

# Resuscitation Science Symposium: Best of the Best (Oral Abstract Presentations – Part I)

Saturday Morning  
Room W230ab  
Abstracts 1–5

3

## The Survival Rate from Out-of-Hospital Cardiac Arrest is Superior with Passive Oxygen Insufflation Compared to Active Assisted Ventilation

Tyler F Vadeboncoeur, Mayo Clinic, Jacksonville, FL; Bentley J Bobrow, Mayo Clinic, Scottsdale, AZ; Lani Clark, Vatsal Chikani, Arizona Dept of Health Dept, Phoenix, AZ; Gordon A Ewy, Univ of Arizona, Tucson, AZ

**OBJECTIVE:** Experimental evidence suggests that excessive volume and rates of positive pressure ventilation during resuscitative efforts for out-of-hospital cardiac arrests (OOHCA) may be deleterious. The optimal ventilation technique for OOHCA, including method, timing, rate, and tidal volume have not been determined. We sought to compare survival rates for adults with OOHCA receiving cardiocerebral resuscitation (CCR) between those receiving passive oxygen insufflation and those receiving oxygen via active bag-valve-mask (BVM) ventilation. **METHODS:** The Save Hearts in Arizona Registry and Education (SHARE) program collected Utstein style data on consecutive adults with OOHCA from 11 different fire departments in Arizona utilizing CCR between May 2005 and December 2006. Passive insufflation was defined as an oro-pharyngeal airway device, and high flow oxygen at 15 L/min provided via a non-rebreather facemask without assisted ventilation while active ventilation was defined as BVM ventilation by paramedics at a recommended rate of 8/minute. The primary outcome was survival to hospital discharge in all arrests and for the subgroup with witnessed ventricular fibrillation (VF). Outcomes were obtained from the Office of Vital Statistics as well as local hospitals and were compared using chi square testing; alpha = 0.05. **RESULTS:** 442 adult OOHCA received CCR and were consecutively enrolled. Standard characteristics did not differ between the passive insufflation and active ventilation groups. 142/442 (32%) received passive insufflation and 300/442 (68%) received BVM ventilation. Overall survival did not differ between the passive insufflation group and the active ventilation group (12.7% (18/142) vs. 8% (24/300),  $p > 0.05$ ). Survival for witnessed VF was significantly higher in the passive insufflation group compared to the active ventilation group (48.6% (17/35) vs. 20.0% (12/60),  $p < 0.01$ ). The odds of survival was 7.2 times higher in the passive insufflation group when compared to the active ventilation group (95% CI 2.4,21.6). **CONCLUSION:** The survival rate of adults with witnessed VF OOHCA was superior in victims receiving passive oxygen insufflation than in victims receiving active ventilation during cardiocerebral resuscitation.

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## Statewide Out-of-Hospital Cardiac Arrest Survival Improves after Widespread Implementation of Cardiocerebral Resuscitation

Bentley J Bobrow, Mayo Clinic, Scottsdale, AZ; Tyler F Vadeboncoeur, Mayo Clinic, Jacksonville, FL; Lani Clark, Vatsal Chikani, Arizona Dept of Health Dept, Phoenix, AZ; Gordon Ewy, Arthur B Sanders; Univ of Arizona, Tucson, AZ

**OBJECTIVE:** To evaluate the impact of cardiocerebral resuscitation (CCR), an alternative emergency medical services (EMS) protocol, on out-of-hospital cardiac arrest (OOHCA) survival in the state of Arizona. CCR, emphasizes 200 preschool chest compressions, a single defibrillator shock (when indicated) followed immediately by 200 postshock chest compressions, early intravenous epinephrine and delayed endotracheal intubation. **METHODS:** The Save Hearts in Arizona Registry and Education (SHARE) program collected Utstein style data from 38 different fire departments (FDs) servicing approximately 70% of Arizona's population. 2671 consecutive OOHCA, of which 1847 were adult and presumed cardiac etiology were enrolled between October, 2004 and December, 2006. The CCR protocol was implemented in 11/38 (29%) FDs and the remaining FDs 27/38 (72%) utilized standard ACLS. The primary end-point was survival to hospital discharge of all cardiac arrests and for the subgroup with witnessed arrest and ventricular fibrillation (VF) on EMS arrival. Outcomes were obtained from the Office of Vital Statistics as well as local hospitals and were compared using chi square testing; alpha = 0.05. **RESULTS:** 457/1847 (24.7%) patients were treated by CCR FDs and 1390/1847 (75.3%) were treated by ACLS FDs. Overall survival in the CCR group was significantly better than in the ACLS group (9.2% (42/457) vs. 3.5% (49/1390),  $p < 0.001$ ). Similarly, survival for witnessed VF arrests was significantly better in the CCR group than the ACLS group (29.3% (29/99) vs. 11.1% (30/271),  $p < 0.001$ ). Odds ratios were adjusted for age, gender, location, bystander CPR performed, % witnessed, % VF and EMS dispatch to arrival time. The odds of overall survival was 2.7 times higher in the CCR group compared to the overall ACLS group (95% CI 1.7,4.4), and 3.0 times higher in the CCR subgroup of witnessed VF (95% CI 1.6,5.6). **CONCLUSION:** Survival of patients with OOHCA in Arizona was significantly better in fire departments utilizing the cardiocerebral resuscitation protocol than in fire departments utilizing ACLS. Implementing the cardiocerebral resuscitation protocol on a large scale is feasible and saves lives.

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## Bone Marrow Mesenchymal Stem Cells Infused Intravenously after Cardiac Resuscitation Improves Cerebral Function

Tong Wang, The Second Affiliated Hosp of Sun Yat-Sen Univ, GuangZhou, China; Wanchun Tang, Shijie Sun, Tingyan Xu, Hao Wang, Max Harry Weil; Weil institute of critical care med, Rancho Mirage, CA

**Background:** Allogeneic bone marrow mesenchymal stem cells (MSCs) differentiate into neurons. In the present study, we investigated the effects of intravenous infusion of MSCs following successful resuscitation on post-resuscitation neurological outcomes. **Hypothesis:** MSCs, when infused intravenously following initial resuscitation, reduce the severity of post-resuscitation cerebral dysfunction. **Methods:** Ventricular fibrillation was induced and untreated for 6 min in 20 male Sprague-Dawley rats weighing 450–550g. CPR, including chest compressions and mechanical ventilation, was performed for 6 min prior to attempted defibrillation. All animals were resuscitated. Two hours later, animals were randomized to receive a bolus injection of either  $5 \times 10^6$  MSCs labeled with PKH26 in phosphate buffer solution (PBS) or PBS as placebo into the right atrium. Survival, adhesive removal, motor test and the Neurological Severity Score (NSS) were measured weekly for a total of 5 weeks. MSCs were counted in 5  $\mu$ m sections of each harvested brain. Cells from MSCs were identified by immunological markers. **Results:** Significant neurological improvement (Table 1) and 5 week survival (9/10 vs. 4/10,  $p = 0.025$ ) followed injection of MSCs. Labeled MSCs localized to the hippocampus, cortex, pons, medulla, cerebellum were identified. Labeled cells expressed protein markers of neural cells. **Conclusion:** MSCs significantly reduce the severity of post-resuscitation cerebral dysfunction and improve survival. Table 1 Adhesive removal, motor test and NSS

Post-resuscitation (weeks)	2	3	4	5
1. Adhesive-removal (sec.)				
MSCs	27.6±7.8	18.1±3.6	15.0±2.4	13.3±2.1
Placebo	37.8±6.0*	33.6±10.3*	31.5±6.7**	31.3±8.9**
2. Motor test (sec.)				
MSCs	63.4±9.8	74.1±9.8	80.7±9.9	85.1±8.5
Placebo	42.7±14.5*	43.9±16.7*	51.1±14.6**	60.4±13.0**
3. NSS				
MSCs	3.7±2.4	3.4±2.5	3.1±2.6	3.1±2.6
Placebo	10.3±8.2**	10.2±8.3**	10.1±8.4**	10.1±8.4**

Values are means ± SD \*  $P < 0.05$  Placebo vs. MSCs; \*\*  $P < 0.01$  Placebo vs. MSCs

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## Inducing Hypothermia During Resuscitation Improves Return of Spontaneous Circulation In Prolonged Porcine Ventricular Fibrillation

James J Menegazzi, Jon C Rittenberger, Brian P Suffoletto, Eric S Logue, David D Salcido, Lawrence D Sherman; Univ of Pittsburgh, Pittsburgh, PA

**Introduction:** Induced hypothermia has been shown to improve survival and neurologic outcomes for ventricular fibrillation (VF) cardiac arrest. Clinical studies have not begun inducing hypothermia until after return of spontaneous circulation (ROSC). The effects of cooling during the resuscitation are not well-studied. **Hypothesis:** We hypothesized that inducing hypothermia at the start of resuscitation would increase the rates of ROSC and short-term survival (20 minutes) in an established porcine model of prolonged VF. We compared intra-resuscitation hypothermia (IRH) with a normothermic control group (CTL). **Methods:** We anesthetized and instrumented 28 domestic swine (mean mass  $26.5 \pm 2.4$  kgs) with ECG, esophageal temperature, and micromanometer-tipped aortic and right atrial catheters. We then randomly assigned them to IRH and CTL groups ( $n = 14$  each). VF was electrically induced and untreated for 8 minutes. Then resuscitation was begun with mechanical chest compression and ventilation. Hypothermia was induced by rapid IV infusion of ice-cold normal saline (30 mL/kg) at the beginning of resuscitation in the IRH group. The CTL group got 30 mL/kg of body-temperature saline at the start of resuscitation. After 8 minutes of VF, two minutes of CPR was followed by delivery of drugs (epinephrine 0.1 mg/kg, vasopressin 40 U, and propranolol 1.0 mg) and 3 more minutes of CPR (first rescue shock at 13 minutes of VF). ROSC (systolic BP above 80 mmHg for one minute continuously) and survival were recorded, as was total fluid given and hematocrits. Temperatures are reported in degrees C. Rates were compared with 2-tailed Fisher's exact test, with alpha=0.05. **Results:** Baseline temperatures at 8 minutes VF did not differ (IRH=37.9° and CTL=37.7°). Post-infusion temperatures at 13 minutes of VF were IRH=34.9° and CTL=37.9°. ROSC occurred in 12/14 (86%) IRH animals and in 6/14 (43%) CTL, with  $p=0.046$ . Survival occurred in 8/14 (57%) IRH animals and 4/14 (36%) CTL, with  $p=0.15$ . Total fluid volumes given and hematocrits did not differ between groups. **Conclusions:** IRH doubled the rate of ROSC compared to CTL. There was a non-significant 58% relative improvement in short-term survival. In this porcine model, rapid infusion of ice-cold saline quickly cooled during resuscitation.

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## CPR Fraction Prior to Defibrillation Determines Survival in Prehospital Cardiac Arrest in the Resuscitation Outcomes Consortium (ROC) Epistry

James Christenson, Douglas Andrusiek, Univ of British Columbia / BC Ambulance Service, Vancouver, Canada; Siobhan P Everson-Stewart, Peter J Kudenchuk, Univ of Washington, Seattle, WA; David Hostler, Univ of Pittsburgh, Pittsburgh, PA; Judy Powell, Univ of Washington, Seattle, WA; Clifton W Callaway, Univ of Pittsburgh, Pittsburgh, PA; Dan Bishop, BC Ambulance Service, Vancouver, Canada; Christian Vaillancourt, Univ of Ottawa, Ottawa, Canada; Daniel P Davis, Univ of California, San Diego, San Diego, CA; Tom P Aufderheide, Med College of Wisconsin, Milwaukee, WI; Ahamed Adris, Texas Univ, Dallas, TX; John A Stouffer, Gresham Fire & Emergency Services, Gresham, OR; Ian Stiell, Univ of Ottawa, Ottawa, Canada; Resuscitation Outcomes Consortium Rschers

**Introduction:** In 2005, the American Heart Association recommended increased "hands-on time" during cardiopulmonary resuscitation (CPR) based on animal research and small case

series. This study estimated the effect of increasing CPR fraction (proportion of resuscitation time with active CPR) on survival in a cohort of patients with out-of hospital ventricular fibrillation or ventricular tachycardia (VF/VT). **Methods:** Patients were selected from the ROC Epistry who had a confirmed VF/VT cardiac arrest that was not witnessed by Emergency Medical Services (EMS), received no public access defibrillation shock prior to EMS arrival, and had impedance recordings of CPR before the first shock. The proportion of each minute with active CPR, from defibrillator pad application until the first shock, was measured from the electronic resuscitation record by skilled readers who were blinded to hospital discharge outcome. The effect of increasing CPR fraction on survival to hospital discharge was adjusted for age, sex, bystander CPR, public location, interval from 911 call to defibrillator activation, chest compression rate, and ROC community. **Results:** Of 7963 EMS-treated cases of cardiac arrest without public access defibrillation, 1893 had an initial rhythm of VF/VT and 283 of those had electronic tracings and confirmed outcome. Mean age was 63 years and 81% were male. Bystanders performed CPR on 51% and 41% arrested in a public location. Outcomes and odds ratios (OR) with 95% confidence intervals (CI) of survival are shown from lowest to highest category of CPR fraction. **Conclusions:** This study provides preliminary evidence that increasing CPR fraction is associated with increased survival from VF/VT cardiac arrest. Though the study was observational, relatively small, and able only to measure CPR fraction after pad application, these findings suggest that provision of minimally interrupted CPR has direct clinical impact on survival after VF cardiac arrest.

CPR Fraction	0–20%	21–40%	41–60%	61–80%	81–100%
n	70	46	56	73	38
Survived to Discharge (%)	6 (8.6%)	10 (21.7%)	11 (19.6%)	20 (27.4%)	13 (34.2%)
Unadjusted OR (95% C I)	Ref	2.96 (1.00, 8.82)	2.61 (0.90, 7.56)	4.02 (1.51, 10.74)	5.54 (1.90, 16.20)
Adjusted OR (95% C I)	Ref	4.38 (1.11, 17.28)	2.04 (0.52, 8.02)	3.45 (0.90, 13.23)	3.60 (0.87, 14.89)

## Resuscitation Science Symposium: Best Original Resuscitation Science (Moderated Poster Session and Reception)

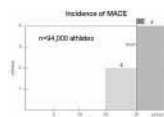
Saturday Evening  
Room W224  
Abstracts 6–60

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### Timing Of Major Adverse Cardiac Events During Endurance Races.

Victor Umans, Jasper Bennik, Jaap Ruiter, Hans de Swart, Jan H Cornel, Med Cntr Alkmaar, Alkmaar, The Netherlands

**Background:** Major adverse cardiac events (MACE) in endurance exercise are usually due to underlying and unsuspected heart disease. We present an analysis of the timing MACE that have occurred in endurance races over the past 6 years. **Methods:** We investigated clinical data of athletes who developed MACE during three national endurance races and were admitted to our hospital. Each year, 10–15 Olympic nominees participate. **Results:** In 6 years (2002–2007), a total of 94,000 athletes had participated in three prestigious cycling or half marathon races. 77% of the participants was male with a mean age of 40 years. In 6 athletes a MACE occurred (males, mean age 48 yrs): One athlete died suddenly despite extensive CPR. Three athletes had a myocardial infarction and underwent primary PCI; one collapsed due to a catecholamine-induced VT/VF and one athlete developed a heat stroke with increased cardiac enzymes. Two athletes were successfully defibrillated at the event's site with an external defibrillator. All events occurred in the last quarter distance of the race or after the finish. This figure shows the timing of MACE in endurance races. **Conclusion:** the incidence of MACE during endurance races is very low. All MACE's occurred in last quarter distance of the race or after the finish. A rapid available external defibrillator at the event's site can be life-saving and may enhance the safety of endurance sport events.



