ED presentation has insufficient diagnostic accuracy for detection of MI. Serial biomarker assays in patients with negative initial TnI are required.

Guideline 14: Acute coronary syndromes


The increase in the size and age of the UK older population has had a major effect on emergency services. Many older people will visit the emergency department but not necessarily require significant clinical intervention. The Paramedic Practitioner in Older People’s Support (PPOPS) scheme was set up to provide community-based clinical assessment of older patients contacting the emergency services with minor acute conditions as an alternative approach to emergency department transfer. Patient carers were followed-up to evaluate the impact of this scheme when compared with standard transfer to the emergency department. Postal questionnaires, including items on the level of care provided, satisfaction with care received and carer impact, were administered to 561 carers. The overall response rate was 71.5% (401/561). The carers were predominantly female, approximately 60 years of age and family members, with more than three-quarters providing some form of physical care before the patient episode. Overall, carers did report an increase in the level of care provided before episode, significantly more so in the emergency department group (p=0.003). These increases related to more input needed in supporting physical activities. The carers in the PPOPS group were more likely to report greater satisfaction with their impression of care and staff attitude and would prefer treatment at home for the patient than those in the emergency department group (p<0.001). A minor health event does impact on the life of a carer. However, community-based schemes, such as PPOPS, do not increase the burden on carers and have high levels of satisfaction among this important group of the community.


Study objective: We compare the quality of ECG recordings obtained with conventional and prewired electrodes in an emergency setting. Methods: This was a prospective, randomized, open comparison study in an emergency medical services setting. Participants were patients undergoing ECG between April and May 2007 (n=105). Two 12-lead ECG recordings were made in random order with conventional and prewired electrodes. Artifacts, ie, signal noise (>0.4 seconds of recording affected) and baseline instability (>1-mV variation), were analyzed and scored by 3 blinded reviewers. Results were expressed as number of affected leads, score/lead (0 to 3 scale for signal noise; 0 to 4 scale for baseline instability), and number of leads that were totally artifact free. Time to make recordings was measured. Results: Recordings were nearly as easy and took 20% less time with prewired than with conventional electrodes (118 [interquartile ratio (IQR) 90 to 150] versus 144 [IQR 120 to 182]). With prewired electrodes, fewer leads were affected by noise (1 [IQR 0 to 3] versus 3 [IQR 0 to 6]) and baseline instability (0 [IQR 0 to 2] versus 2 [IQR 0 to 4]). The mean score/lead was lower for both noise (1 [IQR 0 to 3] versus 3 [IQR 0 to 8]) and instability (0 [IQR 0 to 2] versus 2 [IQR 0 to 5]); the number of artifact-free leads was greater (38 [36%] versus 19 [18%]). There was no significant difference between electrode types in the prevalence of P-wave and QRS complex abnormalities. Conclusion: Recordings with prewired electrodes took
significantly less time. Signal noise and baseline instability were significantly reduced. The time saved was not at the expense of the quality of the recording.


Aims: Out-of-hospital cardiac arrest (OOHCA) survival remains poor, estimated at 3 - 7%. We aim to describe the incidence of OOHCA, survival from OOHCA, and the impact of improved pre-hospital care on survival from OOHCA. Methods and results: A retrospective registry was established using multi-source information to assess survival from cardiac arrest following the introduction of several improvements in pre-hospital emergency medical care from 2003. Survival from OOHCA, from asystole/pulseless electrical activity, and from ventricular tachycardia/ventricular fibrillation was estimated. Adjusted per 100 000 population annual incidence rates from national population census data were calculated. Mean and median emergency medical services (EMS) response times to OOHCA calls were assessed. A total of 962 OOHCA occurred from 1 January 2003 until 31 December 2008. Sixty-nine per cent (69%, n = 664) were male. Seventy-two per cent (72%, n = 693) occurred at home with 28% occurring in a public venue. Of these public venues, 33.9% (91 of 268) had an automated external defibrillator available. Bystander cardiopulmonary resuscitation (CPR) was in progress when emergency services arrived in 11% (n = 106) of the cases. Nineteen per cent (19.4%, n = 187) had a known prior cardiac history or chest pain prior to circulatory collapse. Overall survival to hospital discharge improved significantly from 2.6 to 11.3%, P = 0.001. Survival from ventricular fibrillation (VF) to hospital admission, rose from 28.6 to 86.3%, P = 0.001. Survival to hospital discharge from VF improved from 21.4 to 33%, P = 0.007. Mean EMS response times to the scene of arrest decreased from 9.18 to 8.34 min. Emergency medical services scene time, reflecting acute pre-hospital medical care, rose from 14.46 to 18.12 min. The adjusted incidence of OOHCA for our catchment population declined from 109.4 to 88.2 per 100 000 population between 2003 and 2008. Conclusions: The incidence of OOHCA has declined but importantly, survival to hospital discharge has improved dramatically. Reduction in ambulance response time, resulting in earlier initiation of basic and advanced life support and earlier defibrillation, was associated with an increase in the proportion of victims found in VF rather than asystole and likely accounted for most of the improvement. Further improvements in response times and public education to improve bystander CPR rates should remain a priority.


Objectives: To report time from the onset of symptoms to hospital presentation in Australian and New Zealand patients with subsequently confirmed acute coronary syndrome, and to identify factors associated with prehospital delay time in these patients. Methods: Patients with coronary artery disease enrolled in a randomized clinical trial testing an intervention to reduce delay in responding to acute coronary syndrome symptoms had been followed for 24 months. In cases of admission to the ED for possible acute coronary syndrome, medical records were reviewed to determine the diagnosis, prehospital delay time, mode of transport to the hospital and aspirin use before admission. Clinical and demographic data were taken from the trial database. Results: Patients (n = 140) had an average (SD) age of 67.3 (11.5) years; 36% were female. Two-thirds of patients went to hospital by ambulance and 89.3% had a final diagnosis of unstable angina. The median time from onset of symptoms to arrival at the ED was 2 h and 25 min (interquartile range 1:25–4:59); 12.1% arrived ≤ 1 h and 66% within 4 h. Multiple linear
regression analysis showed that use of ambulance (Beta = 0.247, P= 0.012) and younger age (Beta = 0.198, P= 0.043) were independent predictors of shorter delay times. Conclusion: The time from the onset of symptoms to hospital presentation was too long for maximal benefit from treatment in most patients. Further efforts are needed to reduce treatment-seeking delay in response to symptoms of acute coronary syndrome.

Guideline 14: Acute coronary syndromes


Objectives: The objective was to assess the feasibility of insulin infusion and subcutaneous insulin administered in the prehospital setting and their relative effect on hyperglycemia, a predictor of unfavorable outcome, in acute stroke patients. Methods: Hyperglycemic patients (plasma glucose >6.0 mmol/L) with stroke symptoms were randomized prior to or during transport to the hospital to receive either 1) a single subcutaneous dose of short-acting insulin (n = 11) or 2) a continuous intravenous (IV) insulin infusion (n = 12) at a rate adjusted by glucose levels measured every 10 minutes and targeted to plasma glucose 4.5–6.0 mmol/L. The changes in plasma glucose concentration were compared with a nonrandomized control group (n = 38) receiving standard care. Results: The baseline characteristics did not differ between the study groups. Plasma glucose concentration was significantly decreased during the prehospital phase in the IV-treated group in comparison to the control group (difference between groups –1.9 mmol/L, 95% confidence interval [CI] = –3.5 to –0.27) with no serious adverse events. In contrast, subcutaneous insulin did not achieve significant lowering of plasma glucose (–0.9 mmol/L, 95% CI = –2.4 to 0.6). Conclusions: This small sample suggests that adjusted insulin infusion efficiently lowers blood glucose in the ultra-acute phase of stroke and is feasible in the prehospital setting.

Guideline 9.2.2: Stroke


Objective: The importance of early recognition of hemorrhagic shock and its effects on outcome have long been recognized. Traditional vital signs are relatively insensitive as early diagnostic markers of hemorrhage. The shock index (SI); heart rate (HR) divided by systolic blood pressure (SBP), has been suggested as such a marker. We tested the diagnostic utility of the SI in differentiating major from minor injury in trauma patients. Methods: Retrospective study of a prospectively collected observational cohort at a level I trauma center. Demographics, injury mechanism, HR, SBP, base deficit and lactate were recorded and Injury Severity Score were calculated. Major injury was defined as either a change in hematocrit greater than 10 or blood transfusion requirement during initial 24 h, or Injury Severity Score greater than 15. Results: One thousand four hundred and thirty-five trauma patients were enrolled, average age 35.2+/−16.9 years. Two hundred and forty-two were classified as major injury. The area under the receiver operator characteristic curves for SI [0.63 95% confidence interval (CI) 0.59-0.67] was significantly less than that for base deficit (0.72, 95% CI: 0.69-0.76) or lactate (0.69, 95% CI: 0.65-0.73). The diagnostic performance of SI was slightly better than HR (0.58) but not SBP (0.61). To reach sensitivity of 90%, the SI must be 0.5, well in the range of a normal SBP and HR,
Conclusion: The SI can be a valuable tool, raising suspicion when it is abnormal even when other parameters are not, but is far too insensitive for use as a screening device to rule out disease. A normal SI should not lower the suspicion of major injury.

Several previous studies have focused on establishing the cause of cardiac arrest (CA) during cardiopulmonary resuscitation (CPR) provided in an out-of-hospital setting. To analyze the ability of professional advanced life support providers to correctly establish the aetiology of cardiac arrest during out-of-hospital CPR. A retrospective cohort study analysing 211 cases of out-of-hospital cardiac arrest. The aetiology assumed by out-of-hospital physicians was compared with the diagnosis that was later established by clinicians or pathologists. Cases were sorted into five diagnostic groups and the overall diagnostic concordance was 74.4% (157 of 211 cases). The cardiac aetiology was presumed in 132 out of 211 patients and confirmed in 135 out of 211 patients. However, an analysis of individual cases of the cardiac causes of cardiac arrest revealed diagnostic matches in only 112 cases. Acute myocardial infarction (AMI) or pulmonary embolism (PE), both of which represent cases that can be potentially influenced by thrombolytic therapy, were presumed in 74 (53+21) and confirmed in 97 (77+20) cases, however with individual diagnostic matches in only 55 cases. This study demonstrates the importance of analysing concordance in presumed and definitive diagnosis of individual cases, since an overall comparison in a cohort of cases may be highly misleading. It introduces the method of the crosscheck table for visualization and comparison of presumed and final diagnoses. The two alternative approaches of inclusion rule for applying the thrombolytic therapy in out-of-hospital care were discussed with regard to the recent TROICA study.

No reliable predictor for the prognosis of out-of-hospital cardiac arrest (OHCA) on arrival at hospital has been identified so far. We speculate that ammonia and lactate may predict patient outcome. This is a prospective observational study. Non-traumatic OHCA patients who gained sustained return of spontaneous circulation and were admitted to acute care unit were included. Blood ammonia and lactate levels were measured on arrival at hospital. The patients were classified into two groups: 'favourable outcome' group (Cerebral Performance Category CPC1 at 6-months follow-up) and 'poor outcome' group (CPC3). Basal characteristics obtained from the Utstein template and biomarker levels were compared between these two outcome groups. Independent predictors were selected from all candidates using logistic regression analysis. A total of 98 patients were included. Ammonia and lactate levels in the favourable outcome group (n=10) were significantly lower than those in poor outcome group (n=88) (p<0.05, respectively). On receiver operating characteristic analysis, the optimal cut-off value for predicting favourable outcome was determined as 170gdl of ammonia and 12.0mmol of lactate (area under the curve; 0.714 and 0.735, respectively). Logistic regression analysis identified ammonia (170gdl), therapeutic hypothermia and witnessed by emergency medical service personnel as independent predictors of favourable outcome. When both these biomarker levels were over threshold, positive predictive value (PPV) for poor outcome was calculated as 100%. Blood ammonia and lactate levels on arrival are independent prognostic factors for OHCA. PPV with the combination of these biomarkers predicting poor outcome is high enough to be useful in clinical settings.

Background and context: Helicopter Emergency Medical Services (HEMS) have been incorporated into modern health systems for their speed and coverage. In the state of New South Wales (NSW), nine HEMS operate from various locations around the state and currently there is no clear picture of their resource implications. The aim of this study was to assess the cost of HEMS in NSW and investigate the factors linked with the variation in the costs, coverage and activities of HEMS.

Methods: We undertook a survey of HEMS costs, structures and operations in NSW for the 2008/2009 financial year. Costs were estimated from annual reports and contractual agreements. Data related to the structure and operation of services was obtained by face-to-face interviews, from operational data extracted from individual HEMS, from the NSW Ambulance Computer Aided Dispatch system and from the Aeromedical Operations Centre database. In order to estimate population coverage for each HEMS, we used GIS mapping techniques with Australian Bureau of Statistics census information.

Results: Across HEMS, cost per mission estimates ranged between $9300 and $19,000 and cost per engine hour estimates ranged between $5343 and $15,743. Regarding structural aspects, six HEMS were run by charities or not-for-profit companies (with partial government funding) and three HEMS were run (and fully funded) by the state government through NSW Ambulance. Two HEMS operated as 'hub' services in conjunction with three associated 'satellite' services and in contrast, four services operated independently. Variation also existed between the HEMS in the type of helicopter used, the clinical staffing and the hours of operation. The majority of services undertook both primary scene responses and secondary interfacility transfers, although the proportion of each type of transport contributing to total operations varied across the services.

Interpretation: This investigation highlighted the cost of HEMS operations in NSW, which in total equated to over $50 million per annum. Across services, we found large variation in the cost estimates, which was underscored by variation in the structure and operations of HEMS.


Patients who present to the emergency department (ED) with return of spontaneous circulation after cardiac arrest generally have poor outcomes. Guidelines for treatment can be complicated and difficult to implement. This study examined the feasibility of implementing a care bundle including therapeutic hypothermia (TH) and early hemodynamic optimization for comatose patients with return of spontaneous circulation after out-of-hospital cardiac arrest. The study included patients over a 2-year period in the ED and intensive care unit of an academic tertiary-care medical center. The first year (prebundle) provided a historical control, followed by a prospective observational period of bundle implementation during the second year. The bundle elements included (a) TH initiated; (b) central venous pressure/central venous oxygen saturation monitoring in 2 h; (c) target temperature in 4 h; (d) central venous pressure greater than 12 mmHg in 6 h; (e) MAP greater than 65 mmHg in 6 h; (f) central venous oxygen saturation greater than 70% in 6 h; (g) TH maintained for 24 h; and (h) decreasing lactate in 24 h. Fifty-five patients were enrolled, 26 patients in the prebundle phase and 29 patients in the bundle phase. Seventy-seven percent of bundle elements were completed during the bundle phase. In-hospital mortality in bundle compared with prebundle patients was 55.2% vs. 69.2% (P = 0.29). In the bundle patients, those patients who received all elements of the care bundle had mortality 33.3% compared with 60.9% in those receiving some of the bundle elements (P = 0.22). Bundle patients tended to achieve good neurologic outcome compared with prebundle
patients, Cerebral Performance Category 1 or 2 in 31 vs. 12% patients, respectively (P = 0.08). Our study demonstrated that a post-cardiac arrest care bundle that incorporates TH and early hemodynamic optimization can be implemented in the ED and intensive care unit collaboratively and can achieve similar clinical benefits compared with those observed in previous clinical trials.

Guideline 11.7: Post-resuscitation therapy in ALS


The aim of this investigation was to study the incidence of sudden cardiac death (SCD) in persons aged 1 - 35 years in a nationwide setting [Denmark] (5.38 million people) by systematic evaluation of all deaths. Methods and results: All deaths in persons aged 1 - 35 years in Denmark in 2000-106 were included. Death certificates were read independently by two physicians. The National Patient Registry was used to retrieve information on prior medical history. All autopsy reports were read and the cause of death was revised based on autopsy findings. We identified 625 cases of sudden unexpected death (10% of all deaths), of which 156 (25%) were not autopsied. Of the 469 autopsied cases, 314 (67%) were SCD. The most common cardiac cause of death was ischaemic heart disease (13%); 29% of autopsied sudden unexpected death cases were unexplained. In 45% of SCD cases, the death was witnessed; 34% died during sleep; 89% were out-of-hospital deaths. Highest possible incidence rate of SCD in the young was 2.8 per 100,000 person-years including non-autopsied cases of sudden unexpected death. Excluding those, the incidence rate declined to 1.9 per 100,000 person-years. Conclusions: A total of 7% of all deaths in the young can be attributed to SCD, when including non-autopsied cases (autopsy ratio 75%). The incidence rate of SCD in the young of 2.8 per 100,000 person-years is higher than previously reported.