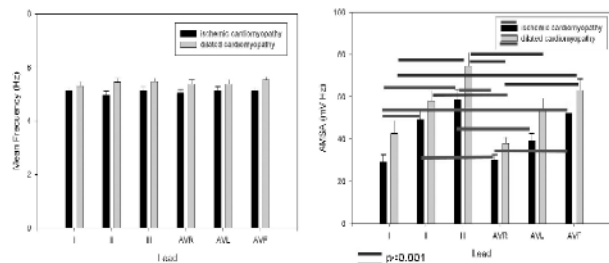
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### Direction of Signal Recording Affects Amplitude Based Measures of Ventricular Fibrillation in Humans Undergoing Defibrillation Testing During ICD Implantation

Julia H Indik, Craig M Peters, Richard L Donnerstein, Peter Ott, Karl B Kern, Robert A Berg; Univ of Arizona, Tucson, AZ

**Introduction:** A shock applied to prolonged ventricular fibrillation (VF) is less likely to result in a perfusing rhythm than if applied early. Waveform analysis may indicate the duration of VF and

the likelihood of defibrillation success, and if such analysis is to be relied upon, we need to understand the errors that may result from variations in AED patch placement. We analyzed VF from patients undergoing implantable cardioverter-defibrillator implantation. **Methods:** VF was induced in 26 patients with ischemic cardiomyopathy and 19 patients with dilated cardiomyopathy and recorded in six limb leads. Frequency characteristics (mean, median, dominant and bandwidth) were computed as well as amplitude-based measures of slope (median of absolute difference of voltage every 5 ms) and AMSA (summed product of frequency and amplitude). Characteristics were compared by ANOVA, with repeated measures by lead. **Results:** Frequency characteristics were similar in all leads. However, slope and AMSA were significantly affected ( $p < 0.001$ ) by lead for both cardiomyopathy groups. In particular, for ischemic cardiomyopathy patients between leads I and II (a change in the frontal plane of 60 degrees), slope varied from  $0.008 \pm 0.001$  mV to  $0.012 \pm 0.001$  mV (mean  $\pm$  SEM,  $p < 0.001$ ) and AMSA varied from  $29.4 \pm 3.2$  to  $49.3 \pm 4.6$  mV Hz ( $p < 0.001$ ). There were no significant differences between ischemic and dilated cardiomyopathy patients. **Conclusion:** Amplitude based measures of VF are significantly affected by recording direction. This investigation implies that AED patches must be consistently and correctly placed if amplitude-based measures are used to decide whether to deliver a defibrillatory shock.



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### What is the Frequency of Inappropriate of Emergency Department Catheterization Laboratory Activation For Patients with Potential ST Elevation MI?

Michael C Kontos, Michael Kurz, Charlotte S Roberts, Sarah Joyner, Laura Kreisa, Joseph P Ornato, George W Vetrovec; Virginia Commonwealth Univ, Richmond, VA

**Background:** To decrease door to balloon time (D2B) for STEMI patients (pts), it is recommended that the Emergency Department (ED) activate the cardiac catheterization laboratory (Cath Lab) directly through a simultaneous group STEMI page that includes the Cath Lab staff and interventionalist. Anecdotal evidence suggests that inappropriate activation is infrequent; however quantitative data is lacking. **Methods:** We assessed the frequency and outcomes of ED STEMI pages to determine the number who had a true STEMI, those who had ECG findings worrisome for but not meeting STEMI criteria, and the frequency of MI. A pt was considered a "false alarm" if emergent cath was not done and MI was excluded. Angiographic findings and outcomes were also evaluated. **Results:** Over a 1 year period, ED activation of the Cath Lab via the STEMI page occurred 98 times. There were 61 (62%) pts with a true STEMI, of whom only two did not have an emergent cath (2 not done because of sepsis and acute stroke)(Table). A total of 32 (33%) pts had ECG findings concerning for but not meeting STEMI criteria, of whom 31 (97%) underwent emergent cath, with PCI performed in 10 (32%). In 5 pts (5%), the Cath Lab was de-activated after further assessment, and would have been considered "false alarms". **Conclusions:** A significant number of ED STEMI Cath Lab activations are for pts who do not meet standard STEMI criteria. However, most have suggestive ECG findings benefiting from emergent angiography, and have either significant disease, undergo PCI, and/or are diagnosed with non-STEMI. Only a small percentage (5%) are clear "false alarms. This data further support current recommendations for ED Cath Lab activation for potential STEMI pts.

	MI	Emergent Cath	Sig CAD in pts with cath	PCI in pts with cath
All pts (n=98)	74 (76)	87 (89)	76 (87)	64 (74)
STEMI (n=61)	61 (100)	59 (97)	59 (100)	55 (93)
Abnormal ECG, concerning for STEMI (n=32)	13 (41)	31 (97)	20 (71)	10 (32)

Data presented as N (%). For Cath and PCI columns, % is of pts with cath performed

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### Ammonia as a Marker of Neurological Outcomes in Patients with Out-of-Hospital Cardiac Arrest

Asuka Kasai, Ken Nagao, Kimio Kikushima, Kazuhiro Watanabe, Takeo Mukohyama, Yoshiteru Tominaga, Katsushige Tada, Nobutaka Chiba, Mitsuru Ishii, Taketomo Soga, Kei Nishikawa, Harumi Ikeda, Yutaka Tateda, Tsukasa Yagi; Surugadai Nihon Univ Hosp, Tokyo, Japan

**BACKGROUND** Excessive accumulation of ammonia (NH<sub>3</sub>) induces neuronal metabolic derangements, promotes astrocyte swelling and perturbs cerebral nitric oxide metabolism which can mediate some of the pathophysiologic changes. Although studies have shown that there was a correlation between increase in blood NH<sub>3</sub> level and hepatic encephalopathy, few studies were available for patients with out-of-hospital cardiac arrest. We therefore evaluated NH<sub>3</sub> as a biochemical marker of neurological outcome. **METHODS** We conducted a prospective clinical

study of patients with out-of-hospital cardiac arrest that followed Utstein style reporting guidelines. Blood samples to measure the  $\text{NH}_3$  concentration were taken from a vein before drug administration in the emergency room (normal range of  $\text{NH}_3$ : 12 to 66  $\mu\text{g}/\text{dl}$ ). The primary endpoint was a favorable neurological outcome at the time of hospital discharge. **RESULTS** Of the 461 patients with out-of-hospital cardiac arrest, 291 adult patients were eligible. The  $\text{NH}_3$  level ranged from 10 to 400  $\mu\text{g}/\text{dl}$ , with a mean ( $\pm\text{SD}$ ) of  $208 \pm 133 \mu\text{g}/\text{dl}$ , and a median of 186  $\mu\text{g}/\text{dl}$ , and 25<sup>th</sup> and 75<sup>th</sup> percentile values of 79 and 337  $\mu\text{g}/\text{dl}$ , respectively. Of those, 20 (7%) had a favorable neurological outcome at the time of hospital discharge, and the  $\text{NH}_3$  level was lower among such patients than among those with unfavorable neurological outcomes (a median, 48  $\mu\text{g}/\text{dl}$  vs. 205  $\mu\text{g}/\text{dl}$ ,  $p < 0.0001$ ). The adjusted odds ratio for a favorable neurological outcome after  $\text{NH}_3$  level was 0.98 (95% CI, 0.97–0.99;  $p = 0.0005$ ), and the  $\text{NH}_3$  level was more accurate than any components of the chain of survival. The neurological prognostic accuracy of  $\text{NH}_3$  level at a cut off of 87.5  $\mu\text{g}/\text{dl}$  was 79 %. The negative predictive value of  $\text{NH}_3$  at levels of more than 189  $\mu\text{g}/\text{dl}$  was 100 %. In patients with return of spontaneous circulation (ROSC) after out-of-hospital cardiac arrest witnessed by bystanders, there was a significant positive correlation between the  $\text{NH}_3$  level and time interval from cardiac arrest to ROSC ( $R = 0.54$ ,  $p < 0.0001$ ). **CONCLUSIONS** We demonstrated that  $\text{NH}_3$  level on arrival at the emergency room was elevated in patients with out-of-hospital cardiac arrest and reliably predicted neurological outcome.  $\text{NH}_3$  is a new candidate marker of neurological outcome after cardiac arrest.

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### Outcome Of Pediatric In-hospital Cardiac Arrest By Extracorporeal Membrane Oxygenation Implementation During Active Cardiopulmonary Resuscitation

Enting Wu, Shuchien Huang, Wenje Ko, YihShang Chen; National Taiwan Univ Hosp, Taipei, Taiwan

**Background:** To achieve intact neurological survival is a challenge for pediatric cardiac arrest. Here we describe the outcome and identify the factors associated with survival among pediatric patients following extracorporeal cardiopulmonary resuscitation (ECPR) for in-hospital pediatric cardiac arrest. **Method:** Retrospective study of 27 pediatric in-hospital cardiac arrest who received extracorporeal membrane oxygenation during active cardiopulmonary resuscitation. The primary outcome was survival to hospital discharge. The secondary outcome was neurological status after ECPR at hospital discharge and late follow-up. Continuous variables were expressed as medians (inter-quartile range) **Results:** We identified 27 ECPR events. The survival rate to hospital discharge was 41% (11/27). The non-survivors had higher serum lactate levels (14 [10.2–19.6] mmol/L vs 8.5 [4.4–12.6] mmol/L,  $p < 0.01$ ), longer durations of cardiopulmonary resuscitation (CPR) (60 [37–81] minutes vs 45 [25–50] minutes,  $p < 0.05$ ) with longer activating time for ECMO (12.5 [7.5–33.8] minutes vs 5 [0–10] minutes,  $p < 0.01$ ), and more renal failure after ECPR (68%  $\frac{1}{16}$  vs 9%  $\frac{1}{11}$ ,  $p < 0.01$ ). By multivariate analysis, the earlier cohort and renal failure after ECPR were independent risk factors for mortality. Among the 11 survivors, 10 of them had good neurological outcomes. **Conclusions:** ECPR successfully rescued some pediatric patients who failed rescue with conventional in-hospital CPR. Good neurological outcomes were achieved in the majority of the survivors. Early cohort and post-ECPR renal failure were associated with poor outcomes. Early activation of the ECMO team could possibly shorten the CPR duration and improve the ECPR results.

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### Medical Emergency Teams Reduce Unexpected Cardiac Arrests, But Not Overall Hospital Costs Per Case

Harish Manyam, Michael S Cratty; Allegheny General Hosp, Pittsburgh, PA

**Introduction:** Medical emergency teams (MET) have been developed to meet the growing needs of hospitalized patients. Medical emergency teams have been shown to reduce unexpected cardiac arrests, unexpected ICU transfers, length of stay (LOS), and inpatient mortality. However, there is no data on overall hospital cost per case with the addition of a MET team. **Hypothesis:** We hypothesized that the addition of a MET to our hospital would reduce our hospital cost per case by reducing unexpected cardiac arrest. **Methods:** A MET was developed at our 714-bed teaching hospital in March 2006. Our goal was to perform a retrospective analysis of hospital costs per case related to cardiac arrest and MET responses before and after establishment of a MET team. The first comparison group included unexpected cardiac arrests for a 6-month period from March 2005–September 2005 before establishment of the MET team. The second group included unexpected cardiac arrest patients and patients seen by the MET team that required unexpected transfer to the ICU for a similar 6-month period from March 2006–September 2006 after development of the MET team. **Results:** Group 1 from 2005 included 76 unexpected cardiac arrest patients and Group 2 from 2006 included 48 unexpected cardiac arrests and 95 unexpected transfers to the ICU. Both groups had similar overall severity scores of 1.7. Overall we had a 37% reduction in unexpected cardiac arrests in the first 6 months after initiation of the MET team. The overall mean LOS was lower in group 2 at 15 days compared to 17 days in group 1, however there was no statistical significance ( $p = 0.59$ ). There was no difference in the mean total cost per case in group 2, \$34,653  $\pm$  \$32,500 compared to group 1, \$37,657  $\pm$  \$38,517 ( $p = 0.58$ ). **Conclusion:** The implementation of the medical emergency team at our hospital decreased unexpected cardiac arrests, but did not decrease mean total cost per case for patients suffering unexpected cardiac arrests and unexpected ICU transfer during activation of the medical emergency team.

### The Influence Of Sex On Endogenous Adenosine Production And The Occurrence Of Ventricular Fibrillation During Myocardial Ischemia

Timothy Mader, Baystate Med Cntr, Springfield, MA; Kazuaki Uchino, Toshiaki Ebina; Yokohama City Univ Sch of Medicine, Yokohama, Japan

**Background:** Endogenous adenosine (ADO) is cardioprotective during acute ischemic insult. Myocardial ischemia can cause ventricular arrhythmias and is used to induce ventricular fibrillation (VF) in some animal models of cardiac arrest. Recent evidence suggests that sex may influence VF decay and the rate of ROSC in porcine VF. We sought to determine the effect of animal sex on ADO production and the occurrence of VF during left anterior descending artery (LAD) occlusion in dogs. Our null hypothesis was there would be no difference between male and female animals. **Methods:** This was a secondary analysis of previously published data from an IACUC approved protocol. Twenty-nine anesthetized mongrel dogs (15 M, 14 F) were prepared in a standard fashion. Hemodynamic parameters were monitored continuously during the experiment. Blood from the great cardiac vein was sampled for endogenous ADO concentration at baseline and at 1, 2, 3, 5, 7, and 10 minutes of LAD occlusion. Plasma ADO concentration was determined by radioimmunoassay. Group comparisons were assessed using descriptive statistics, Student's t-test for continuous variables and Fisher's Exact Test for dichotomous variables. Proportions with 95% confidence intervals were calculated for the AUC and the rate of VF induction. **Results:** Baseline characteristics between the two groups were the same. VF occurred in 14 of the 29 animals in the primary study, with ADO concentration being higher in the non-VF group compared to the VF group ( $p = 0.026$ ). Between the sexes, the proportion of males in the non-VF group was 10/15 [0.66 (95%CI=0.43,0.91)] and in the VF group it was 5/14 [0.35 (95%CI=0.11,0.61)]. ADO concentrations in the male animals were slightly higher [AUC=924(95%CI=476,1372)] compared to females [AUC=659(95%CI=124,1195)] at all points during LAD occlusion. The small sample size is a limitation of this study. In this study, there was a trend toward male dogs generating higher ADO levels and having lower fibrillation rates when compared to females but the difference was not statistically significant. Further clarification of the influence of sex on endogenous ADO in ischemia-induced VF is needed. Meanwhile, investigators using an ischemia model of VF may want to control for animal sex.