Aim: To assess whether the routine use of observation charts incorporating a Paediatric Early Warning Tool (PEWT) are effective for screening inpatients, predicting those at risk of acute deterioration, in a paediatric hospital. Method: A retrospective case note audit of all cardiac arrests calls for inpatients between May and December 2009 inclusive. Case notes, observation charts and computerised patient information records were studied to analyse the 24 h period preceding the arrest call to assess whether the deterioration could have been detected earlier. We define the PEWT as ‘triggered’ when documented on the observation chart, a medical review is requested within the PEW time targets and the PEWT logged onto the hospital computerised patient information system. Results: There were 72 arrest calls during the 8-month period of which 56 met the inclusion criteria to the study. One set of notes was unavailable, 55 sets of data were analysed. The reason for arrest calls were: apnoeas (n=15), sudden desaturation (n=15), airway obstruction (n=6), increased work of breathing (n=8), cardiac arrest (n=6), sudden bradycardia (n=3) and seizures with desaturation (n=2). Of 55 arrest calls analysed, 10 (18%) patients triggered the PEWT in the preceding 24 h. Six of these had an arrest call within 30 min of triggering PEWT. Of the 45 patients who did not trigger the PEWT, 17 (38%) patients should have triggered the tool on documented observations. Although the PEWT was not triggered, staff were concerned enough to request a review by the medical team for 10 of these 17 (59%) patients. In total only 27 (49%) of cardiac arrest calls could have been predicted by either observation charts or the PEWT. Of the cardiac arrest calls 28 patients (51%) remained on the ward after intervention. Two (4%)
resuscitations were unsuccessful. 25 (45%) were transferred to PICU and 3 later died. Conclusions: The use of observation charts incorporating a PEWT was only 49% sensitive at predicting cardiac arrest calls in inpatients in a tertiary paediatric hospital. This sensitivity is being reduced further by incorrect implementation of the PEW process when the tool is 'triggered'.


Aims: Prompt coronary reperfusion following acute ST-segment elevation myocardial infarction is pivotal to survival. Primary angioplasty is the gold standard in restoring reperfusion, but thrombolysis needs consideration when optimal call to balloon time is not feasible. Following lysis and with evolving pharmacoinvasive therapies, the advantage of routine, early percutaneous coronary intervention (PCI) over standard ischaemia-guided PCI remains debatable. We meta-analysed studies comparing these two interventional strategies. Methods and results: A MEDLINE search for randomized control studies was performed using the search terms ‘coronary, thrombolysis, early or immediate stenting, and acute ST-elevation myocardial infarction’ Further, relevant studies were identified from global cardiovascular scientific sessions/congresses. Two interventional strategies were studied in 3195 patients in eight trials and meta-analysed using a random effects model. The combined endpoint of 30-day mortality, re-infarction, and ischaemia was reached in 106/1487 (7.3%) patients in the routine early PCI group and in 199/1470 (13.5%) patients in the ischaemia-guided PCI group following lysis with odds ratio (OR) 0.47 [95% confidence interval (CI), 0.32-0.68, P < 0.0001] favouring routine early PCI, driven by significant reduction in both re-infarction OR 0.62 (95% CI, 0.42-0.90, P < 0.011) and ischaemia OR 0.21 (95% CI, 0.10-0.47, P < 0.001). Thirty-day mortality or major bleeding rates between strategies were not significantly different. Conclusion: Where primary PCI is not feasible, our meta-analysis favours routine early PCI within 24 h of thrombolysis for acute ST-elevation myocardial infarction; strategy that is safe and a time-target that is easily achievable. Early PCI is associated with reduced recurrence of ischaemia and re-infarction, but at no increased risk of major haemorrhage.

Systematic review


In recent years, there has been an increase in the number of very low birth weight (VLBW) infants and an improvement in their survival. However, there are no specific recommendations regarding the use of resuscitative efforts for VLBW infants, and there is scant data in the literature on morbidity and mortality in relation to epinephrine administration. Due to the vulnerability of VLBW infants, studies that examine the effects and consequences of cardiovascular resuscitation and epinephrine administration are needed. The objective of this study is to determine the outcome of very low birth weight (VLBW) infants, who received epinephrine in the delivery room. Medical records of VLBW infants admitted to neonatal intensive care unit (NICU) from 1999 to 2007 were reviewed, and infants who received epinephrine in the delivery room were identified and included in the study. Infants who received epinephrine are smaller in terms of gestational age and birth weight and have decreased survival. After adjusting for gestational age and birth weight, infants who received epinephrine presented lower 1 and 5min APGAR (Appearance, Pulse, Grimace, Activity, Respiration) scores, more respiratory distress syndrome, lower survival (26% vs. 43%, p<0.01) and lower survival without severe brain injury (17% vs. 32%, p<0.01). VLBW infants, who require epinephrine in the delivery room, are
smaller in terms of gestational age and birth weight. The requirement of epinephrine in the delivery room during resuscitation may be associated to worst outcomes and decreased survival without severe brain injury. These findings lead to more questions on how aggressive resuscitation efforts should be for these infants.

*Guideline 13: Neonatal resuscitation*

**Reviews**


The medication used in cardiopulmonary resuscitation (CPR) has by no means yielded the expected prognostic benefit. This review focuses on drugs that are currently under investigation as part of novel therapeutic strategies in CPR and post-resuscitation care. The main categories of drugs under investigation were identified in position papers regarding gaps in scientific knowledge and research priorities in CPR. The electronic bases of Medline via PubMed and the ClinicalTrials.gov registry were searched. Research terms were identified using the MESH database and were combined thereafter. Initial search terms were 'cardiac arrest' 'cardiopulmonary resuscitation' 'post-cardiac arrest syndrome' combined with 'drugs' and also the names of pharmaceutical categories and related drugs. Novel pharmaceutical approaches rely on a better understanding of the pathophysiology of cardiac arrest and post-resuscitation syndrome. Some medications are targeted primarily towards enhancing the return of spontaneous circulation and increasing survival rates, while others mostly aim at the attenuation of post-arrest myocardial and neurological impairment. Only a few of these therapies are currently being evaluated for clinical use. Despite the remarkable variability in study quality and success in achieving therapeutic targets, results for most therapies seem encouraging and support the continuation of research. New pharmaceutical modalities are being investigated for future use in CPR. Currently, none has been unequivocally accepted for clinical use, while only a few of them are undergoing clinical testing. This research is likely to continue, in view of the unsatisfactory results of current pharmaceutical therapies and the encouraging results of preliminary studies.

*Guideline 11.5: Medications in adult ALS*  
*Guideline 11.7: Post-resuscitation therapy in adult ALS*


Three intraosseous devices have been approved by the Food and Drug Administration for use in adult trauma patients when intravenous access cannot be obtained. Sites of insertion are the sternum (FAST1), proximal tibia and humerus (Big Injection Gun), and proximal and distal tibia and humerus (EZ-IO). Insertion generally requires less than 1 minute, and flow rates up to 125 mL/min can be achieved. The devices are used for emergency resuscitation and should be removed within 24 hours of insertion or as soon as practical after peripheral or central intravenous access has been achieved. Contraindications include fractures or other trauma at the insertion site, prosthetic joints near the site, previous attempts to insert an intra osseous device at the same site, osteoporosis or other bone abnormalities, infections at the proposed site, and
inability to identify pertinent insertion landmarks. Primary complications are extravasation of medications and fluids into the soft tissue, fractures caused by the insertion, and osteomyelitis.


Therapeutic hypothermia involves the controlled reduction of core temperature to attenuate the secondary organ damage, which occurs following a primary injury. Clinicians have been increasingly using therapeutic hypothermia to prevent or ameliorate various types of neurological injury and more recently for some forms of cardiac injury. In addition, some recent evidence suggests that therapeutic hypothermia may also provide benefit following acute kidney injury. In this review we will examine the potential mechanisms of action and current clinical evidence surrounding the use of therapeutic hypothermia. We will discuss the ideal methodological attributes of future studies using hypothermia to optimise outcomes following organ injury, in particular neurological injury. We will assess the importance of target hypothermic temperature, time to achieve target temperature, duration of cooling, and re-warming rate on outcomes following neurological injury to gain insights into important factors which may also influence the success of hypothermia in other organ injuries, such as the heart and the kidney. Finally, we will examine the potential of therapeutic hypothermia as a future kidney protective therapy.

*Guideline 11.8: Therapeutic hypothermia after cardiac arrest*


More than 25% of children survive to hospital discharge after in-hospital cardiac arrests, and 5-10% survive after out-of-hospital cardiac arrests. Cardio-pulmonary resuscitation differs in children from adults. Following the Airway, Breathing, Circulation format, this article reviews the physiology of paediatric cardio-pulmonary resuscitation. It addresses the appropriate interventions during cardio-pulmonary resuscitation, mechanisms of action of the drugs that are commonly used in advanced life support, and special resuscitation circumstances: premature and newly born infants, traumatic cardiac arrest, ECMO (Extracorporeal Membrane Oxygenation) CPR. New exciting discoveries in resuscitation science postulate that the key factor in improving outcomes of paediatric cardiac arrest is improving the quality of interventions. Evolving training strategies include simulation training with real-time feedback in simulated scenarios that use high-tech mannequins.

*Guideline 12: Paediatric ALS*


Out-of-hospital cardiac arrest (OHCA) is a common initial presentation of cardiovascular disease, affecting up to 325 000 people in the United States each year. In a recent meta-analysis of >140 000 patients with OHCA, survival to hospital admission was 23.8%, and survival to hospital discharge was only 7.6%. In patients who initially achieve return of spontaneous circulation (ROSC) after OHCA, the significant subsequent morbidity and mortality are due largely to the cerebral and cardiac dysfunction that accompanies prolonged whole-body ischemia. This syndrome, called the post cardiac arrest syndrome, comprises anoxic brain injury, post cardiac arrest myocardial dysfunction, systemic ischemia/reperfusion response, and persistent precipitating pathology. The contribution of each of these components in an individual patient
depends on various factors, including prearrest comorbidities, duration of the ischemic insult, and cause of the cardiac arrest. This review focuses on therapeutic strategies and recent developments in managing patients who are initially resuscitated from cardiac arrest.

**Guideline 11.7: Post-resuscitation therapy in adult ALS**

39. Sunde K and Streide E. *Therapeutic hypothermia after cardiac arrest: where are we now? Current Opinion in Critical Care 2011; Publish Ahead of Print (April 1)*

**Purpose of review:** Therapeutic hypothermia is widely recommended after cardiac arrest. In this review, we present publications reflecting the current discussion and opinions related to use of therapeutic hypothermia in comatose adult cardiac arrest survivors. **Recent findings:** The clinical outcome benefit of therapeutic hypothermia found in recent effectiveness studies is similar to that found in previous randomized trials. No single cooling method has been shown to be superior in terms of clinical outcomes. Therapeutic hypothermia is easy to perform and lacks severe side effects or complications associated with mortality. Prehospital and intra-arrest cooling are being explored as a way to further improve outcome, although no clear relationship between timing of cooling and outcome has been documented. **Summary:** Although only proven beneficial for patients with ventricular fibrillation, the majority of centres today use therapeutic hypothermia also for comatose survivors with other initial rhythms. Some controversies still exist; the optimal target temperature, timing and duration of cooling have not yet been defined, and some researchers still think that the concept of therapeutic hypothermia is not satisfactorily proven scientifically. A new randomized study comparing temperature management to 36°C with 33°C is therefore underway.

**Guideline 11.8: Therapeutic hypothermia after cardiac arrest**

**Animal, Manikin & Cadaver models**

40. Indik JH, Allen D, Gura M, Dameff C, Hilwig RW, Kern KB. *Utility of the VF Waveform to Predict a Return of Spontaneous Circulation and Distinguish Acute from Post Myocardial Infarction or Normal Swine in VF Cardiac Arrest. Circ Arrhyth Electrophys 2011; (Online first): April 14*

**Background:** In cardiac arrest, the ventricular fibrillation (VF) waveform, particularly amplitude spectral area (AMSA) and slope, predicts the return of spontaneous circulation (ROSC), but it is unknown whether the predictive utility differs in an acute myocardial infarction (MI), prior MI, or normal myocardium, and if the waveform can distinguish the underlying myocardial state. We hypothesized that in a swine model of VF cardiac arrest, amplitude spectral area (AMSA) and slope predict ROSC following a shock independent of substrate and distinguish an acute from non-acute MI state. **Methods and Results:** AMI was induced by occlusion of the left anterior descending artery. Post MI swine recovered for a two week period prior to induction of VF. VF was untreated for 8 minutes in N=10 acute MI, N=10 post MI, and N=10 control swine. AMSA and slope predicted ROSC following a shock independent of substrate and distinguish an acute from non-acute MI state. Post MI swine recovered for a two week period prior to induction of VF. VF was untreated for 8 minutes in N=10 acute MI, N=10 post MI, and N=10 control swine. AMSA and slope predicted ROSC following a shock independent of substrate and distinguish an acute from non-acute MI state. For AMSA>31 mV-Hz the odds ratio (OR) was 62 (P=<0.001) compared to AMSA<19 mV-Hz. For slope>3.1 mV/sec, OR=52 (P=<0.001) compared to slope< 1.8 mV/s. With chest compressions, AMSA and slope were significantly lower for acute MI swine compared to controls, whereas in post MI swine the waveform characteristics were similar to
controls. In particular, for an AMSA>33.5 mV-Hz the sensitivity to identify an acute from non-acute (control or post MI) state was 83%.

Conclusions: In a swine model of VF cardiac arrest, AMSA and slope predict ROSC independent of myocardial substrate. Furthermore, with chest compressions, the VF waveform evolves differently and may offer a means to distinguish an acute MI.


This study aimed to evaluate whether an automated external defibrillator (AED) was accurate enough to analyze the heart rhythm during a simulated rotor wing critical care transport. We hypothesized that AED analysis of the simulated rhythms during a helicopter flight would result in significant errors (i.e., inappropriate shocks, analysis delay). Three commercial AEDs were tested for analyzing the heart rhythm in a helicopter using a manikin and a human volunteer. Ventricular fibrillation (VF), sinus rhythm, and asystole were simulated by using an arrhythmia simulator of the manikin. The intervals from analysis to shock recommendation were collected on a stationary and in-motion helicopter. Sensitivity and specificity of three AEDs were also calculated. Vibration intensities were measured with a digital vibration meter placed on the chest of the manikin/human volunteer both on the stretcher and on the floor of the helicopter. All AEDs correctly recommended shock delivery for the cardiac rhythms of the manikin. Sensitivity for VF was 100.0% (95% CI 91.2-100.0) and specificity for sinus rhythm and asystole were 100.0% (95% CI 91.2-100.0). Although the recorded ECG rhythms of the volunteer in an in-motion helicopter showed baseline artifacts, all AEDs analyzed the cardiac rhythm of the volunteer correctly and did not recommend shock delivery. On the floor of the helicopter, the median measured vibration intensity was 6.6m/s² (IQR 5.5-7.7m/s²) with significantly less vibrations transmitted to the manikin/human volunteer chest (manikin median 3.1m/s², IQR 2.2-4.0m/s²; human volunteer median 0.95m/s², IQR 0.65-1.25m/s²). This study suggested that current AEDs could analyze the heart rhythm correctly during simulated helicopter transport. Further studies using an animal model would be needed before applying to patients.