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### Prospective Implementation of Medical Emergency Team on a Cardiothoracic Unit

Stephen D Small, Jai Raman; Univ of Chicago, Chicago, IL

**Background:** Medical emergency or rapid response teams (MET) may reduce the need for in-hospital resuscitation, and improve hospitalized patient outcomes. METs have become commonplace and are emerging on regulatory agendas. Controlled, prospective studies of MET have, however, provided conflicting data on effectiveness. There have only been two published studies of MET in the U.S. We implemented a prospective MET on a cardiothoracic unit in August, 2005. **Methods:** An interdisciplinary clinical team established MET policies and procedures. The response team composition included an ICU RN, respiratory therapist, and most senior available MD. A six-week pre-implementation training period was instituted for the nursing staff. Immediately post implementation, an immersive simulation workshop with video feedback was provided to nurses on the target unit. Baseline cardiac arrest data for the target unit pre-implementation over the past two years was 1.2 per month. **Results:** 53 MET calls occurred over 640 days, approximately 3/month. Mean response time = 6 minutes, mean duration of MET call care = 34 minutes, 53% of patients required ICU transfer, over 90% of patients experiencing a MET call survived to discharge. 7% of patients had a cardiopulmonary arrest at some point during their hospital stay post-MET call. Cardiac arrests on the pilot unit decreased and remained 63% below controls over 640 days. Confounding factors which might have influenced MET results included new hospital-wide surgical resident night float and quality improvement initiatives. Cardiac arrests in the rest of the hospital units did not change. Qualitative analysis of MET debriefings revealed chains of events of patient deterioration managed effectively with the MET framework for teamwork, resource utilization, and systems management. **Conclusions:** We present a longstanding MET intervention in a unique setting - a cardiothoracic hospital unit embedded in a tertiary care hospital which has not yet instituted organization-wide MET. Despite widespread systems changes, only the MET unit had sustained drop in cardiac arrests. Staff and patient satisfaction for the MET was high. Immersive simulation training with video feedback may have significant potential for augmenting MET impact.

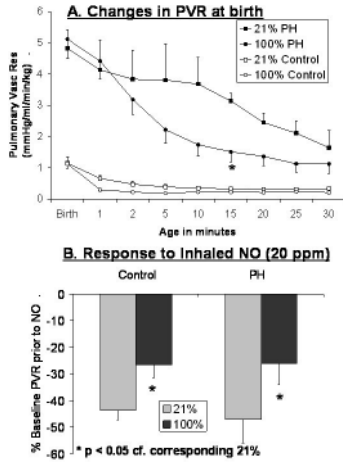
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### Pulmonary Hemodynamics in Neonatal Lambs with Pulmonary Hypertension - Effect of Resuscitation with 21% versus 100% Oxygen

Satyan Lakshminrusimha, Daniel D Swartz, Sylvia F Gugino, Karen A Wynn, Rita M Ryan, SUNY, Buffalo, NY; Robin H Steinhorn, Northwestern Univ, Chicago, IL; James A Russell; SUNY, Buffalo, NY

The optimal level of  $\text{O}_2$  supplementation during neonatal resuscitation is controversial. We recently published data that resuscitation with 21% or 100%  $\text{O}_2$  for 30 min results in similar decreases in pulmonary vascular resistance (PVR) in normal newborn lambs (*Pediatr Res in press*). However, the effect of resuscitation with 21% or 100%  $\text{O}_2$  on pulmonary hemodynamics in lambs with *in-utero* pulmonary hypertension (PH) is not known. **Methods:** PH was induced in fetal lambs by antenatal ductal ligation at 126 d of gestation (term ~ 145 d). Lambs were delivered 9 d later by C-section and ventilated with 21%  $\text{O}_2$  or 100%  $\text{O}_2$  for 30 min. Control lambs without PH were ventilated similarly for comparison ( $n = 4-7$  in each group). The lambs

were instrumented to measure PVR prior to delivery. After 30 min, lambs with PH were ventilated with 50% O<sub>2</sub> and pulmonary vasodilator responses to inhaled NO 20 ppm were evaluated. **Results:** PVR was significantly higher in lambs with PH compared to control. The decrease in PVR was similar by 30 min in 21% and 100% O<sub>2</sub> resuscitated control lambs. In contrast, 100% O<sub>2</sub> resuscitation resulted in a significantly greater decrease in PVR in lambs with PH (fig A). However, 100% O<sub>2</sub> resuscitation impaired subsequent decrease in PVR in response to inhaled NO in both control and PH lambs (fig B).



**Conclusions:** 100% O<sub>2</sub> resuscitation results in a greater decrease in PVR but impairs subsequent pulmonary vasodilation to NO in lambs with PH. **Speculation:** Ventilation of PH lambs with 100% O<sub>2</sub> significantly increases lung isoprostane levels (*AJRCCM 2006 174 12:1370*). We speculate that a similar increase in reactive oxygen species following 100% O<sub>2</sub> resuscitation interferes with the vasodilator response to NO.

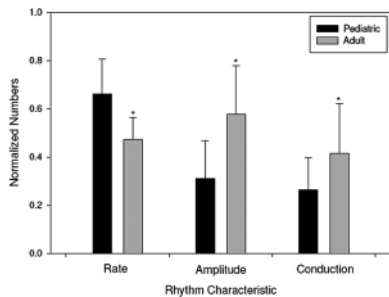
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**Electrocardiographic Characteristics for Automated External Defibrillator Algorithms are Different between Children and Adults**

Brant A Rustwick, Univ of Iowa, Iowa City, IA; Frederick Geheb, ZOLL Med Corp, Chelmsford, MA; James E Brewer, ZOLL Med Corp, Chelmsford, MA; Dianne L Atkins; Univ of Iowa, Iowa City, IA

**Introduction** An AED is recommended for children < 8 years if the rhythm detection algorithm has been validated in children with extensive testing. The purpose of our study was to determine if there were significant differences among ECG characteristics between pediatric vs. adult patients. **Methods** Digitized recordings of NSR were obtained from PhysioNet's archives and the ZOLL pediatric database. Rhythms were divided into 9-sec strips, creating 820 samples from; 103 patients < 10 years (children) and 71 patients > 18 years (adult). Rate, QRS signal amplitude, (SA) and conduction (COND) were analyzed. The rate and SA were determined using R-R interval detection and baseline to peak QRS measurements, respectively. COND was defined as the maximum QRS complex slope following the first major deflection, representing the rate of ventricular activation. **Results** There were statistical differences between pediatric and adult rhythm characteristics of rate, SA, and COND. (Fig 1) Heart rate for children was significantly higher than adult (113 ± 25 bpm vs 80 ± 16 bpm, P<0.001). Conversely, SA for pediatric subjects was significantly lower than adult subjects (1.2 ± 0.6 mV vs 2.2 ± 0.8 mV, P<0.001), as was COND (35.2 ± 18.0 mV/ms vs. 54.0 ± 29.0 mV/ms) (P<0.001). **Conclusions** The results showed significant differences between adult and pediatric ECG characteristics in rate, SA, and COND. These differences may result in inaccurate rhythm detection during AED use in children if the algorithm detection validation program did not include pediatric rhythms. This study confirms the recommendation that an AED rhythm algorithm should be validated with ECG strips obtained from children.

**Fig. 1** Comparison of NSR characteristics between adult and pediatric rhythms. \*P<0.001



**Subsequent VF is Associated with Better Outcomes from Out-of-Hospital Cardiac Arrests with Initial Non-shockable Rhythms~population-based Utstein Study In Japan~**

Kentaro Kajino, Osaka Univ Graduate Sch of medicine, Suita, Japan; Taku Iwami, Kyoto Univ, Kyoto, Japan; Robert A Berg, The Univ of Arizona College of Medicine, Tucson, AZ; Masahiko Nitta, Osaka Med College, Takatuki, Japan; Yasuyuki Hayashi, Senri Critical Care Med Cntr, Suita, Japan; Tathuya Nishiuchi, Senshu Critical Care Med Cntr, Izumisano, Japan; Hiroshi Nonogi, National Cardiovascular Cntr, Suita, Japan; Hisashii Ikeuchi, Osaka General Med Cntr, Osaka, Japan; Takashi Kawamura, Kyoto Univ Sch of Public Health, Kyoto, Japan; Atushi Hiraide, Kyoto Univ Graduate Sch Faculty of Medicine, Kyoto, Japan; Osamu Tasaki, Hiroshi Tanaka, Takeshi Shimazu, Hisashi Sugimoto; Osaka Univ Graduate Sch of medicine, Suita, Japan

**OBJECTIVE:** To compare survival rates from out-of-hospital cardiac arrest (OHCA) with an initial non-shockable rhythms according to whether they remained in a non-shockable rhythm or converted to shockable rhythms. **METHODS:** Design: Population-based cohort study. **Subjects:** Witnessed OHCA cases of cardiac etiology with pulseless electrical activity (PEA) or asystole as initially recorded rhythm. **Main outcome measure:** Neurologically favorable one-month survival. We enrolled all adult (age ≥ 18 years) patients with witnessed OHCA of cardiac etiology who were treated by the emergency medical services (EMS) in Osaka, Japan, from January 1 to December 31, 2005, by means of the Utstein Style. Resuscitation was performed according to the AHA guideline 2000. Survival indicators were compared between patients with sustained non-shockable rhythm (No-shock group) and patients with subsequent VF/VT and electrical shock (Shock group) using logistic regression. **RESULTS:** Of 3191 OHCA of cardiac etiology, 824 witnessed cases had PEA or asystole as initially recorded rhythm. Of the 824, 742 (90%) remained in a non-shockable rhythm at each evaluation throughout the resuscitation while 82 (10%) subsequently converted to VF/VT and were shocked by EMS personnel. Neurologically favorable one-month survival was significantly greater in the Shock group (4.9% versus 0.8%, p=0.001). Subsequent VF/VT was a significant predictor (OR, 5.4; 95%CI, 1.38–20.9) of neurologically favorable survival after adjustment for potential confounders. **CONCLUSIONS:** Among these patients with OHCA and initial non-shockable rhythm, subsequent VF/VT was associated with better outcomes.

	Baseline and Resuscitation Care Characteristics		p
	No-Shock	Shock	
	N=742	N=82	
age (yr), mean (S.D.)	74.7 (14.7)	69.6 (13.6)	p=0.003
male, n (%)	430 (58)	53 (64.6)	p=0.244
Citizen CPR, n (%)	274 (36.9)	37 (45.1)	p=0.146
EMS care interval (min), mean (S.D.)			
119 to EMS arrival	6.3 (2.6)	6.0 (2.3)	p=0.421
119 to EMS CPR	8.1 (2.9)	7.8 (2.5)	p=0.374
119 to first shock		16.9 (6.1)	

	Main Outcome		p
	No-Shock	Shock	
	N=742	N=82	
ROSC, n (%)	231 (31.1)	26 (31.7)	p=0.915
Hospital admission, n (%)	178 (24)	21 (25.6)	p=0.745
One month survival, n (%)	31 (4.2)	7 (8.5)	p=0.075
Neurologically favorable outcome, n (%)	6 (0.8)	4 (4.9)	p=0.001

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**Ambulance Paramedics Interrupt Chest Compressions And Delay Defibrillation After Taking Over From Lay Rescuers With An Automated External Defibrillator**

Jocelyn Berdowski, Ron J Schulten, Rudolph W Koster; AMC, Amsterdam, The Netherlands

**Introduction:** There are no guidelines for transition of care from rescuers with AED to paramedics with ongoing CPR. After disconnection of the AED, clock time as running in the AED is not available for subsequent protocolized CPR duration, rhythm check and shock. We hypothesize that defibrillation shocks are delayed and CPR interrupted without reason after AED disconnection. **Methods:** This was a prospective observational community study in an area of 2.6 million inhabitants. During 16 months, all available continuous ECG recordings of AEDs and associated manual defibrillator (mDFB) recordings of out-of-hospital cardiac arrests were collected. All clock times were synchronized. We observed CPR time through the impedance signal. For shockable rhythms, we measured the duration of CPR given between the connection time of the mDFB and expected time of defibrillation of the AED. For non shockable rhythms, the expected moment of AED rhythm analysis was the endpoint of the time interval. Time available for CPR given during that time interval was set at 100%. Delay in defibrillation was the difference between expected moment of the next shock as advised by the AED and the actual shock given by paramedics. **Results:** Results are shown in table 1. Of the 245 cases, 73 cases had a shockable rhythm during take over, 141 a non-shockable rhythm and 31 patients had Return of Spontaneous Circulation. A shock was delivered too early or too late in 68 of 73 patients. Four patients were never defibrillated. **Conclusion:** Disconnection of the AED by professionals interrupts the treatment protocol of the AED, delaying time of defibrillation by almost two minutes. Premature defibrillation leads to decrease in CPR time. The optimal moment of disconnecting the AED should be described in new guidelines.

Table 1: Shock delay and CPR interruption, divided in shockable and non shockable rhythms

	Shockable (n = 73)*		Non shockable (n = 141)
	Delayed shock (n = 41)	Premature shock (n = 27)	
Median time interval between connection of mDFB and expected AED shock in sec (range)	53 (1,197)	71 (20,140)	-
Median time interval between connection of mDFB and expected AED analysis in sec (range)	-	-	72 (2,200)
Median CPR given (% of available time) until expected AED shock / analysis	86 (0,100)	25 (0,77)	76 (0,100)
Shock delay (observed shock by mDFB minus expected AED shock) in sec (range)	106 (5,862)	-23 (-118, -8)	-

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### Can Schoolchildren provide Life Supporting First Aid sufficiently?

Roman Fleischhackl, Alexander Nuernberger, Christina Schoenberg, Tanja Urso, Tanja Habart, Martina Mittlboeck, Fritz Sterz; Med Univ OF VIENNA, Vienna, Austria

**Aims:** We investigated possible relationships between body constitution, age and sex of school children and their intellectual and physical abilities to provide effective life supporting first aid. **Methods:** Our observational study was carried out at the end of a school year, after first aid training had been provided by local teachers. As primary outcomes we measured CPR effectiveness parameters (depth of chest-compressions, number of chest-compressions, ventilation volume). As secondary outcomes we rated emergency calls, guideline adherence when checking signs of life and recovery position according to predefined checklists. Possible inter-dependencies between age, sex, body mass index (BMI) and physical or intellectual performance were calculated. Correlations between continuous data were assessed by Spearman rank correlation coefficient and differences between groups were tested by Wilcoxon's rank-sum test. A p-value < 0.05 was considered significant. **Results:** We included 147 pupils at the age from 9 to 18 years. The median depth of chest-compressions was calculated at 35 mm (IQR 31–41 mm), median number of compressions per minute was 129 bpm (IQR 108–143 bpm). Median volume applied during mouth-to-mouth ventilation was 540 ml (IQR 0–750 ml). Secondary outcomes are displayed in table 1. BMI ( $r=0.35$ ;  $p<0.0001$ ), body weight ( $r=0.38$ ;  $p<0.0001$ ) and body height ( $0.31$ ;  $p=0.0002$ ) showed statistically highly significant dependencies with chest-compression depth and ventilation volume. All other outcomes were not related to sex, age or body constitution. **Conclusions:** Children above the age of 9 years showed high quality overall performance after being trained in life supporting techniques. Effectiveness parameters obtained from adults previously seem to be comparable. Even if physical strength could limit CPR effectiveness, children should not be withheld from first aid education.