Objectives: Uncontrolled hemorrhage remains one of the leading causes of trauma deaths and one of the most challenging problems facing emergency medical professionals. Several hemostatic agents have emerged as effective adjuncts in controlling extremity hemorrhage. However, a review of the current literature indicates that none of these agents have proven superior under all conditions and in all wound types. This study compared several hemostatic agents in a lethal penetrating groin wound model where the bleeding site could not be visualized. Methods: A complex groin injury with a small penetrating wound, followed by transection of the femoral vessels and 45 seconds of uncontrolled hemorrhage, was created in 80 swine. The animals were then randomized to five treatment groups (16 animals each). Group 1 was Celox-A (CA), group 2 was combat gauze (CG), group 3 was Chitoflex (CF), group 4 was WoundStat (WS), and group 5 was standard gauze (SG) dressing. Each agent was applied with 5 minutes of manual pressure. Hetastarch (500 mL) was infused over 30 minutes. Hemodynamic parameters were recorded over 180 minutes. Primary endpoints were attainment of initial hemostasis and incidence of re-bleeding. Results: Overall, no difference was found among the agents with respect to initial hemostasis, re-bleeding, and survival. Localizing effects among the granular
agents, with and without delivery mechanisms, revealed that WS performed more poorly in initial hemostasis and survival when compared to CA. Conclusions: In this swine model of uncontrolled penetrating hemorrhage, SG dressing performed similarly to the hemostatic agents tested. This supports the concept that proper wound packing and pressure may be more important than the use of a hemostatic agent in small penetrating wounds with severe vascular trauma.

This study sought to determine whether using the Resuscitation Council UK’s iResusCopyright application on a smart phone improves the performance of doctors trained in advanced life support in a simulated emergency. Thirty-one doctors (advanced life support-trained within the previous 48 months) were recruited. All received identical training using the smart phone and the iResus application. The participants were randomly assigned to a control group (no smart phone) and a test group (access to iResus on smart phone). Both groups were tested using a validated extended cardiac arrest simulation test (CASTest) scoring system. The primary outcome measure was the overall cardiac arrest simulation test score; these were significantly higher in the smart phone group (median (IQR [range]) 84.5 (75.5-92.5 [64-96])) compared with the control group (72 (62-87 [52-95])); p=0.02. Use of the iResus application significantly improves the performance of an advanced life support-certified doctor during a simulated medical emergency. Further studies are needed to determine if iResus can improve care in the clinical setting.

44. Martin PS, Theobald PS, Kemp AM, O'Brien S, Maguire SA and Jones MD. Chest compression performance during infant CPR. Arch Dis Child 2011; 96 (Suppl 1): A86
Aims: The 2010 International Liaison Committee of Resuscitation (ILCOR) guidelines highlighted the need to perform quality chest compressions during paediatric cardiopulmonary resuscitation to improve current outcomes. The guidelines emphasised infant chest compression target rates of 100-120 cpm, depths of 4cm and complete release. This study aims to determine the performance of two-thumb (TT) and two-finger (TF) chest compressions against these guideline targets. Methodology: A randomised, cross-over study was designed to investigate rescuer performance during TT and TF chest compressions. 12 certified advanced paediatric life support instructors performed each technique for 2 min on a commercially available infant CPR training manikin. The manikin was instrumented with a linear potentiometer, allowing the measurement of anteroposterior chest deflections. Participants were instructed to perform continuous compressions, without ventilations, and neither technique was refreshed or coached. Chest compression rates (CR), depths (CD) and residual leaning depths (remaining depth during chest release phase; LD) were recorded. Normalised performance scores were developed quantifying how accurately (ACR, ACD, ALD) and consistently (CCR, CCD, CLD) individuals performed each target relative to the ILCOR guidelines. Overall individual performance scores (ACPR, CCPR) were averaged from their respective scores, and mean scores describe cohort performance. Scores indicate that chest compressions were more comparable to the guideline targets. Shapiro-Wilk tests evaluated distribution normality and results were statistically compared using paired parametric (paired Student's t test) or non-parametric (Wilcoxon signed rank test) tests. Results: Performance scores for each technique are presented in figure 1. Relatively poor accuracy scores are demonstrated by both techniques, with
the exception of TF technique leaning depths. While it can be observed that TT chest compressions were performed with greater accuracy (ACPR: 1.70 vs 1.85) and consistency (CCPR: 0.74 vs 0.90) than TF chest compressions, neither technique was performed to ILCOR guidelines. Table of results comparing measures and performance scores between two-thumb (TT) vs two-finger (TF) techniques. Conclusions: The performance of the TT technique showed a greater compliance with the 2010 ILCOR guidelines than the TF technique; however, guideline targets were rarely met by either technique. The results of this manikin-based study indicate that there is a need to improve the accuracy of both chest compression techniques during infant CPR, which could potentially improve survivability.

Guideline 12: Paediatric ALS

45. Noguchi K, Matsumoto N, Shiozaki T, Tasaki O, et L. Effects of timing and duration of hypothermia on survival in an experimental gerbil model of global ischaemia. Resuscitation 2011; 82 (4): 481-86. Despite the use of animal models to study post-cardiac-arrest resuscitation, the effects of hypothermia on physiological circulatory parameters are still not fully understood. In this study, using a gerbil model of global ischaemia/reperfusion, we aimed to assess the effects of hypothermia on physiological parameters and evaluated the optimal timing for the induction of hypothermia to achieve a better survival rate. Survival rates at 72h after reperfusion were evaluated by varying the degree of hypothermia and/or duration of ischaemia, and then examined by varying induction timing and/or extending the duration of ischaemia. Physiological parameters were measured using an intravital microscopy system. Under normothermic cerebral ischaemia, the survival rate was dramatically decreased by the induction of 15-20min of ischaemia. Induction of hypothermia significantly improved the survival rate only when it occurred less than 10min after ischaemic onset. In the hypothermia-treated groups, post-ischaemic hyperperfusion was significantly suppressed, and post-ischaemic vasoconstriction of the pial arteriole was prevented. Hypothermia-induced suppression of post-ischaemic hyperperfusion and the prevention of vasoconstriction of the pial arteriole play an important role in improving the survival rate after global ischaemia/reperfusion, but the time window for induction of hypothermia remains relatively narrow.

Guideline 11.8: Therapeutic hypothermia after cardiac arrest

46. Schebesta K, Hopfl M, Ringl H, Machata A-M, Chiari A, Kimberger O. A comparison of paediatric airway anatomy with the SimBaby high-fidelity patient simulator. Resuscitation 2011; 82 (4): 468-72. The SimBaby high-fidelity patient simulator is a widely used paediatric simulator for the training of standard and critical airway management scenarios. Furthermore this simulator is frequently used for the evaluation of different airway devices and techniques. However, the anatomic structures of the SimBaby have not been compared to actual patients’ anatomy. The CT radiographic measures of the upper airway anatomy of two SimBaby simulators were compared to MRI images of the upper airway of 20 children aged 1-11 months who underwent routine MRI scans under sedation for diagnostic purposes. Various distances of the tongue, soft palate and pharynx, cross sectional areas and volumes of anatomic structures of the upper airway including the retroglossal airspace were compared. The SimBaby’s retroglossal airspace volume greatly differed from the measurements in patients (SimBaby 5.3±0.4 vs. 1.9±0.8cm3 in infants, p<0.01). Furthermore the distance from the alveolar process of the mandible to the posterior pharyngeal wall was larger in the SimBaby than in infants (5.8±0.1 vs. 4.5±0.5cm, p<0.001) and dimensions of the epiglottis and pharynx were larger in the Simbaby. The anatomic features of the SimBaby do not adequately simulate the upper airway anatomy.
of infants. These results imply inadequate realism of this simulator for airway training and compromise the validity of comparative trials of different airway devices with the SimBaby as airway model.


The vast majority of laboratory studies on animals have focused on ventricular fibrillation (VF) and not on cardiac arrest (CA) resulting from asphyxia. The aim of this study was to develop a clinically relevant animal model in Landrace/Large-White swine of asphyxial CA resuscitated using the European Resuscitation Council guidelines. Survival and 24 h neurological outcome in terms of functional deficit were also evaluated. Asphyxial arrest was induced by clamping the endotracheal tube (ETT) in 10 Landrace/Large-White piglets. After 4 min of untreated arrest, resuscitation was initiated by unclamping the ETT, 100% oxygen mechanical ventilation, 2 min chest compressions and epinephrine administration. Advanced Life Support algorithm was followed. In case of restoration of spontaneous circulation, the animals were supported for one hour and then observed for 23 h. Coronary perfusion pressure was significantly higher in surviving animals (P < 0.001) during cardiopulmonary resuscitation. End-tidal CO2 was significantly higher in the animals that survived than in non-surviving animals (P = 0.001). All of the animals were severely neurologically impaired 24 h after CA. This refined model of asphyxia CA is easily reproducible and may be used for pharmacological studies in CA.