**Sec. Outcomes: Check f. vital signs, recovery position, emergency call, chestcompr/ventilation ratio**

Checked for responsiveness	85.4%
Shouted for help	43.7%
Opened airways correctly	70.2%
Checked for normal breathing	79.5%
Stable recovery position	96.7%
Head tilt, chin lift after establishing recovery position	68.0%
Named address, described the simulated problem correctly	98.1%
Named the number of affected victims	96.1%
Left their contact details for possible ring back	92.9%
Ratio of chest compressions and ventilations 30:2	86.4%

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### Effects of Stomach Inflation on Hemodynamic and Pulmonary Function During Cardiopulmonary Resuscitation in Pigs

Peter Paal, Andreas Neurauder, Michael Loedl, Daniel Pehböck, Holger Herff, Achim von Goedecke, Karl H Lindner, Volker Wenzel; Innsbruck Med Univ, Innsbruck, Austria

**Background:** Stomach inflation during cardiopulmonary resuscitation (CPR) is frequent. The purpose of this study was to evaluate effects of different levels of stomach inflation on hemodynamic and pulmonary function during CPR in a porcine model. **Methods:** After 4min of ventricular fibrillation, randomization to 0, 5, or 10L of stomach inflation was performed in 21 piglets. Basic life support CPR was then initiated for 3min, followed by a combination of epinephrine (45mcg/kg) and vasopressin (0.4U/kg) and defibrillation 2min later, and a post resuscitation phase of 30min. Kruskal-Wallis test was used for analysis; results are given as median (range). **Results:** During basic life support CPR, 0, 5, and 10L stomach inflation resulted in comparable coronary perfusion pressure between groups [10 (2–20), 8 (4–35), and 5 (0–18) mmHg, respectively]. Increasing (0, 5, and 10L) stomach inflation resulted in significantly ( $P<0.05$ ) decreasing static pulmonary compliance [52 (38–98), 19 (8–32), and 12 (7–15) mL/cmH<sub>2</sub>O, respectively], and significantly increasing mean airway pressure during mechanical ventilation [14 (12–15), 26 (20–66), and 40 (13–46) cmH<sub>2</sub>O]. Arterial partial pressure of oxygen was significantly higher with 0L when compared with 5 and 10L stomach inflation, but comparable between 5 and 10L stomach inflation [378 (88–440), 58 (47–113), and 54 (43–126) mmHg, respectively]. Similarly, arterial partial pressure of carbon dioxide was significantly lower with 0L when compared with 5 and 10L of stomach inflation [30 (24–36), 41(34–51), and 56 (45–68) mmHg, respectively]. Return of spontaneous circulation rates were comparable between groups [5/7 in 0L, 4/7 in 5L, and 3/7 in 10L stomach inflation]. **Conclusion:** In this CPR model, increasing levels of stomach inflation had adverse effects on pulmonary, but not on hemodynamic function.

### NT-proBNP Elevations in Adult Respiratory Distress Syndrome Strongly Predict Morbidity and Mortality: An Analysis from the Molecular Epidemiology of ARDS Study.

James Januzzi, Ednan Bajwa, Michelle Gong, B. T Thompson, David Christiani; Massachusetts General Hosp, Boston, MA

**Introduction:** Patients with ARDS suffer from a syndrome of marked cardiopulmonary derangement, including right ventricular strain and noncardiogenic pulmonary edema. We hypothesized that N-terminal pro-brain natriuretic peptide (NT-proBNP) levels would be elevated in ARDS, and serve as a marker of prognosis in this setting. **Methods:** Patients were diagnosed with ARDS according to the American-European Consensus Committee definition. Blood was taken within the first 72 hours of ARDS onset and assayed for NT-proBNP. Associations between NT-proBNP and presence/severity of sepsis, as well as ICU resource utilization were identified. Patients were followed for the primary outcome of 60-day mortality. Multivariable logistic regression and Cox proportional hazards models were constructed including variables selected using backwards elimination, clinical relevance, and significant interactions. **Results:** 177 patients were enrolled and analyzed. There were 70 deaths in the study population. Overall NT-proBNP median was 3181 ng/L (interquartile range=723–9246 ng/L); median NT-proBNP concentrations were relatively higher among those with sepsis plus shock, compared to those with sepsis without shock or neither sepsis nor shock (5015 vs 2131 vs 582 ng/L,  $P<.001$ ). Patients with marked elevation of NT-proBNP had fewer ventilator free days (5.7 versus 7.5,  $P<.001$ ). Median NT-proBNP concentrations were significantly higher among decedents versus survivors (6898 versus 2243 ng/L;  $P<.001$ ). Receiver operating characteristic analysis demonstrated an area under the curve of 0.66 ( $P<.001$ ) for predicting death; at a cutpoint of 6813 ng/L, NT-proBNP was a significant predictor of death in crude (HR=4.24, 95% CI=2.2–8.3,  $P=.001$ ) and adjusted (HR=2.36, 95% CI=1.1–5.0,  $P=.02$ ) analyses, comparable to the APACHE III score for this indication. **Conclusion:** NT-proBNP levels are elevated among patients with ARDS in a range typically considered consistent with heart failure. Importantly, NT-proBNP concentrations are strongly associated with morbidity and mortality in this population, with comparable predictive accuracy as more complex tools such as the APACHE III score. This demonstrates the potential utility of NT-proBNP monitoring for prognosis in ARDS.

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### Automated External Cardioversion Defibrillation Monitoring in Telemetry Patients

Bakhtiar Ali, Atlanta Veterans Affairs Med Cntr, Decatur, GA; Heather L Bloom, Atlanta Veterans Affairs Med Cntr/ Emory Univ Sch of Medicine, Decatur, GA; Emir Veledar, Emory Univ Sch of Medicine, Atlanta, GA; Dorothy House, Atlanta Veterans Affairs Med Cntr, Decatur, GA; Robert Norvel, Veterans Affairs Med Cntr/ Emory Univ Sch of Medicine, Decatur, GA; Samuel C Dudley, A. M Zafari; Atlanta Veterans Affairs Med Cntr/ Emory Univ Sch of Medicine, Decatur, GA

**Background:** Sudden cardiac death causes 300,000 deaths each year. The initial rhythm of approximately 25% of in-hospital CPR events is pulseless ventricular tachycardia/ventricular fibrillation (VT/VF). Early defibrillation is an independent predictor of survival in CPR events caused by VT/VF. The automated external cardioverter defibrillator (AED) is a device attached by pads to the chest wall that monitors, detects, and within seconds, automatically delivers electric countershock to a shockable rhythm. **Study Objectives:** ● To evaluate safety of AEDC monitoring in hospitalized patients. ● To evaluate whether AEDCs provide earlier defibrillation than hospital code teams. **Methods:** Using the PowerHeart CRM AEDC monitor we designed a prospective trial randomizing patients to standard CPR (code team) or standard CPR plus AEDC monitoring. The AEDC is programmed to deliver a 150 Joule biphasic shock to patients in sustained VT/VF. Data is collected using the Utstein criteria for cardiac arrest. The primary endpoint is time-to-defibrillation; secondary outcomes include neurological status and survival to discharge, with 3-year follow-up. **Results:** To date, 130 patients have been enrolled into the trial; one patient experienced sustained VT, which was successfully defibrillated (13 seconds after meeting programmed criteria) by the AEDC. The patient survived the event without neurological complications. No events have occurred in the control arm of the trial. During the same time period, mean time to shock for VT/VF cardiac arrest occurring outside the telemetry ward was  $230 \pm 50$  seconds. A total of 2,311 hours of telemetry data has been analyzed in the AEDC arm. The AEDC has monitored ambulatory telemetry patients in sinus rhythm, sinus tachycardia, supraventricular tachycardia, atrial flutter or fibrillation, with premature ventricular complexes and non-sustained VT without delivery of inappropriate shocks. **Conclusions:** Our initial experience suggests that AEDC technology is safe, and has the potential to reduce time to defibrillation in cardiac arrest. Additional data is needed to confirm safety of the AEDC technology in other hospital settings and to assess its impact on short- and long-term outcomes in patients with in-hospital cardiac arrest.

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### Systemic Nitrite (NO<sub>2</sub>-) Levels are Depleted in a Mouse Model of Asystolic Cardiac Arrest and Therapeutic Repletion Improves Survival and Functional Neurological Recovery

Cameron Dezfulian, Aleksey Alekseyenko, National Institutes of Health, Bethesda, MD; Kenneth R Jeffries, Mark T Gladwin; National Heart, Lung and Blood Institute, Bethesda, MD

Nitrite (NO<sub>2</sub>) represents a circulating reservoir of nitric oxide (NO) that is reduced to NO during ischemia. In pre-clinical studies, NO<sub>2</sub> therapy was cytoprotective following focal heart, brain and liver ischemia-reperfusion. We hypothesized that systemic NO<sub>2</sub> is depleted during global

ischemia (cardiac arrest) and its early reperfusion could protect the heart and brain from reperfusion injury. C57BL/6 mice were rendered asystolic using a KCl bolus. After 12 min of warm ischemia (36.5°C), paired mice were randomized to IV nitrite (blinded) or saline placebo given just prior to epinephrine, mechanical ventilation and chest compressions. All mice received identical pre- and post-CPR care until euthanasia and had similar physiologic parameters. NO<sub>2</sub>-treated mice had improved survival 22 hours post-CPR compared to saline-treated controls (HR 2.75 [95% CI: 1.1–6.8]; Table 1). Deaths occurred 1–6 h post-CPR and were associated with worsened cardiac ejection fraction 1.5h post-CPR. Neurologic function and thermoregulation were significantly improved in NO<sub>2</sub>-treated 22h survivors vs. paired controls. Cardiac arrest depleted whole blood and plasma NO<sub>2</sub> (Table 2). NO<sub>2</sub> therapy restored levels near pre-arrest baseline with associated improvements in post-CPR oxygenation, ventilation and pH, without altering metabolic acidosis. Intravenous NO<sub>2</sub> as adjunctive therapy to epinephrine early in CPR shows promise in improving cardiac and neurologic outcomes in a mouse model of cardiac arrest. The ease of NO<sub>2</sub> delivery (vs. hypothermia), its approved and known safety profile in humans and its efficacy against reperfusion injury after prolonged asystole make NO<sub>2</sub> an excellent drug candidate.

#### Survival, Cardiac and Neurologic Function After Resuscitation from Cardiac Arrest

Group	22 Hour Survival	1.5 Hour Ejection Fraction (%)	22 Hour Neuro Score (Scale: 1–12)	22h Temperature (Degrees Celcius)
Pre-arrest (sham)		68.9 ± 5.6		
Post-arrest NO <sub>2</sub> -treated	19/25 (76%)	54.7 ± 3.2	11.0 (10.0 - 12.0)	34.8 ± 0.385
Post-arrest NS-treated	12/25 (48%)	48.8 ± 1.9	9.0 (9.0 - 11.0)	31.2 ± 0.825
p-value (NO <sub>2</sub> vs. NS)	0.033	0.038	0.016	<0.001
N (per group unless specified; all mice paired except temperature)	25	4	11	8 (NO <sub>2</sub> ) 6 (NS)

#### Arterial Nitrite Levels and Blood Gases 5 minutes After Resuscitation from Cardiac Arrest

Group	Whole blood NO <sub>2</sub> (mM)	Plasma NO <sub>2</sub> (mM)	pH	paCO <sub>2</sub> (mm Hg)	paO <sub>2</sub> (mm Hg)	Lactate (mEq/L)	HCO <sub>3</sub> (mEq/L)
Pre-arrest (sham)	1.15 ± 0.21	0.72 ± 0.12	7.35 ± 0.07	38.5 ± 6.5	253.7 ± 43.0	0.9 ± 0.2	20.9 ± 2.0
Post-arrest NO <sub>2</sub> -treated	1.01 ± 0.06	0.60 ± 0.07	6.73 ± 0.11	66.2 ± 36.2	210.7 ± 57.4	15.6 ± 2.7	8.4 ± 2.1
Post-arrest NS-treated	0.64 ± 0.05	0.26 ± 0.05	6.61 ± 0.08	108.3 ± 35.8	128.2 ± 53.3	16.5 ± 1.2	9.9 ± 2.1
p-value (NO <sub>2</sub> vs. NS)	<0.001	0.002	<0.001	0.013	0.004	0.346	0.324
N (per group unless specified)	5 (NO <sub>2</sub> ) 7 (NS)	5 (NO <sub>2</sub> ) 7 (NS)	5	5	5	5	5

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### The Systemic Inflammatory Response Syndrome Following Cardiac Surgery

Niall S MacCallum, Sarah E Gordon, Gregory J Quinlan, Timothy W Evans, Simon J Finney; NHLI, Imperial College, London, United Kingdom

The systemic inflammatory response syndrome (SIRS) is the leading cause of morbidity & mortality in the critically ill. It is associated with a 50% reduction in 5 year life expectancy. SIRS is defined as 2 of the following criteria: heart rate >90, respiratory rate >20 or pCO<sub>2</sub><4.3kPa, temperature <36 or >38°C, white cell count <4 or >12 x10<sup>9</sup>/l. These criteria are used to stratify patients for specific therapies & in research to define interventional groups. Cardiac surgery is associated with systemic inflammation. The validity of the SIRS criteria have never been formally evaluated post cardiac surgery. We undertook to describe the incidence of SIRS post cardiac surgery & relate this to outcome. **Methods:** We retrospectively analysed prospectively collected data from 2764 consecutive admissions following cardiac surgery (coronary bypass grafting 1425, valve surgery 763, combined procedure 252, other 324). The number of criteria met simultaneously within 1 hour epochs was recorded for the entire admissions. **Results:** 96.4%, 57.9% & 12.2% of patients met at least 2, 3 or 4 criteria respectively within 24hrs of admission. The temperature criterion was least often fulfilled. ICU mortality was 2.67%. Length of stay exceeded 3 days in 18.5% of patients. The capacity of the criteria to predict mortality & prolonged ICU stay is presented in the table. **Discussion:** Nearly all patients fulfilled the standard 2 criteria definition of SIRS within 24hrs of admission. This definition does not adequately define the subgroup of patients with greater systemic inflammation, mortality or length of stay. Thus, some clinical manifestations of inflammation are very common following cardiac surgery, although not necessarily prognostic. By contrast, the presence of 3 or more criteria was more discriminatory of death & prolonged ICU stay. We propose that 3 or more SIRS criteria is a more appropriate threshold that defines those patients with clinically significant inflammation post cardiac surgery.

Criteria met	Mortality			Length of stay >3 days		
	2	3	4	2	3	4
Sensitivity	100.0	91.9	47.3	98.2	71.6	22.9
Specificity	3.6	43.0	88.8	4.1	45.2	90.3
Positive predictive value	2.6	4.2	10.4	18.9	22.9	34.8
Negative predictive value	100.0	99.5	98.4	90.9	87.5	83.8

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### Quality Of Cardiopulmonary Resuscitation Before And During Transport In Out-of-hospital Cardiac Arrest.

Theresa M Olasveengen, Lars Wik, Ullevål Univ Hosp, Oslo, Norway; Petter Andreas Steen; Univ of Oslo, Oslo, Norway

**Aim of the study:** To evaluate quality of cardiopulmonary resuscitation (CPR) performed during transport after out-of-hospital cardiac arrest. **Materials and methods:** Retrospective, observational study of all non-traumatic cardiac arrest patients older than 18 years who received CPR both before and during transport between May 2003 and December 2006 from the community run EMS system in Oslo. Chest compressions and ventilations were detected from

impedance changes in routinely collected ECG signals, and hands-off ratio calculated as time without chest compressions divided by total CPR time. **Results:** Seventy-five of 787 consecutive out-of-hospital cardiac arrest patients met the inclusion criteria. Quality data were available from 36 of 66 patients receiving manual CPR and seven of nine receiving mechanical CPR. CPR was performed for mean 21 ± 11 min before and 12 ± 8 min during transport. Quality of manual CPR deteriorated during transport compared to on-scene CPR with hands-off intervals increasing from 0.19 ± 0.09 to 0.27 ± 0.15 (p=0.002) and compressions per minute decreasing from 94 ± 14 min<sup>-1</sup> to 82 ± 19 min<sup>-1</sup> (p=0.001). Compression and ventilation rates were unchanged. Quality was significantly better with mechanical than manual CPR. Four patients (5%) survived to hospital discharge; two with manual CPR (Cerebral performance categories (CPC) 1 and 2), and two with mechanical CPR (CPC scores 3 and 4). No discharged patients had any spontaneous circulation during transport. **Conclusions:** Quality of CPR deteriorated during transport of out-of-hospital cardiac arrest patients. Every effort should therefore be made to stabilise patients on-scene before transporting the patient to hospital, but all transport with ongoing CPR is not futile.

#### Quality of CPR with manual chest compressions (n=36).

	Entire episode	Before transport	During transport	P-value
CPR time (min)	33 ± 13	21 ± 11	12 ± 8	0.001
Hands off ratio	0.22 ± 0.09	0.19 ± 0.09	0.27 ± 0.15	0.002
Compression rate	118 ± 9	118 ± 11	119 ± 11	0.697
Compressions min <sup>-1</sup>	89 ± 13	94 ± 14	82 ± 19	0.001
Ventilation rate	13 ± 4	13 ± 4	14 ± 3	0.267

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### Effect of Thrombolytics on the Immediate Prognosis for Out-of-Hospital Cardiac Arrest

Aurelien Renard, Daniel Jost, Paris Fire Brigade, Paris, France; Catherine Verret, Val-de-Grâce, Paris, France; Frederique Briche, David Fontaine, Paris Fire Brigade, Paris, France; Isabelle L Banville, Physio-Control, Redmond, WA; Anne-Celine Martin, Ecole du Val-de-Grâce, Paris, France; Patrick Benner, Paris Fire Brigade, Paris, France; Andre Spiegel, Val-de-Grâce, Paris, France; Claude Fulla; Paris Fire Brigade, Paris, France

Immediate care of out-of-hospital cardiac arrest (CA) is standardized by the established ILCOR ACLS Guidelines. Studies concerning the impact of thrombolysis, generally for CA of cardiac etiology have not shown a benefit. We sought to evaluate the rate of hospital admission for all CA patients treated with pre-hospital thrombolytics. **Methods:** Non-randomized retrospective study was conducted from 09/1/2005 to 02/15/2007 of non-traumatic CA patients treated with (T+) or without (T-) thrombolysis. The protocol for administration of thrombolytics was at the discretion of the field physician, aiming for within 20 minutes of collapse in almost all cases, and prior to return of spontaneous circulation. The primary endpoint was admission alive to the hospital. We performed multivariate analysis by logistic regression to identify risk factors independently associated with outcome: age, gender, response time, defibrillation, witnessed arrest, bystander CPR. **Results:** We reviewed 1331 consecutive patient records, of which 116 (8.7%) received thrombolytics. Both T+ and T- groups had comparable response times, witnessed arrest, and bystander CPR. Patients in T+ were significantly younger (59 ± 14 vs 67 ± 19 years old), predominantly males (81% vs 61%), and received more defibrillation shocks (61% vs 26%). Significantly more patients T+ arrived alive to hospital for admission (45% vs 24%). Risk factors independently associated with hospital admissions were thrombolysis, age, response time, witnessed arrest, and bystander CPR. The impact of thrombolysis was different whether or not the patient was defibrillated (odds ratio with shocks 1.1 [95%CI: 0.2–5.0] vs without shocks 3.6 [95%CI: 1.9–6.9]), despite a greater overall rate of hospital admission for shocked patients. **Conclusion:** Thrombolysis appears to improve the rate of admission alive to the hospital in patients that were not defibrillated with adjustment for age, gender, response time, witnessed arrest, and bystander CPR. These preliminary results should be confirmed by a prospective randomized study. This analysis can help determine appropriate inclusion criteria for a future study.

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### Predictor of Neurologic Outcome in Mild Hypothermia After Cardiac Arrest. : Age<70 and Ventricular fibrillation in initial rhythm were the positive predictive value and shock was the negative predictive value of neurologic outcome.

Shinichi Shirai, Kenji Ando, Yoshimitsu Soga, Katsuhiko Kondo, Koyu Sakai, Hiroyoshi Yokoi, Masashi Iwabuchi, Masahiko Goya, Hitoshi Yasumoto, Hideyuki Nosaka, Masakiyo Nobuyoshi; Koura Memorial Hosp, Kitakyushu, Japan

**Background)** To evaluate the efficacy of mild hypothermia therapy (MT) and investigate the predictor of neurologic outcome. **Methods)** Inclusion criteria of this study were as follows. 1) Documented cardio-pulmonary arrest (CPA) 2) Successful return of spontaneous circulation (ROSC) after appropriate BLS and ACLS 3) Without hemorrhagic disorder 4) Persistent come after ROSC 5) Good ADL before cardiac arrest, age under 80 yrs. 6) All cases were referred to catheter laboratory, emergency coronary angiography was performed immediately after ROSC. 7) In the case acute coronary syndrome, percutaneous coronary intervention was subsequently performed if needed. 8) Intra-aortic balloon pumping (IABP) with or without Percutaneous Cardio-Pulmonary Bypass System (PCPS) was performed in patients (pts) with shock in spite of conservative therapy Mild hypothermia(MH) was performed with cooling temperature of 34°C for 1~2 days. **Results)** In the historical control group, from May 1998 to May 2001, 53 pts in CPA and ROSC were met the above criteria and treated with normothermia therapy (NT). The mean time until ROSC 33 ± 18 min. Survival at hospital discharge was 22 pts (42%), and favorable neurologic outcome (GR: Good recovery and MD: Moderate disability) was achieved

7pts (13.2%). From June 2001 to April 2007, eligible 65 pts were cooled after ROSC. The mean time of CA-CPR was  $5 \pm 4$  min ( $p=NS$ ), and mean time until ROSC  $34 \pm 23$  min ( $p=0.8031$ , compared to NT group). Of those 65 pts, favorable neurologic outcome patients after MT were seen in 33pts (50.8%,  $p<0.0001$ ). In the multivariate analysis, the significant predictors of favorable outcome after MH were Age $<70$  (Relative Risk (RR) 7.95) and Ventricular fibrillation (Vf) in the initial rhythm (RR 5.59), on the other hand, hemodynamic compromise state (RR 0.14) after ROSC was the negative predictive value. **Conclusion** Compared with NT, MH was considered to be effective for the patients with CPA-survivor patients. Age $<70$  and Vf were the positive, and shock was the negative predictive value of neurologic outcome.

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### Pathological Findings Of Ventricular Fibrillation In Pts Without Coronary Heart Disease

Rinya Kato, Takahiro Okumura, Yoshimi Kitagawa, Tatsunari Satake; Nagoya Ekisaikai Hosp, Nagoya, Japan

To clarify histological characteristics in pts (pts) with out-of-hospital cardiac arrest, autopsies were immediately performed in 224 pts. We studied the cause of their sudden death investigating the incidence and the role of following pathological findings in 125 pts with sudden cardiac death (SCD). There were 95 men and 30 women aged from 16 to 93 years old (mean age:  $60.3 \pm 14.8$  years old). Evaluated pathological findings were 1) myofiber break-up (MFB), 2) contraction band necrosis (CBN), 3) contraction band (CB), 4) hyper eosinophilic myofiber (HEM). MFB and CBN are known to indicated hypercontracted myofibers due to ventricular fibrillation (VF) associated with acute myocardial infarction (AMI). The latter two findings were not considered to indicate severe myocardial damage as defined by MFB and CBN. Postmortem autopsies revealed AMI in 24 pts, old myocardial infarction (OMI) in 24 pts but coronary heart disease (CHD) was not observed in 77 pts including 2 pts with hypertrophic cardiomyopathy. Cardiac rupture was observed in 16 out of 24 pts with AMI. MFB was not observed in pts with AMI but it was observed in 2 pts with OMI and 28 pts without CHD. CBN was observed in 4 pts with AMI, 13 pts without CHD but not in pts with OMI. CB and HEM were observed diffusely in both ventricles except subendocardium in all 77 pts without CHD and 24 pts with OMI but in only 7 pts with AMI in whom cardiac rupture was not observed. Ischemic event to induce VF could not be confirmed in pts without CHD and in pts with OMI in this study. Therefore, CB and HEM were considered to be the pathological evidence of VF not related to CHD. **Conclusions:** Cardiac rupture was the major reason of sudden death in pts with AMI rather than VF. In pts without CHD, the mechanism of SCD was considered to be VF. Nonischemic SCD was more frequently than SCD related to AMI in Japan.

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### A Prospective and Randomized Trial to Compare a Left Ventricular Assist Device (Impella LP2.5) With IABP in Patients With Cardiogenic Shock by Acute Myocardial Infarction: The ISAR-SHOCK Trial

Melchior Seyfarth, Iris Bauer, Dirk Sibbing, Lorenz Bott-Flügel, Adnan Kastrati, Albert Schömig; Technische Universität München, München, Germany

Cardiogenic shock due to left ventricular failure after myocardial infarction is associated with a high mortality and morbidity rate despite immediate PCI, positive inotropic drugs, and the use of intraaortic balloon counterpulsation (IABP). The ISAR-SHOCK trial was a randomized trial comparing the left ventricular assist device (LVAD) Impella LP2.5 with the standard care using a IABP. Impella LP2.5 (Abiomed-Europe) is a catheter-based miniaturized rotary blood pump with a maximal flow of 2.5 L/min from the left ventricle to the ascending aorta. Hemodynamic data were presented as Late-Breaking Clinical Trial at the ACC meeting 2007. In brief, 26 patients were randomized in this prospective, parallel assigned, and bicentric trial. Patients were included if clinical and hemodynamic criteria of cardiogenic shock were met within 48 hours after AMI. Primary end point was the hemodynamic improvement 20 minutes after implantation of either device. Secondary end points were additional hemodynamic changes as well as metabolic changes (BNP, Lactate) during hospital stay, mortality after 30 days, major bleeding, extent of hemolysis (fHb), and cerebrovascular events. There was no technical failure with both devices. At baseline patients did not differ in both groups. After 20 minutes of support cardiac index was significantly increased in patients with Impella P2.5 ( $2.20 \pm 0.64$  vs.  $1.71 \pm 0.45$  L/min/m<sup>2</sup> at baseline), compared to patients with IABP ( $1.84 \pm 0.71$  vs.  $1.73 \pm 0.59$  L/min/m<sup>2</sup> at baseline). Furthermore, mean arterial pressure and enddiastolic pressure were different in both groups. During the first 24 hours lactate levels were lower in patients with Impella LP2.5 compared to IABP. Whether these demonstrated hemodynamic improvements result in better clinical outcomes (mortality and morbidity) is unclear. Hemodynamic, infarct size, left ventricular function, and clinical data will be collected at 6–9 months follow-up and presented at the meeting.

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### Heart Rate and Systolic Arterial Pressure Variability during Controlled Hemorrhagic Shock in Rats

Masaru Suzuki, Shingo Hori, Naoki Aikawa; Keio Univ, Tokyo, Japan

**OBJECTIVES:** The autonomic response to hemorrhagic shock is complex and has been under-investigated. Spectral analyses of RR interval (RRI) and systolic arterial pressure (SAP) have been proposed as an indirect index of autonomic modulation. The objective of this study was to investigate the relationship among hemodynamic variables and autonomic nervous activity presented by the spectral analyses of RRI and SAP during controlled hemorrhagic shock in rats. **METHODS:** Twelve Wistar male rats weighing  $215 \pm 9$  g were anesthetized with sodium

pentobarbiturate (1.5 mg/kg i.p.). RRI and SAP were recorded continuously and analyzed by wavelet transform using PC soft ware (Fluclet™, Dainippon-Sumitomo Pharma Co., Ltd., Osaka, Japan). Their power spectra were quantified into low-frequency (LF: 0.27–0.74 Hz) and high-frequency (HF: 0.74–2.00 Hz) components. Baroreceptor sensitivity (BRS) was defined as RRI-LF/SAP-LF. The left carotid artery was cannulated to draw blood (0.1 ml/min) continuously to induce hemorrhagic shock. Spontaneous respiration was kept during this study. Cerebral blood flow (CBF) was measured by Laser flow meter (Advance Co., Ltd., Tokyo, Japan). Statistical analyses were performed by a factor analysis using SPSS15.0J. **RESULTS:** During controlled hemorrhagic shock, SAP gradually decreased (0 min:  $104 \pm 18$  mmHg, 20 min:  $69 \pm 9$ , 40 min:  $60 \pm 16$ , 60 min:  $47 \pm 7$ ). Factor analysis extracted three major factors: vagal activity, volume status, and sympathetic activity. In the factor extracted as vagal activity, variables which had greater than 0.3 of partial correlation coefficient, were RR-HF (0.98), RR-LF (0.97), and BRS (0.96). Volume status was indicated by SAP (0.92), shed volume (-0.90), CBF (0.62), and SAP-HF (0.61). Sympathetic activity was indicated by SAP-LF (0.89), respiratory rate (0.85), and CBF (0.32). **CONCLUSIONS:** Factor analysis extracted autonomic activity and volume status. During hemorrhagic shock, sympathetic activity including arterial sympathetic activity indicated as SAP-LF, which was correlated with respiratory rate, could contribute to maintain CBF, although vagal activity did not affect hemodynamic variables. SAP-HF, represented as respiration related fluctuation of SAP, was indicative of volume status.

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### Incomplete Chest Recoil During Piglet CPR Worsens Hemodynamics

Mathias Zuercher, Ronald W Hilwig, Sarver Heart Cntr, Tucson, AZ; Jon Nysaether, Laerdal Med Corp, Stavanger, Norway; Vinay M Nadkarni, Children's Hosp, Philadelphia, PA; Marc D Berg, Univ of Arizona College of Medicine, Tucson, AZ; Gordon A Hopy, Karl B Kern, Sarver Heart Cntr, Tucson, AZ; Robert A Berg; Univ of Arizona College of Medicine, Tucson, AZ

**Background:** Incomplete chest recoil during cardiopulmonary resuscitation (CPR) (ie, leaning on the chest during the decompression phase) is purported to decrease venous return, and thereby decrease forward blood flow. **Aim** To determine the effect of 10% and 20% lean on hemodynamics during piglet CPR. **Methods:** 10 piglets ( $10.7 \pm 1.2$  kg) were anesthetized with isoflurane and instrumented with micromanometer-tipped catheters in the right atrium (RA) and aorta (Ao). After induction of ventricular fibrillation, CPR was provided in three-minute epochs with no lean, 10% lean, or 20% lean while aortic systolic pressure (AoS) was targeted at 80–90 mmHg. Because the mean force to attain 80–90 mm Hg AoS was 18 kg in preliminary studies, 10% and 20% lean were provided as 1.8 and 3.6 kg weights on the chest, respectively. Left ventricular myocardial blood flow (MBF) and cardiac index (CI) were determined by fluorescent, color-microsphere technique. Statistics: paired *t*-test and repeated measurement ANOVA for parametric, Wilcoxon Rank Sum Test and Friedman's ANOVA for non-parametric data. **Results:** 10% and 20% lean resulted in higher right atrial diastolic pressure (RAD) and lower coronary perfusion pressure (CPP) than no lean. Hemodynamics were not different with 10% lean vs. 20% lean. Mean 10%–20% lean resulted in substantially lower MBF and CI than no lean (Table). **Conclusions:** 10–20% leaning during CPR increases RAD, decreases CPP, and substantially decreases MBF and CI.