The aim of this study was to assess the performance of the GlideScope in a manikin cardiopulmonary resuscitation (CPR) scenario. Following a brief didactic session, 45 volunteer doctors inexperienced with airway management, attempted to intubate a manikin using a Macintosh laryngoscope and GlideScope with uninterrupted and without chest compressions. Primary endpoints were intubation times and success rate with each device. Dental compression and level of self-confidence in using each device were also assessed. In the scenario without chest compressions the cumulative success rate related to time to intubation was significantly higher with the Macintosh blade than with the GlideScope (p<0.001). On the contrary, in the scenario with continuous chest compressions, the cumulative rate related to time to intubation was significantly higher with the GlideScope (p=0.035). Significantly fewer attempts were required for the first successful intubation with the Macintosh blade in the non-CPR scenario versus the CPR scenario (p=0.007). Moreover, the number of attempts for the first successful intubation was significantly lower for the GlideScope in the non-CPR (p=0.001) and the CPR scenario (p<0.001). Dental compression was significantly lower with the GlideScope in both scenarios (p<0.001). Using the GlideScope in a manikin CPR scenario provides extremely high intubation success rates in short times with the first attempt, in medical practitioners inexperienced in intubation.

Guideline 11.6: Equipment & techniques in adult ALS

The objective of this study was to evaluate and compare the complications of cardiopulmonary resuscitation after manual or mechanical chest compressions in a swine model of ventricular fibrillation. In this retrospective study, 106 swine were treated with either manual (n=53) or mechanical chest compressions with the LUCAS device (n=53). All swine cadavers underwent necropsy. The animals with no autopsy findings were significantly fewer in the LUCAS group (P=0.004). Sternal fractures were identified in 18 animals in the manual and only two in the LUCAS group (P=0.003). Rib fractures were present in 16 animals in the manual and only four in the LUCAS group (P=0.001). Nine animals in the manual, and two in the LUCAS group had liver hematomas (P=0.026%). In the manual group, eight animals were detected with spleen hematomas whereas no such injury was identified in the LUCAS group (P=0.003). LUCAS device minimized the resuscitation-related trauma compared with manual chest compressions in a swine model of cardiac arrest.

Guideline 11.6: Equipment & techniques in adult ALS


BACKGROUND: Vasopressors administered IV late during resuscitation efforts fail to improve survival. Intraosseous (IO) access can provide a route for earlier administration. We hypothesized that IO epinephrine after 1 minute of cardiopulmonary resuscitation (CPR) (an ‘optimal’ IO scenario) after 10 minutes of untreated ventricular fibrillation (VF) cardiac arrest would improve outcome in comparison with either IV epinephrine after 8 minutes of CPR (a ‘realistic’ IV scenario) or placebo controls with no epinephrine. METHODS: Thirty swine were randomized to IO epinephrine, IV epinephrine, or placebo. Important outcomes included return of spontaneous circulation (ROSC), 24-hour survival, and 24-hour survival with good neurological outcome (cerebral performance category 1). RESULTS: ROSC after 10 minutes of untreated VF was uncommon without administration of epinephrine (1 of 10), whereas ROSC was nearly universal with IO epinephrine or delayed IV epinephrine (10 of 10 and 9 of 10, respectively; P = 0.001 for either versus placebo). Twenty-four hour survival was substantially more likely after IO epinephrine than after delayed IV epinephrine (10 of 10 vs. 4 of 10, P = 0.001). None of the placebo group survived at 24 hours. Survival with good neurological outcome was more likely after IO epinephrine than after placebo (6 of 10 vs. 0 of 10, P = 0.011), and only 3 of 10 survived with good neurological outcome in the delayed IV epinephrine group (not significant versus either IO or placebo). CONCLUSION: In this swine model of prolonged VF cardiac arrest, epinephrine administration during CPR improved outcomes. In addition, early IO epinephrine improved outcomes in comparison with delayed IV epinephrine.

Guideline 11.5: Medications in adult ALS
A mother and her daughter both suffered submersion injuries. In an air temperature of 7 °C, bystanders witnessed a car drive into a dirty river and sink in less than 1 min. A diver found the car at depth of 4 m, front-end down and with the back window smashed. Both patients were asystolic, had a Glasgow Coma Scale score of 3 and non-reacting dilated pupils. Cardiopulmonary resuscitation (CPR) was started immediately, and the patients were transported in the same helicopter to the nearest hospital with a cardiothoracic surgery service, which was 69 min away...
Case study

In this study, the administration of an intravenous ketamine formulation to the nasal mucosa of a paediatric burn victim is described in the prehospital environment. Effective analgesia was achieved without the need for vascular or osseous access. Intranasal ketamine has been previously described for chronic pain and anaesthetic premedication. This case highlights its potential as an option for prehospital analgesia.
Case study

The concept of triage is well established in emergency medicine. Originating in the Napoleonic wars it has been used internationally to determine the clinical need of patients presenting to emergency departments (ED). Triage systems have typically relied on the use of experienced staff or decision support systems to judge the time a patient can afford to wait before treatment commences. There are various triage models in place, but all follow this same principle and can be applied to both adults and children. Despite being well established in emergency medicine the concept of ‘triage’ has only recently been adopted on hospital wards. It had become increasingly recognised that patients who deteriorated in hospital, especially those who subsequently died or were admitted to intensive care, demonstrated measurable physiological changes hours before recognition by medical and nursing staff.
Editorial

Primary coronary intervention (PCI) is the preferred reperfusion therapy in patients with acute ST-elevation myocardial infarction (STEMI). However, many hospitals lack PCI facilities and few provide around-the-clock staffing for these procedures. Therefore, thrombolysis is
administered to eligible patients if primary PCI cannot be performed in a timely fashion. Traditionally, the standard approach for a patient who had received thrombolytics and presented signs of reperfusion injury was to assess the risk of future cardiac adverse events before discharge...

**Editorial**


Advanced pre-hospital airway management is a rapidly evolving and controversial area. ...Tracheal intubation has been used in pre-hospital cardiac arrest since the 1970s, and has become known as the “gold standard” of care. However, it must be remembered that when this practice began there were no readily available supraglottic airway devices, and the only real alternative to tracheal intubation was bag-mask ventilation. Recently, several publications have suggested that tracheal intubation may not be the best technique for pre-hospital airway management in cardiac arrest. The reasons to suggest this are multi-factorial, and well highlighted by this paper (Wang et al 2011). Tracheal intubation is a highly technical skill, with a learning curve of up to 60 procedures. In addition, skill fade will occur when there is a lack of regular exposure to the procedure: EMS providers in the UK perform tracheal intubation between 1 and 4 times annually. This rate of exposure is supported by the findings of Wang and colleagues, with intubation attempted once in every 225 patient care episodes. An EMS provider attending 1000 patients annually will therefore attempt intubation only four times. Some EMS systems make provision to increase exposure by limiting the skill to smaller teams who are selectively tasked to such events; the German Notarzt system and recently introduced “critical care paramedics” in the UK are examples of this. However the inevitable consequence is that general EMS providers will lose the skill, and it is hard to identify a way of increasing exposure of all providers except through simulation or placement in other settings (e.g. hospital operating theatres) which is expensive and often logistically challenging....