Table

Lean	AoS (mmHg)	RAD (mmHg)	CPP (mmHg)	MBF (ml/min/g)	CI (l/min/m <sup>2</sup> )
No	$87 \pm 4$	$9 \pm 1.9^{\wedge}$	$22 \pm 5.4^{\wedge}$	$0.40 \pm 0.34^{\wedge}$	$1.8 \pm 0.77^{\wedge}$
10%	$86 \pm 4$	$11 \pm 1.7^*$	$19 \pm 6.6^{\#}$	$0.24 \pm 0.22$	$1.2 \pm 0.59$
20%	$87 \pm 5$	$13 \pm 2.7^*$	$17 \pm 6.4^{\#}$	$0.19 \pm 0.12$	$1.0 \pm 0.31$

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### Comparison between Mechanical Active Chest Compression/Decompression and Standard Mechanical Chest Compression

Giuseppe Ristagno, Weil Institute of Critical Care Medicine, Rancho Mirage, CA; Wanchun Tang, Hao Wang, Shijie Sun, Max H Weil; Weil Institute of Critical, Rancho Mirage, CA

**Introduction.** After cardiac arrest, uninterrupted chest compressions with restoration of myocardial blood flow facilitate defibrillation. Accordingly, decreases in intrathoracic pressure (ITP), following complete chest recoil, increase the venous return to the heart prior to the next compression. Several new devices have recently been introduced to facilitate chest compressions and some of them are able to perform active chest decompression. We compared the hemodynamic effectiveness of "LUCAS<sup>®</sup>" (Jolife, Medtronic, Sweden) with that of the conventional "Thumper<sup>®</sup>" (Model 1000, Michigan Instruments, Grand Rapids, MI) **Hypothesis.** LUCAS<sup>®</sup> able to produce active chest compression/decompression, might be more effective than the standard "Thumper<sup>®</sup>" for restoring circulation during CPR. **Methods.** In 10 domestic pigs weighing  $39 \pm 2$  kg, ventricular fibrillation (VF) was electrically induced and untreated for 5 min. Animals were then randomized to receive chest compressions with either LUCAS<sup>®</sup> or Thumper<sup>®</sup>. After 5 min of mechanical chest compressions, defibrillation was attempted with a 150 J biphasic shock. Coronary perfusion pressure (CPP) and end tidal CO<sub>2</sub> (ETCO<sub>2</sub>) were measured by conventional techniques. Carotid artery blood flow (CBF) was assessed utilizing an ultrasonic flowprobe, together with ITP, measured with the aid of a balloon tipped catheter advanced into the esophagus. **Results.** Each animal treated with LUCAS<sup>®</sup> and 4 of 5 animals treated with Thumper<sup>®</sup> were successfully resuscitated. LUCAS<sup>®</sup> continuously produced negative ITP during the decompression phase ( $p < 0.05$  vs Thumper<sup>®</sup>) and this was accompanied by greater CPP, ETCO<sub>2</sub> and CBF compared to animals treated with Thumper<sup>®</sup>. Animals compressed with LUCAS<sup>®</sup> also had lesser broken ribs ( $p < 0.05$ ). **Table Conclusions.**

The mechanical chest compressor LUCAS® is able to produce greater negative ITP during the active decompression phase and therefore produces greater forward blood flow during CPR.

#### Results

	LUCAS®	Thumper®
No. of broken ribs	0.8 ± 0.8	4.4 ± 2.6 *
ITP (mmHg)		
PC 1 min PC 2min PC 4 min	-9 ± 9 -9.4 ± 9 -9.5 ± 9	1.7 ± 3.4 * 2.7 ± 4.4 * 3.3 ± 5.3 *
CPP (mmHg)		
PC 1 min PC 2min PC 4 min	27.9 ± 9 28.5 ± 7 31 ± 19	13.8 ± 3 * 19.3 ± 6 * 19.0 ± 9
EtCO <sub>2</sub> (mmHg)		
PC 1 min PC 2min PC 4 min	35 ± 5 31.4 ± 6 28.6 ± 8	20.5 ± 2 ** 23.0 ± 3 * 22.5 ± 5
CBF (mL/min)		
PC 1 min PC 2min PC 4 min	93.2 ± 20 88 ± 16 84.3 ± 23	72.5 ± 15 61.0 ± 13 * 70.0 ± 20

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### Mechanical Chest Compressions With The LUCAS Device Does Not Increase The Incidence Of Injuries In Cardiac Arrest Victims

Sten Rubertsson, David Smekal, Tibor Huzevka, Jakob Johansson; Uppsala Univ Hosp, Uppsala, Sweden

**Introduction:** The eventual harm done by mechanical chest compressions using the LUCAS device during cardiopulmonary resuscitation (CPR) is under debate. However, a prospective study comparing injuries after mechanical or manual chest compressions has not been performed. **Hypothesis:** We hypothesized that there is no difference in the incidence of injuries after manual versus mechanical chest compressions using the LUCAS device. **Methods:** In a prospective study, from February 1, 2005, to April 1, 2007, patient's not surviving cardiac arrest in two Swedish cities underwent autopsy based upon decision by the admitting physician. The pathologist recorded data from the autopsy in a standardized study protocol regarding external and internal injuries. During CPR, the patients had been treated with either manual or mechanical chest compressions with the LUCAS device. **Results:** Eighty-five patients underwent autopsy out of which 47 patients had received manual chest compressions and 38 patients mechanical chest compressions. No injuries (skin wounds and skin marks not included) were found in 23/47 patients in the manual group versus 18/38 patients in the LUCAS group ( $p = 1.0$ ). Sternum fracture and multiple costal fractures ( $\geq 3$  fractures) were present in 10/47 versus 11/38 ( $p=0.46$ ) and in 13/47 versus 16/38 ( $p=0.18$ ) in the manual and LUCAS group respectively. Bleeding in the ventral mediastinum, 2/47 versus 3/38 ( $p=0.65$ ), retrosternal bleeding, 1/47 versus 3/38 ( $p=0.32$ ), epicardial, 1/47 versus 4/38 ( $p=0.17$ ) and hemopericardial bleeding, 4/47 versus 3/38 ( $p=1.0$ ) was found in the manual and LUCAS group respectively. There was one ruptured abdominal aortic aneurysm in the LUCAS group and one thoracic aortic dissection in each group, all considered by the pathologist as primary cause of the cardiac arrest and not secondary injuries from either treatment. One patient in the LUCAS group had a 4 cm rift in the liver with no bleeding and one patient in the manual group had a rift in the spleen with bleeding. Neither of these injuries was considered to be the cause of death. **Conclusion:** Mechanical chest compressions with the LUCAS device seem to have the same pattern of injuries as manual compressions and do not increase the incidence of injuries after CPR.

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### Impact of Delayed Time to Defibrillation on Neurological and Functional Status Among Survivors of In-Hospital Cardiac Arrest

Paul S Chan, Univ of Michigan, Ann Arbor, MI; Harlan M Krumholz, Yale Univ Sch of Medicine, New Haven, CT; Graham Nichol, Univ of Washington-Harborview, Seattle, WA; Brahmajee K Nallamothu; Univ of Michigan, Ann Arbor, MI

**Background:** Expert guidelines advocate defibrillation within 2 minutes of an in-hospital cardiac arrest due to ventricular arrhythmias. However, the impact of delayed defibrillation on neurological and functional status at discharge among survivors is unknown. **Methods:** We identified 6,744 patients with cardiac arrests due to ventricular fibrillation or pulseless ventricular tachycardia at 369 hospitals within the National Registry of Cardiopulmonary Resuscitation. Using multivariable logistic regression that adjusted for demographics, clinical variables, hospital site, hospital-level variables (hospital size, monitored bed or intensive care status), and admitting diagnoses, we examined the association between delayed defibrillation ( $>2$  minutes) and neurological and functional status at discharge using the previously developed Cerebral and Overall Performance Categories. Performance categories were dichotomized as no major disability vs. major disability and/or vegetative state. **Results:** The median time to defibrillation was 1 minute (interquartile range:  $<1$  to 3 minutes), with delayed defibrillation found in 2,000 (29.7%) patients. Overall, 2,311 (34.3%) patients survived to hospital discharge [ $n=1,863$  (39.3%) for prompt defibrillation;  $n=448$  ( $n=22.4\%$ ) for delayed defibrillation]. Among those surviving to discharge, delayed defibrillation was associated with a lower likelihood of no major disability in neurological status (adjusted OR of 0.73; 95% CI: 0.57 to 0.94;  $p=0.01$ ) and functional status (adjusted OR of 0.73; 95% CI: 0.55 to 0.96;  $p=0.02$ ). **Conclusion:** Delayed defibrillation is associated with worse neurological and functional status among survivors of in-hospital cardiac arrests. Minimizing time to defibrillation represents a major opportunity to improve neurological and functional status in these high-risk patients.

### Efficacy and Safety of a Novel Rapid Non-invasive Surface Cooling Device for Induction of Therapeutic Hypothermia in Patients after Cardiac Arrest

Michael Holzer, Andreas Janata, Moritz Haugk, Danica Krizanac, Fritz Sterz; Med Univ of Vienna, Vienna, Austria

**Background:** Therapeutic hypothermia after cardiac arrest improves neurologic recovery and mortality. Rapid induction of therapeutic hypothermia might further improve neurologic outcome after cardiac arrest. The safety and effectiveness of the ThermoSuit® System was assessed in survivors of cardiac arrest. **Methods:** Eight patients who have been successfully resuscitated from cardiac arrest were included in a prospective observational case series at an emergency department of a tertiary care university hospital. Patients were surface cooled with ice cold water circulating in the device (Thermosuit® System, Life Recovery Systems, Kinnelon, USA) until a target esophageal temperature of 34.5°C was achieved. Further they were kept at a temperature between 32 and 34 °C for 12 hours by external surface cooling or warming and were then passively rewarmed. Results are presented with median and interquartile range. **Results:** The age of the patients was 63 (48–69), there were 7 male patients, the body mass index was 26.1 (24.7–27.7) kg/m<sup>2</sup>, the time from cardiac arrest to ROSC was 18.5 (15.5–34.5) min. The esophageal temperature immediately before start of cooling was 36.2 (35.1–36.9). The patients were cooled with the device for 37 (24–51) min and a temperature of 34°C was reached after 44 (30–60) min. This led to a cooling rate of 3.0 (1.9–3.5) °C/h. In 4 patients additional warming and in 3 patients additional cooling was needed during the maintenance phase. Seven patients (88%) were successfully discharged from the hospital. The NIH stroke scale at discharge was 0 (0–4.3) and the Mini Mental score was 29.5 (23–30). A total of 5 serious adverse events (ventricular fibrillation, pneumonia, sepsis) and 7 adverse events occurred in the 8 patients. No adverse event was related to the cooling device. **Conclusions:** The ThermoSuit® System was safe and highly effective in inducing therapeutic hypothermia in patients after cardiac arrest. The vast majority of the survivors had excellent neurologic performance scores at hospital discharge.

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### Integrin alpha-5 beta-1 and Fibronectin Receptor-Ligand Pair Determines Reparative and Neovascularization Potential of Endothelial Progenitor Cells

Kishore K Wary, Choun Mock, Sean Garean, Yidan D Zhao, Asrar B Malik; Univ Illinois Chicago, Chicago, IL

Endothelial Progenitor Cell (EPC)-based therapy may be useful for the treatment of microvascular disorders associated with ischemic diseases and for therapeutic neovascularization. Here, we addressed whether mouse bone marrow derived EPCs (mEPCs) express integrins, synthesize and deposit fibronectin, requirements for EPC engraftment in injured microvessels. We used anti-CD34, anti-Fli-1, and anti-VE-cadherin antibodies as mEPC markers. Ex vivo expanded mEPCs were analyzed by fluorescent microscopy and Western blotting for expression of integrins, fibronectin, and von Willebrand Factor (ligands for integrins alpha-5 beta-1 and alpha-v beta-3). Fibronectin and vWF expression of mEPCs was compared with adult mouse lung endothelial cells (mECs). Fluorescent microscopy showed markedly increased fibronectin and vWF staining and Western blotting showed  $>20$ -fold increase in fibronectin and vWF expression in mEPCs compared with mECs. The appearance of polymerized fibronectin matrix suggested that mEPCs synthesized, deposited, and assembled fibronectin. Next, ex vivo expanded mEPCs were subjected to shRNA-mediated silencing of alpha-5 integrin, fibronectin and vWF genes. Silencing of alpha-5 integrin and fibronectin genes reduced the proliferative potential of mEPCs whereas vWF silencing had no effect. To evaluate the effectiveness of mEPCs treatment, we irradiated C57BL/6J mice (5.0 Gy) and challenged the mice i.p. with bacterial lipopolysaccharide (LPS) to induce endothelial barrier injury and pulmonary edema. Infusion of mEPCs induced greater survival ( $\sim 50\%$  at 7.5 mg of LPS/kg BW,  $n=6$ ) and prevented pulmonary edema resulting from microvessel injury; in contrast, mECs infusion had no protective effect. Thus, EPC expression of alpha-5 beta-1 integrin and secretion of fibronectin matrix may be crucial determinants of engraftment of EPCs at sites of vascular injury, and their ability to promote repair of injured microvessels and neovascularization.

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### Professional Rescuers provide two Bag-Valve-Mask Ventilations within the Time recommended by Guidelines during Out-Of-Hospital Cardiac Arrest

Silje Ødegaard, Theresa M Olasveengen, Jo Kramer-Johansen; Ullevål Univ Hosp, Oslo, Norway

**Aims:** The quality of CPR performed by professional rescuers during out-of-hospital cardiac arrest has been found substandard in several studies. In particular, the time without chest compressions (no flow time) has been too long and it has been higher before the time of intubation. In manikin-studies lay rescuers need approximately 15 seconds to deliver two ventilations. It is not known how long time professional rescuers use for two ventilations and we hypothesized that time used for two ventilations with a bag-valve-mask device before endotracheal intubation is longer than recommended, and that the extended time contributes to the high no flow time. **Methods:** Quality of CPR was available for analysis in 628 cases of out-of-hospital cardiac arrest in the ambulance service in Oslo, Akershus, London, and Stockholm from 2002–2005. The 2000 Guidelines was used as reference. Ventilations were registered via changes in transthoracic impedance as measured via the standard defibrillation pads. We only included episodes with CPR with a 15:2 pattern for at least one minute and registered all pauses between chest compressions before intubation. **Results:** In 172 (27%) episodes we identified 3097 chest compression pauses. In 1587 (51%) of the pauses we



identified two ventilations and a mean pause length for each episode was calculated. The median of these means was 5.5 s (IQR; 4.5, 7). These pauses comprised only a median 14% (IQR 6%, 30%) of the no flow time before intubation in these episodes. In 892 (29%) of the pauses we identified a different number of ventilations, or other interventions in addition to ventilation. In the remaining 618 pauses (20 %) no ventilations were registered. **Conclusions:** It is achievable to deliver two bag-valve-mask ventilations close to the recommended 5 seconds during out-of-hospital cardiac arrest for professional rescuers. However, only half of the pauses were used for two ventilations in accordance with Guidelines. Excessive time for ventilation can not explain the high no flow time during CPR by professional rescuers before intubation.

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### The Impact Of Bodyweight On Early And Late Mortality And ICD Shocks In Ventricular Fibrillation Out-of-hospital Cardiac Arrest Survivors

T. J Bunch, Roger D White, Francisco Lopez-Jimenez, Randal J Thomas; Mayo Clinic, Rochester, MN

**Background:** Studies have shown an association between obesity and total mortality in patients with and without coronary artery disease. Less is known regarding the impact of obesity after cardiac arrest. Obese survivors of ventricular fibrillation (VF) out-of-hospital cardiac arrest (OHCA) may have worse outcomes than nonobese patients due to resuscitation challenges, long-term risks of cardiovascular disease, and other comorbidities. **Methods:** All patients who presented with a VF OHCA in Rochester Minnesota from November 1990-September 2006 were included. Patients were classified by weight (BMI <25, 25-30, >30). ICD shocks for VF/VT were determined by review of subsequent device interrogations. **Results:** 226 patients (age 63.7±13.5) were treated for VF OHCA with an average call-to-shock time of 6.3±1.8 minutes. 99 patients (44%) survived to hospital discharge with neurologic recovery. Data to calculate BMI were available in 213(95%). There was no difference between the relative distribution of body weight between the hospital survivors [<25(32%), 25-30(37%), >30(31%)] and nonsurvivors [<25(32%), 25-30(44%), >30(28%)], p=0.711. There was no difference in ICD implantation rates between weight groups (p=0.251). The patients were followed for an average of 5.8±4.4 years. The 5-year survival was 80±5%. 5-year survival was lower in underweight/normal patients [<25, 71% (63-79) compared to heavier patients (25-30:88% (82-94), p=0.001]. The survival difference persisted after adjustment for age (p=0.02). Malignancy was the most common cause of death in the underweight group. The 5-year survival free of ICD shocks was 61±7% with no weight-based difference in shocks. **Conclusion:** There was no apparent weight-based influence on resuscitation survival after VF OHCA. Patients who are under to normal weight had a lower long-term survival and represent a high-risk population primarily due to noncardiac diseases.

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### Demonstration of Mitochondrial Membrane Depolarization with FRET Spectroscopy in the Intact Heart

Sverre E Aune, Thomas L Clanton, Mark G Angelos; Ohio State Univ, Columbus, OH

Current methods for real time detection of mitochondrial membrane depolarization in the intact heart are very limited. **Objective:** To utilize fluorescence resonance energy transfer (FRET) as a sensitive new method to distinguish mitochondrial membrane depolarization within the intact heart. **Methods:** Isolated perfused male Sprague Dawley rat hearts were perfused at 85 mm Hg with temperature controlled (37.4° C) modified Krebs Henseleit buffer. A fiberoptic spectrometer measured fluorescence at the left ventricular wall. Hearts were loaded with mitotracker green (MTG), which localizes to the mitochondria, and then with tetramethyl rhodamine methyl ester (TMRM), a mitochondrial membrane specific probe that changes fluorescent intensity in response to mitochondrial membrane potential ( $\Delta\psi$ ). Excitation of MTG resulted in both the expected MTG emission and also a strong emission from TMRM, indicating that FRET occurred when the two probes were co-localized in the mitochondria. Hearts were infused with increasing concentrations of carbonyl cyanide p-(tri-fluoromethoxy) phenylhydrazone (FCCP), an uncoupler of oxidative phosphorylation, at 30 nM, 100 nM and 300 nM. NADH, TMRM, MTG and FRET signals were simultaneously monitored to determine if changes in the mitochondrial membrane potential could be detected in the presence of uncoupling of the electron transport chain. Fluorophore signal changes at specific time points were expressed as  $\Delta F/F_0$ . **Results:** After loading of both probes, excitation of MTG yielded emission in the TMRM emission wavelengths which constituted FRET. No changes in NADH were noted with 30 nM and 100 nM FCCP. However, at 300 nM there was a significant increase in NADH (p<0.001). A simultaneous increase in MTG and a significant decrease in FRET were seen with both 100 nM and 300 nM FCCP infusion (p<0.001 vs. baseline). Changes in FRET showed a dose response effect with increasing concentrations of FCCP ( $F/F_0 = 0.989 \pm 0.003$  at 30 nM FCCP,  $F/F_0 = 0.973 \pm 0.013$  at 100 nM FCCP and  $F/F_0 = 0.926 \pm 0.020$  at 300 nM FCCP). **Conclusions:** Utilizing the fluorescent probe pair of TMRM and Mitotracker green, FRET can be used as a sensitive measure of mitochondrial membrane depolarization in the intact heart.

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### Atropine for Patients with Out-Of-Hospital Cardiac Arrest

Ken Nagao, Tetsuya Sakamoto, Masaki Igarashi, Shinichi Ishimatsu, Akira Sato, Shingo Hori, Shigeru Kanesaka, Yuichi Hamabe, Kimio Kikushima, SOS-KANTO committee, Tokyo, Japan; SOS-KANTO study group

BACKGROUND AHA guidelines for cardiopulmonary resuscitation (CPR) have recommended that administration of atropine can be considered for asystole or pulseless electrical activity (PEA),

because atropine has improved survival to hospital admission in a retrospective review (Ann Emerg Med, 1984), and is inexpensive, easy to administer, and has few side effects. However, there are insufficient data in humans. **METHODS** We assessed the effects of atropine in 7,443 adults patients with asystole or PEA arrest from the SOS-KANTO study: a prospective, multicenter, observational trial. The medications for asystole or PEA arrest were managed according to the advanced cardiovascular life support algorithm of the CPR guidelines (i.e. a 1-mg dose of epinephrine was administered intravenously every 3 to 5 minutes and at 1-mg dose of atropine was administered intravenously every 3 to 5 minutes; maximum total of 3 doses). The primary endpoint was a favorable neurological outcome 30 days after cardiac arrest. **RESULTS** Of the 7,443 adult patients who had out-of-hospital cardiac arrest with asystole or PEA, 1,708(23%) were treated with epinephrine and atropine and 5,735(77%) were treated with epinephrine. At baseline, the epinephrine and atropine group had significantly higher proportions of cardiac cause, witnessed arrest, and bystander CPR attempt than the epinephrine group. However, the two groups had a similar frequency of the favorable neurological outcome (0.3% in each group, p=0.805). Multiple logistic-regression analysis showed that the adjusted odds ratio for the favorable neurological outcome was 0.6 (95% CI 0.2-1.7, p=0.37) after epinephrine and atropine (compared with epinephrine). On the other hand, the epinephrine and atropine group had significantly higher rate of return of spontaneous circulation (ROSC) than the epinephrine group (35% vs. 23%, p<0.0001), and the adjusted odds ratio for ROSC was 1.6 (95% CI 1.4-1.7, p<0.0001) after epinephrine and atropine (compared with epinephrine). **CONCLUSIONS** We demonstrated that administration of atropine during management of asystole or PEA arrest did not increase the frequency of favorable neurological outcome, although the atropine favored initial ROSC.

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### Is Severe Post-shock Bradycardia In Patients Using Wearable Defibrillators Common or Serious?

Gary Freeman, Weilun Quan, Steven Szymkiewicz, ZOLL Med, Chelmsford, MA; Graham Nichol; Univ of Washington, Seattle, WA

**Background:** Previous studies have shown a 40% to 60% incidence of asystole immediately after transthoracic defibrillation of pulseless ventricular tachycardia/ventricular fibrillation (VT/VF). Such post-shock asystole has very poor outcomes. Wearable cardioverter defibrillators (WCD, LifeVest, ZOLL Lifecor) automatically record and treat VT/VF by delivering transthoracic defibrillation without the need for a bystander. Post-shock bradycardia (PSB) is of clinical concern in patients (pts) using WCD. **Objective:** Determine the incidence and outcomes of PSB during WCD use. **Methods:** ECG recordings from consecutive pts who had VT/VF while using WCD between March 2005 and March 2007 were retrospectively analyzed. All VT/VF occurring within 24 hours from the initial shock for VT/VF were defined as a single sudden death event (SDE) while those beyond 24 hours as a SDE recurrence. ECGs contained 30 seconds prior to the VT/VF detection and > 15 seconds following VT/VF termination. Severe PSB was defined as a pause longer than 10 seconds. Survival was defined as conscious at emergency department (ED) arrival or not needing to go to the ED. Pt calls and medical orders were reviewed to determine the indications for WCD use and pt post-shock status. **Results:** Between March 2005 and March 2007, 3564 pts used WCD for an average of 51 days. 56 pts (1.6%) ICD explants, 28% ischemic cardiomyopathy (ICM), 11% Non-ICM, 8% delayed ICD implant, 2% others) received 142 shocks for 79 SDE. 14 pts had > 1 SDE (max = 5). 15 SDE had > 1 VT/VF (max = 4). 79/79 (100%) initial SDE shocks terminated VT/VF. 76/79 (96%) of treated SDE resulted in survival. Severe PSB was found in 4 ECGs from 4 pts. 3/4 (75%) occurred after the initial SDE shock, 1/4 (25%) after VT/VF recurrence; 2/4 (50%) developed ventricular complexes prior to the end of the recording, 2/4 (50%) did not; 3/4 (75%) pts survived, 1/4 (25%) did not. Median time from VT/VF onset to shock was 44 seconds. **Conclusions:** WCD is an efficacious therapy. The majority of pts with severe PSB after WCD survived. Severe PSB was less frequent and had a better prognosis than that observed in EMS studies. This may be attributed to faster WCD shock therapy (median 44 seconds) compared with EMS (>10 minutes).

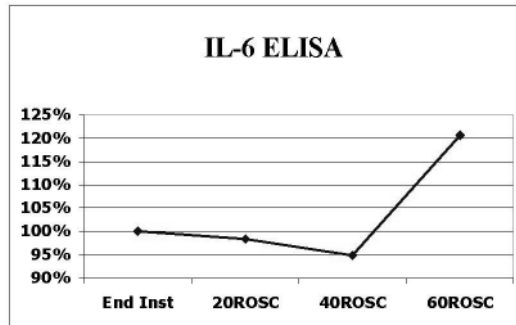
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### Early Post-Resuscitation Levels of Cytochrome-c and Interleukin-6 after Prolonged Porcine Cardiac Arrest

David D Salcido, Eric S Logue, Brian P Suffoletto, Jon C Rittenberger, James J Menegazzi; Univ of Pittsburgh, Pittsburgh, PA

**Background:** The identification of serum biomarkers of ischemic injury could provide a means of assessing interventions designed to limit reperfusion injury after return of spontaneous circulation (ROSC). We sought to characterize the early post-ROSC timecourse of two candidate biomarkers of ischemic injury (cytochrome-c and IL-6) in a swine model of ventricular fibrillation (VF). We hypothesized that these two biomarkers would be elevated immediately after ROSC. **Methods:** Twenty-five mixed breed domestic swine were anesthetized and instrumented with ECG, temperature probe, and aortic and right atrial pressure transducers. VF was induced with a transthoracic shock and untreated for 8 minutes. Then mechanical CPR was done for 2 minutes, before drugs were given (epinephrine, vasopressin, and propranolol) with 3 additional minutes of CPR (first defibrillation attempt at 13 minutes of VF). Blood samples were drawn at the end of instrumentation (i.e. just prior to VF), and at 20, 40, and 60 minutes after ROSC. Samples were centrifuged and serum extracted. Cytochrome-c was analyzed via Western immunoblotting. IL-6 was analyzed with ELISA. **Results:** No cytochrome-c was detected in any animal, at any timepoint through 60 min. IL-6 was similar to baseline levels through 40 min, but was 121% of baseline at 60. **Conclusions:** Neither biomarker was elevated immediately after ROSC. Mitochondrial damage (as indicated by the absence of cytochrome-c) may be delayed by as much as an hour after ROSC, hinting at a possible therapeutic window

for interventions like hypothermia. Likewise, inflammatory cascades (as indicated by IL-6) may not begin immediately post-ROSC, but might by one hour.



#### Effects Of Intracerebroventricular Application Of Granulocyte Colony-stimulating Factor On Cerebral Recovery After Cardiac Arrest In Rats

Tobias Rabsahl, Erik Popp, Peter Vogel, Peter Teschendorf, Bernd W Boettiger, Dept of Anesthesiology, Heidelberg, Germany

**Introduction:** After transient global cerebral ischemia, selective vulnerable brain areas show delayed neuronal degeneration with characteristic signs of apoptosis. Recent data demonstrated potent neuroprotective effects of the application of granulocyte colony-stimulating factor (G-CSF) after focal cerebral ischemia. In order to assess possible effects of intracerebroventricular application of G-CSF on cerebral recovery after global cerebral ischemia due to cardiac arrest (CA) neurological testing according to a tape removal test as well as histological analysis of the hippocampal CA-1 sector were performed. **Methods:** Global cerebral ischemia was initiated by ventricular fibrillation in rats during general anesthesia. After 6 min of CA cardio pulmonary resuscitation (CPR) was initiated. After restoration of spontaneous circulation (ROSC) the animals were divided into two groups (G-CSF vs. placebo; n=16 per group). G-CSF (4µl=3.84µg) or placebo was applied in single shot technique 30 min after ROSC. During CA, CPR and for the first 24 h after ROSC all animals were kept normothermic using a feedback control system with intraperitoneal implanted telemetric probes. The tape removal test was applied pre-CA, 24 h, 3 d, 7 d, 10 d and 14 d after ROSC. After 14 days histological analysis was done by counting TUNEL positive neurons in the hippocampal CA-1 sector. All experiments were performed in a randomized and blinded setting. **Results:** All animals were kept normothermic within the first 24 h after ROSC (G-CSF: 37.3 ± 0.3 °C; placebo: 37.5 ± 0.5 °C). Pre-CA all animals removed the adhesive tapes promptly. After ROSC in both treatment groups a clear neurological damage was shown that improved within the first 14 days, without reaching baseline values. No statistically significant differences between the group could be seen. With regard to TUNEL-positive neurons in the hippocampal CA-1 sector no significant differences could be observed between the groups (G-CSF: 47 ± 22; placebo: 51 ± 24). **Conclusions:** Regarding neurological recovery and neurohistopathological outcome 14 d after global cerebral ischemia, the present study was not able to show any beneficial effects of G-CSF, despite the well known effects of G-CSF in non global cerebral ischemia models.

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#### Patient Characteristics and Outcomes of Witnessed Out-of-Hospital Cardiac Arrest in Osaka: A 7-Year Emergency Medical Services Perspective in a Large Population

Taku Iwami, Kyoto Univ, Health Service, Kyoto, Japan; Atsushi Hiraide, Cntr for Med Education, Kyoto Univ Graduate Sch Faculty of Medicine, Kyoto, Japan; Kentaro Kajino, Dept of Traumatology and Acute Critical Medicine, Osaka Univ Graduate Sch of Medicine, Suita, Japan; Robert A Berg, Sarver Heart Cntr, The Univ of Arizona College of Medicine, Tucson, AZ; Tatsuya Nishiuchi, Osaka Prefectural Senshu Critical Care Med Cntr, Izumisano, Japan; Yasuyuki Hayashi, Saiseikai Senri Critical Care Med Cntr, Suita, Japan; Masahiko Nitta, Toshimasa Hayashi, Osaka Med College, Takatsuki, Japan; Hisashi Ikeuchi, Osaka General Med Cntr, Osaka, Japan; Hiroshi Nonogi, National Cardiovascular Cntr, Suita, Japan; Takashi Kawamura, Kyoto Univ, Health Service, Kyoto, Japan; J-PULSE investigators

**Objectives:** To evaluate the temporal trend of baseline characteristics, resuscitation care characteristics, and outcomes of out-of-hospital cardiac arrests (OHCA) from a large population-based cohort study. **Methods:** We enrolled all OHCA of presumed cardiac etiology in adults (>17 years old) that were witnessed by bystanders and were treated by emergency medical service (EMS) in Osaka Prefecture (population, 8.8 million), Japan from 1999 through 2005. Data were prospectively collected by EMS personnel and physicians in charge using an Utstein-style database. Time course was divided into 7 successive one-year periods. We evaluated changes in demographic and cardiopulmonary resuscitation (CPR)-related factors, and outcomes. Multivariate logistic regression analysis was performed to evaluate the relationship between prognostic factors and outcomes. **Results:** Mean age gradually increased over time. The proportion of cases with bystander CPR and with ventricular fibrillation (VF) increased. The time interval from emergency call to the first defibrillation by EMS personnel shortened from 14 to 8 min, while the time to the initiation of CPR by EMS remained 6–7 min. Neurologically favorable outcome 1-month after arrest improved from 1.5% to 4.7% in the

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entire cohort (Table) and from 5.5% to 16.9% in witnessed VF cases during the observation period. Excluding very-long-duration cardiac arrests (>15 minutes), bystander-initiated cardiac-only resuscitation yielded a higher rate of favorable neurological outcome than no bystander CPR (3.6% versus 2.8%; OR, 1.51; 95% CI, 1.00–2.26), and conventional CPR showed similar effectiveness (3.6%; OR, 1.39; 95% CI, 0.96–2.02). **Conclusion:** This study showed the continuous improvement of the chain of survival and outcomes of patients with witnessed OHCA in a large population. Further efforts to increase bystander-initiated cardiac-only resuscitation would improve the outcomes more.