**Editorial**


A 54-year-old man with no known cardiac disease collapsed outdoors in a small rural community. The cardiac arrest was witnessed, and immediate cardiopulmonary resuscitation was begun by a bystander and a trained first responder who was nearby. The patient was moved into a building across the street for continued resuscitation. First responders arrived with an automated external defibrillator, and ventricular fibrillation was documented. First responders delivered 6 defibrillation shocks, 4 of which transiently restored an organized electrocardiographic rhythm but with no pulse at any time. Additional emergency medical services personnel from nearby communities and an advanced life support (ALS) flight crew arrived. The flight crew initiated ALS care. The trachea was intubated, ventilation controlled, and end-tidal carbon dioxide tension continuously monitored. Antiarrhythmic and inotropic drugs were administered intravenously. An additional 6 shocks were delivered using the ALS defibrillator. End-tidal carbon dioxide measurements confirmed good pulmonary blood flow with chest compressions, and resuscitation was continued until a stable cardiac rhythm was restored after 96 minutes of pulselessness. The patient was transported by helicopter to the hospital. He was in cardiogenic shock but maintained a spontaneous circulation. Coronary angiography confirmed a left anterior descending coronary artery thrombotic occlusion that was treated successfully. After hospital admission, the patient required circulatory and ventilatory support and hemodialysis for acute renal failure. He experienced a complete neurologic recovery to his
pre-cardiac arrest state. To our knowledge, this is the longest duration of pulselessness in an out-of-hospital arrest with a good outcome. Good pulmonary blood flow was documented throughout by end-tidal carbon dioxide measurements.

Case study

Education & ethics in resuscitation

AIMS: To determine whether healthcare providers apply the best interest principle equally to different resuscitation decisions.

METHODS: An anonymous questionnaire was distributed to consultants, trainees in neonatology, paediatrics, obstetrics and 4th medical students. It examined resuscitation scenarios of critically ill patients all needing immediate resuscitation. Outcomes were described including survival and potential long-term sequelae. Respondents were asked whether they would intubate, whether resuscitation was in the patients best interest, would they accept surrogate refusal to initiate resuscitation and in what order they would resuscitate.

RESULTS: The response rate was 74%. The majority would wish resuscitation for all except the 80-year-old. It was in the best interest of the 2-month-old and the 7-year-old to be resuscitated compared to the remaining scenarios (p value <0.05 for each comparison). Approximately one quarter who believed it was in a patient best interests to be resuscitated would nonetheless accept the family refusing resuscitation. Medical students were statistically more likely to advocate resuscitation in each category.

CONCLUSION: These results suggest resuscitation is not solely related to survival or long-term outcome and the best interest principle is applied differently, more so at the beginning of life.

Guideline 10.5: Legal & ethical issues relating to resuscitation

To describe (a) changes in the organisation of training in cardiopulmonary resuscitation (CPR) and the treatment of cardiac arrest in hospital in Sweden and (b) the clinical achievement, i.e. survival and cerebral function, among survivors after in-hospital cardiac arrest (IHCA) in Sweden. Aspects of CPR training among health care providers (HCPs) and treatment of IHCA in Sweden were evaluated in 3 national surveys (1999, 2003 and 2008). Patients with IHCA are recorded in a National Register covering two thirds of Swedish hospitals. The proportion of hospitals with a CPR coordinator increased from 45% in 1999 to 93% in 2008. The majority of coordinators are nurses. The proportions of hospitals with local guidelines for acceptable delays from cardiac arrest to the start of CPR and defibrillation increased from 48% in 1999 to 88% in 2008. The proportion of hospitals using local defibrillation outside intensive care units prior to arrival of rescue team increased from 55% in 1999 to 86% in 2008. During the past 4 years in Sweden, survival to hospital discharge has been 29%. Among survivors, 93% have a cerebral performance category (CPC) score of I or II, indicating acceptable cerebral function. During the last 10 years, there was a marked improvement in CPR
training and treatment of IHCA in Sweden. During the past 4 years, survival after IHCA is high and the majority of survivors have acceptable cerebral function.

Guideline 10: education & implementation


Background: Little data exists on whether the physicians' skills in responding to cardiac arrest are fully developed after the advanced cardiac life support (ACLS) course, or if there is a significant improvement in their performance after an initial learning curve. Objective: To estimate the effect of physician experience on the results of prehospital cardiac arrests. Materials and methods: Prospective data were collected on all prehospital resuscitative attempts in the area by ACLS-trained ambulance physicians. Results: Of 232 attempted cardiac resuscitations, 96 (41%) patients survived to hospital admission and 44 (19%) were discharged alive. A group of 39 physicians responded to from one up to 29 cases with a mean of four cases. Physicians responding to five or fewer cases had a trend to fewer patients surviving to admission compared with those responding to six or more (36 vs. 45%, P=0.31) but no difference was found on survival to discharge (19 vs. 20%, P=0.87). Conclusion: In this study, resuscitative experience of the physician did not have a significant effect on survival suggesting that experience does not significantly add to the current ACLS training in responding to ventricular fibrillation/ventricular tachycardia. More studies are needed.

Guideline 10: Education & implementation


Cardiopulmonary resuscitation (CPR) during flight is challenging and has to be sustained for long periods. In this setting a mechanical-resuscitation-device (MRD) might improve performance. In this study we compared the quality of resuscitation of trained flight attendants practicing either standard basic life support (BLS) or using a mechanical resuscitation device (MRD) in a cabin-simulator. Prospective, open, randomized and crossover simulation study. Study participants, competent in standard BLS were trained to use the MRD to deliver both chest compressions and ventilation. 39 teams of two rescuers resuscitated a manikin for 12min in random order, standard BLS or mechanically assisted resuscitation. Primary outcome was 'absolute hands-off time' (sum of all periods during which no hand was placed on the chest minus ventilation time). Various parameters describing the quality of chest compression and ventilation were analysed as secondary outcome parameters. Use of the MRD led to significantly less 'absolute hands-off time' (16±33s vs. 203±42s, p<0.001). The quality of chest compression was comparable among groups, except for a higher compression rate in the standard BLS group (123±14min, vs. 95±11min: p<0.001). Tidal volume was higher in the standard BLS group (0.48±0.14l vs. 0.34±0.13l, p<0.001), but we registered fewer gastric inflations in the MRD group (0.4±0.3% vs. 16.6±16.9%, p<0.001). Using the MRD resulted in significantly less 'absolute hands-off time' but less effective ventilation. The translation of higher chest compression rate into better outcome, as shown in other studies previously, has to be investigated in another human outcome study.
61. Girasek DC. *Evaluation of a brief intervention designed to increase CPR training among pregnant pool owners*. Health Ed Res 2011; (Online first): 29 April

This study evaluated whether a brief videotape could motivate pregnant pool owners to be trained in infant/child cardiopulmonary resuscitation (CPR). Women were recruited from prenatal classes in South Florida. Eligible volunteers were randomized to view a video or receive standard treatment, after completing a questionnaire. The video explained toddler drowning risk, as well as the value of isolation pool fencing and CPR training. Women were contacted by phone 6 months after giving birth to complete a follow-up survey. Sixty-one percent of eligible mothers agreed to study enrollment and 92% of those completed a follow-up interview (n = 101). At baseline, there was no significant difference between the proportion of mothers with current CPR training in the treatment and control groups. At follow-up, 48% of those in the intervention group reported CPR instruction versus 28% of the control group (x² = 3.93, P = 0.03). Video viewers were also more likely to report significant changes in perceptions that favored CPR training. Health care facilities located in communities with high rates of toddler drowning may want to screen prenatal students for pool ownership and encourage at-risk families to be trained in infant/child CPR. Such programs should, however, emphasize the primacy of isolation fencing as a preventive measure.

*Guideline 10.1: Basic life support training*


Objective: We surveyed US neonatologists and high-risk obstetricians about preferences for resuscitation in ethically difficult situations to determine whether (1) their responses adhered to traditional ethical principles of best interests and patient autonomy and (2) physician specialty seemed to influence the response. Methods: In an electronic survey, we presented 8 vignettes with varying prognoses for survival and long-term outcome. Respondents were provided outcome data for mortality and morbidity in each vignette. We asked whether resuscitation was in the patient's best interest and whether the physician would accede to requests for nonresuscitation. Results: We analyzed surveys for 587 neonatologists and 108 high-risk obstetricians (15% overall response rate, 75% of web site visitors). There were no statistically significant differences in responses between the 2 physician subspecialty groups. As expected, in most cases there were inverse relationships between valuation of best interest and deferred resuscitation at the family's request. For example, for the oldest patient (an 80-year-old), 9.9% found resuscitation to be in the patient's best interest and 94.3% would allow nonresuscitation; for a 2-month-old, 93.9% found resuscitation to be in the patient's best interest and 24.5% would allow nonresuscitation. However, this pattern was not observed in the 2 newborn cases, in which resuscitation and nonresuscitation were both acceptable. In the triage scenario, the 7-year-old with cerebral palsy and acute trauma was consistently resuscitated first despite others having equivalent or better short- and long-term prognoses. Conclusions: On the basis of our results, physicians' decisions to resuscitate seem to be context-specific, rather than based on prognosis or consistent application of best-interest or autonomy principles. Despite their different professional perspectives, neonatologists and high-risk obstetricians seemed to converge on these judgments.

*Guideline 10.5: Legal & ethical issues in resuscitation*
The study examined the effects of brief monthly practice on nursing students' CPR psychomotor skill performance at 3, 6, 9, and 12 months compared to a control group with no practice, and of repeating the initial BLS course at 12 months. Nursing students (n=606) completed either HeartCode BLS or an instructor-led course and were then randomly assigned to an intervention group practice schedule, consisting of experimental (6min of monthly practice on a voice advisory manikin) or control (no practice) and test out month. Every 3 months, a subset of students was randomly selected from both groups for reassessment of their CPR psychomotor skills. Outcome measures were compression rate and depth, percent of compressions performed with adequate depth, percent performed with correct hand placement, ventilation rate and volume, and percent of ventilations with adequate volume. At 3 months, there were no differences between the groups in mean ventilation volume (p=0.71), but with practice by 6 months students were able to ventilate with an adequate volume; this skill continued to improve with monthly practice. In the control group, the mean ventilation volumes were less than the recommended minimum throughout the 12 months. The control group had a significant loss of ability to compress with adequate depth between 9 and 12 months (p=0.004). By practicing only 6min a month, students maintained or improved their CPR skills over the 12-month period. The findings confirmed the importance of practicing CPR psychomotor skills to retain them and also revealed that short monthly practices could improve skills over baseline.

Guideline 10: Education & implementation

As part of the strategy to increase bystander CPR, training schoolchildren has been recommended because of their ability to learn and retain knowledge and skills. We hypothesized that a popular song (an inexpensive and widely available training method) with a beat fitting recommended chest compression (CC) rate would improve the acquisition and retention of this skill in schoolchildren. We performed a parallel manikin study in 59 untrained schoolchildren (aged 13–14 years) randomized into two groups: “Macarena song” (34 children) and “Silent or control” (25 children). All children received 1 h of BLS training emphasizing continuous CC. “Macarena song” was trained to make CC with the audio guidance of the song “Macarena” by Los del Río (103 beats per minute)...

Guideline 10.1: Basic life support training

Uncontrolled donation after cardiac death (DCD) could increase the donor pool in the UK. Air ambulance (AA) teams may be well placed to recruit these donors. They cover large geographical areas, have short transfer times and tasked predominantly to life-threatening cases. The potential to recruit from this pool of donors was reviewed. Seventy-five month activity of an AA unit was analysed identifying patients who entered prehospital cardiac arrest (PHCA). Patients over 70 years of age were excluded as were those whose cardiac arrest was unwitnessed. A minimum potential donor pool was estimated based upon patients dying of medical causes. Rates of bystander resuscitation, mechanism of death and patient demographic data were observed. During 10 022 missions 534 patients entered PHCA. A total of 106 patients met inclusion
criteria. There were 12 paediatric cases; 39 cases of 17–50 year olds and 55 cases of 50–70 year olds. Medical and traumatic causes of death accounted for 60 and 46 cases respectively. Bystander resuscitation efforts were provided in 47% of cases. A regional AA could contribute to a national uncontrolled DCD programme. Given that there are 31 AA’s in England and Wales, we estimate that there could be a minimum of 300 additional potential donors annually.


The present study evaluates a new CPR feedback application for the iPhone (iCPR) designed to improve chest compression performance tested in a cardiac arrest simulation to evaluate performance and acceptance by healthcare professionals and lay people. We built an application specifically dedicated to self-directed CPR training through a tutorial that includes a simple feedback module to guide training in order to improve the quality of chest compressions. We tested it in a sample of 50 users to evaluate the effect of iCPR on performance and it is acceptance. The participants were randomly assigned to one of the study groups and were asked to perform a trial of 2min of chest compressions (CC), to answer a predefined set of questions and then to perform two more minutes of CC. The first group performing the sequence of CC with iCPR questions CC without feedback, and the second the sequence CC without feedback questions CC with iCPR. The mean compression rate was 101±2.8min when CC were performed with iCPR and 107.8±20.5min when performed without iCPR (p<0.01). Overall, the participants considered iCPR useful to maintain CC at the desired rate of 100 compressions per minute. The iCPR feedback tool was able to significantly improve the performance of chest compressions in terms of the compression rate in a simulated cardiac arrest scenario. The participants also believed that iCPR helped them to achieve the correct chest compression rate and most users found this device easy to use.

**Guideline 10: Education & implementation**


Simulation-based interprofessional team training is important to ensure high-quality, safe patient care, but several barriers exist, including diverging learning needs and schedules as well as limited available resources. Methods: The authors developed an in situ, simulation-based interprofessional team training program around pediatric emergencies for physicians, nurses, respiratory therapists, and pharmacists at their institution and performed an analysis of the program; impact on self-efficacy in resuscitation skills among pediatric residents and nurses. Results: The results showed that with a design based in best principles of team training and simulation education, interprofessional team training is feasible and sustainable. The program had a beneficial effect on self-efficacy in resuscitation skills among both residents and nurses at the authors’ institution and received widespread acceptance. Conclusions: A collaborative approach to design and implementation of interprofessional team training can lead to a sustainable program that serves both patient safety and training requirements set forth by professional organizations.

**Guideline 10: Education & implementation**
Finally... a glossary of commonly used terms in the research literature

(Graham CD, *A glossary for research reports* Metal Progress. 1957; 71(5) – with slight adaptation)

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Translation</th>
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<tbody>
<tr>
<td>It has been long known..</td>
<td>I didn't look up the original reference</td>
</tr>
<tr>
<td>Typical results are shown...</td>
<td>The best results are shown</td>
</tr>
<tr>
<td>It is known</td>
<td>I believe</td>
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<tr>
<td>It is believed</td>
<td>I think</td>
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<tr>
<td>It is generally believed</td>
<td>My colleagues and I think</td>
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<tr>
<td>There has been some discussion</td>
<td>Nobody agrees with me</td>
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<tr>
<td>It can be shown</td>
<td>Take my word for it</td>
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<tr>
<td>It is proven</td>
<td>It agrees with something mathematical</td>
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<tr>
<td>Of great theoretical importance</td>
<td>I find it interesting</td>
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<tr>
<td>Of great practical importance</td>
<td>This justifies my employment</td>
</tr>
<tr>
<td>Of great historical importance</td>
<td>This ought to make me famous</td>
</tr>
<tr>
<td>Three of the samples were chosen for study.</td>
<td>The others didn't make sense</td>
</tr>
<tr>
<td>Typical results are shown</td>
<td>The best results are shown</td>
</tr>
<tr>
<td>Correct within order of magnitude</td>
<td>Wrong</td>
</tr>
<tr>
<td>The values were obtained empirically</td>
<td>The values were obtained by accident</td>
</tr>
<tr>
<td>The results are inconclusive</td>
<td>The results seem to disprove my hypothesis</td>
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<tr>
<td>Additional work is required</td>
<td>Someone else can work out the details</td>
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<tr>
<td>It might be argued that</td>
<td>I have a good answer to this objection</td>
</tr>
<tr>
<td>The investigations proved rewarding</td>
<td>My grant has been renewed</td>
</tr>
<tr>
<td>The most reliable values are those of Jones</td>
<td>Jones is my graduate student</td>
</tr>
<tr>
<td>Thanks are due to Joe Blotz for assistance with the experiment and to George Frink for valuable discussions...</td>
<td>Blotz did the work and Frink explained to me what it meant.</td>
</tr>
<tr>
<td>A careful analysis of obtainable data....</td>
<td>Three pages of notes were obliterated when I knocked over a glass of beer.</td>
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