**Table: Baseline, Resuscitation Care Characteristics and Outcomes according to time period**

	1999 (n=944)	2000 (n=975)	2001 (n=1037)	2002 (n=935)	2003 (n=1005)	2004 (n=967)	2005 (n=1066)
Age, yr, Mean (SD)	68.4 (15.5)	69.4 (15.6)	70.6 (14.8)	70.2 (14.7)	70.4 (15.5)	72.0 (14.7)	71.6 (15.3)
Male, % (n)	63.3 (593)	63.4 (616)	64.8 (669)	62.0 (578)	63.4 (636)	60.5 (585)	63.5 (677)
Presenting rhythm VF, % (n)	17.4 (164)	15.1 (146)	16.6 (170)	19.2 (177)	21.0 (210)	23.0 (221)	22.5 (239)
Bystander CPR, % (n)							
Cardiac-only	11.8 (111)	9.7 (94)	12.8 (132)	12.9 (119)	13.3 (133)	15.5 (148)	14.4 (153)
Conventional CPR	13.3 (125)	15.2 (147)	18.0 (185)	19.5 (180)	19.8 (198)	21.0 (201)	20.8 (222)
Time from call to CPR, min, median (IQR)	7 (6 - 9)	7 (6 - 9)	7 (6 - 9)	7 (6 - 9)	7 (6 - 9)	6 (6 - 9)	7 (6 - 9)
Time from call to defibrillation, min, median (IQR)	14 (12 - 19)	12 (10 - 16)	12 (10 - 16)	11 (9 - 15)	10 (8 - 12)	9 (7 - 12)	8 (7 - 11)
One-month survival, % (n)	4.6 (42)	5.6 (54)	6.6 (68)	7.9 (72)	8.0 (80)	7.8 (74)	9.4 (100)
Neurologically favorable outcome, % (n)	1.5 (14)	2.4 (23)	2.5 (26)	3.0 (28)	3.4 (34)	3.5 (34)	4.7 (50)

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#### Cardiac Catheterization After In-hospital Cardiac Arrest: Guidelines Needed

Raina M Merchant, Benjamin S Abella, Univ of Pennsylvania, Philadelphia, PA; Monica Khan, Kuang-Ning Huang, David G Beiser, Univ of Chicago, Chicago, IL; Brendan G Carr, Robert W Neumar, Univ of Pennsylvania, Philadelphia, PA; Terry L VandenHoek, Univ of Chicago, Chicago, IL; Lance B Becker; Univ of Pennsylvania, Philadelphia, PA

**Background:** The benefit of immediate cardiac catheterization after in-hospital cardiac arrest is uncertain as electrocardiographic and clinical criteria may be unreliable in this population. We sought to evaluate rates of cardiac catheterization after in-hospital ventricular fibrillation (VF) cardiac arrest and the potential association of cardiac catheterization with survival. **Methods:** Using a single hospital billing database we retrospectively identified cases with an ICD-9 code of cardiac arrest (427.5) or ventricular fibrillation (427.41). Discharge summaries were then reviewed to identify arrests that occurred in-hospital with an initial rhythm of VF. Rates of catheterization were determined by identifying cardiac catheterization charges on the day of or day after arrest. All cardiac catheterization reports were reviewed. Unadjusted analysis was performed to look for factors that may have contributed to survival to hospital discharge. A logistic regression was performed to further evaluate possible interactions. **Results:** There were 110 patients with return of circulation after VF in-hospital arrest included in the analysis. Cardiac catheterization was performed immediately or within one day of arrest in 27% (30/110) of patients and 57% (17/30) received angioplasty. Of those who received cardiac catheterization the indication for the procedure was ST elevation myocardial infarction (STEMI) in 12% (13/110) of cases. Using an unadjusted model, patients who received cardiac catheterization were more likely to survive (80% vs. 54%, p<.01). Controlling for cardiac catheterization, age, gender, and race using logistic regression, this relationship persisted with patients undergoing cardiac catheterization having a 3.8 increased odds of survival (OR 3.8, 95% CI 1.35–10.90, p<.01). **Conclusion:** In patients receiving cardiac catheterization, more than half received this procedure for indications other than STEMI. Cardiac catheterization was associated with better survival although this study is limited in its ability to draw inference or causality. Future recommendations need to be established to guide clinicians on which in-hospital cardiac arrest patients might benefit from immediate cardiac catheterization.

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#### A Mathematical Model of Ventilation, Perfusion, and Oxygenation in Low-Flow States

Daniel P Davis, Paul W Davis; UC San Diego, San Diego, CA

**Background:** Recent investigations underscore the critical importance of ventilation strategies on resuscitation outcomes. In low perfusion states, such as cardiac arrest and traumatic shock, the rise in intrathoracic pressure that accompanies positive-pressure ventilation (PPV) can significantly impede venous return and lead to a decrease in cardiac output. The optimal ventilation strategy in these "low-flow" states remains unclear. **Objectives:** To create a mathematical model of perfusion and oxygenation to predict the effects of PPV with both normotension and hypotension. **Methods:** The lung pressure-volume relationship was modeled using a novel formula allowing manipulation of various lung characteristics, including vital capacity, compliance, and the upper and lower inflection points. A separate formula was then derived to predict mean intrathoracic pressure for a given minute ventilation using the pressure-volume formula. The addition of positive end-expiratory pressure was also modeled. Finally, a formula was derived to model oxygen absorbance as a function of alveolar surface area and flow based on ventilation rate and mean intrathoracic pressure. **Results:** Mathematical models of the lung pressure-volume relationship, mean intrathoracic pressure, and absorbance were successfully derived. Manipulation of vital capacity, compliance, upper and lower inflection points, positive end-expiratory pressure, and minute ventilation allowed prediction of optimal ventilation rate and tidal volume for a normal and an ARDS lung. For a normal lung, optimal values for both mean intrathoracic pressure and absorption were achieved with a

ventilation rate of 4 breaths/min. A decrease in the upper inflection point or increase in minute ventilation resulted in faster optimal ventilation rates, although none exceeded 14 breaths/min. Conclusions: A mathematical model of ventilation was successfully created allowing manipulation of multiple variables related to lung compliance and ventilation strategy. This model suggests the use of lower ventilation rates with larger tidal volumes to minimize the hemodynamic effects of PPV and maximize oxygen absorbance.

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### Outcome And Quality Of Life After Central Pulmonary Embolism: Surgical Embolectomy Versus Medical Treatment

Alexander Kadner, Flurina Recher, Franz F Immer, Jürg Schmidli, Hendrik Teveaarai, Thierry P Carrel, Friedrich S Eckstein; Cardiovascular Surgery, Bern, Switzerland

**Background:** Therapy of massive pulmonary embolism is still a matter of debate. In tertiary centres different modality of treatments are available. Aim of the present study was to assess outcome and mid-term quality of life (QoL) of patients with massive central pulmonary embolism treated either by surgical embolectomy (SE) or thrombolytic agents (TA). **Methods:** 69 patients with central pulmonary embolism and severely haemodynamic compromised have been identified. 19 patients (27.5%) were treated by SE and the remaining patients with TA. All the in-hospital data have been assessed and a follow-up, focussing on outcome and quality of life, was made. **Results:** The surgical collective was younger ( $57.9 \pm 14.9$  y vs.  $63.1 \pm 16.9$ ;  $p < 0.05$ ) and more symptomatic at the time of diagnosis, with a Schock-Index: of  $0.9 \pm 0.4$  vs.  $1.3 \pm 0.5$  ( $p < 0.05$ ) and a  $pCO_2$  of  $50.3 \pm 19.5$  mmHg vs.  $36.7 \pm 12.2$  mmHg ( $p < 0.05$ ) in patients treated with TA. Early mortality was similar in both collectives (SE: 5.3% vs. TA: 7.1%;  $p = ns$ ) as well as follow-up survival after an average follow-up  $33.2 \pm 12.3$  months (SE: 68.4% vs. TA 66.1%;  $p = ns$ ). 2 patients in the TA-group were hospitalized due to a massive pulmonary embolism in the follow-up. 89.7% in the SE-group are under oral anticoagulation, compared to 81.8% in the TA-group ( $p = ns$ ). No anticoagulation-related complications have been reported in the follow-up. Average age- and gender-matched quality of life was similar in both groups (SE: 85.7 vs. TA 85.0;  $p = ns$ ). Patients treated with TA reported a significant higher level of fear, than patients treated with SE. **Conclusions:** SE is an excellent therapy of central pulmonary embolism in haemodynamic compromised patients. Despite being more symptomatic early and mid-term outcome was similar in both groups. Follow-up revealed that age and gender matched QoL is preserved in both groups. However, patients treated with TA are much more scared than patients who underwent surgery.

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### Comparison between Intraosseous and Central Venous Drug Delivery in Normovolemic and Hypovolemic Swine

Stephen L Hoskins, Brian S Zachariah, Nick Copper, George C Kramer; Univ of Texas Med Branch, Galveston, TX

In traumatic injuries vascular access must be secured promptly. Peripheral intravenous access is the most common form of emergency vascular access. However, a number of studies suggest that establishing IV access can take minutes to occur. The intraosseous (IO) route delivers drugs to the non-collapsible vessels of the bone and can be established in <60 seconds. We compared tracer delivery to the systemic circulation via the tibial IO route versus the central venous route in normovolemic and hypovolemic swine. **METHODS:** Isoflurane anesthetized swine N=6 were instrumented and allowed to stabilize. IO de were placed in the proximal tibia using the EZ-IO® (Vidacare Corporation) device. Central venous (CV) tracer delivery was via the right atrial port on a pulmonary catheter. Animals were hemorrhaged to 45 mmHg and held for 5 min. Cardiac output decreased to 45–60% of baseline. Simultaneous injections of different dye tracers (indocyanine green and Evan's blue) were delivered via the IO and the CV routes. The time course (in seconds) for arterial blood sampling included pre-injection T-8, T-6, T-4, T-2, and at T0 dye boluses were delivered. Samples were taken at 2 second intervals until 50 seconds post-injection. Samples were analyzed by spectrophotometer and dye concentrations were determined. Normovolemic N=6 evaluations of drug delivery utilized the same drug delivery protocol. **RESULTS:** Peak appearance times of tracer detection were  $7.2 \pm 1.3$  s and  $10.8 \pm 1.8$  s for CV and T delivery respectively in normovolemia. The total dose of tibial delivery was 83% that of CV delivery in normovolemia as measured by area under the curve (AUC). Peak appearance time of tracers for the hemorrhaged group was  $7.3 \pm .6$  s and  $11.7 \pm 1.2$  s for CV and tibia groups, respectively. The IO tibial delivery was 70% that of CV delivery in the hemorrhage group. **CONCLUSIONS:** Normovolemic drug delivery was marginally faster and more effective than drug delivery during hemorrhage for both CV and IO routes. These small differences are not likely to be clinically relevant. Tibial IO delivery is an effective alternative to central venous delivery in emergent care situations. Tibial IO delivery should be considered when time is a critical factor involved in drug delivery and venous access is not available.

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### Reduction of Histological Damage with Mild Therapeutic Hypothermia after Prolonged Cardiac Arrest

Gregor Springler, Dept of Pathobiology, Univ of Veterinary Medicine Vienna, Vienna, Austria; Andreas Janata, Wolfgang Weihs, Keywan Bayegan, Alexandra Schratler, Oliver Robak, Michael Holzer, Martin Frossard, Wilhelm Behringer, Dept of Emergency Medicine, Med Univ of Vienna, Vienna, Austria; Robert B Schock, Marc Coté, Robert J Freedman, Life Recovery Systems, Kinnelon, USA, Kinnelon, NJ; Udo M Losert, Core Cntr of BioMed Rsch, Med Univ of Vienna, Austria, Vienna, Austria; Peter Schmidt, Dept of Pathobiology, Univ of Veterinary Medicine Vienna, Vienna, Austria; Anton N Lagner, Fritz Sterz; Dept of Emergency Medicine, Med Univ of Vienna, Vienna, Austria

Purpose: The aim of our study was to assess the effect of hypothermia on histological damage in 19 brain regions after prolonged cardiac arrest in pigs. Methods: Pigs were anaesthetized

and mechanically ventilated. After stabilisation of pulmonary artery temperature (Tpa) at  $38.5 \pm 0.2$  °C, ventricular fibrillation (VF) was induced and 10 min of untreated VF were followed by 8 min of cardiopulmonary resuscitation (mechanical chest compressions, two doses of vasopressin 0.4 IE/kg). At 8 min of CPR, up to 3 countershocks were delivered. Pigs that had return of spontaneous circulation (ROSC) were randomized to one of 2 groups (control, hypothermia). Pigs in the hypothermia group were cooled to Tpa  $33.0 \pm 1.0$  °C with a surface cooling device (LRS Thermosuit™) circulating ice water over most of the skin surface. Pigs in the control group were kept at  $38.5 \pm 1.0$  °C throughout the experiment. After 14 hours of hypothermia, pigs were rewarmed, weaned and brought to the stable. At day 9 of the experiment, final neurologic examination was performed. After that the animals were sacrificed and perfused with 4 liters of saline, followed by 1 liter of paraformaldehyde (3%, pH 7.4). The brain was removed and 19 different regions of the brain were examined by means of lightmicroscopy using a histopathologic damage score that was used in previous studies. Following damage qualities were considered: edema, eosinophilic necrosis (oncosis), vacuolar degeneration and malacia. The total numeric histological damage score (HDS) was the sum of all area scores. Data are presented as median and interquartile range, group comparison was done with a Mann-Whitney-U test. Results: 16 (29–35 kg) pigs were randomized. The time to reach target temperature in the hypothermia group (n = 8) was 9.0 (5.3; 11.9) min. Total HDS in the hypothermia group was 71 (61; 84), in the control group 132 (124; 174;  $p < 0.001$ ). Significant ( $p < 0.05$ ) improvements in damage were found in hippocampus, temporal, parietal, frontal and occipital cortex. Conclusions: Histological damage after prolonged cardiac arrest was improved significantly in cooled animals compared to control animals. Not all brain regions could benefit to the same extent.

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### Comparison of Intraosseous Proximal Humerus and Sternal Routes for Drug Delivery during CPR

Stephen L Hoskins, Brian S Zachariah, Nick Copper, George C Kramer; Univ of Texas Med Branch, Galveston, TX

Intravenous access can be delayed during medical emergencies such as shock and cardiac arrest. The intraosseous (IO) route delivers drugs into the non-collapsible vessels within the bone marrow and can be an effective alternative to intravenous (IV) access. Recently, there have been a number of intraosseous devices developed for the adult market. A previous study from our group has shown the sternal IO to be 90% as effective as central IV in drug delivered during CPR and delivers drugs 2.5 times as fast as the tibial IO route. However, the safety of sternal puncture continues to be debated. Drug delivery via the proximal humerus may be an effective alternative for IV drug delivery during CPR. **METHODS:** Seven isoflurane anesthetized swine (30–45kg) were subjected to cardiac arrest by KCl injection. Eight min post cardiac arrest CPR was initiated via Thumper (Michigan Instruments Inc.) at 100 compressions per min without ventilation. Delivery of epinephrine was evaluated by 2 routes after 2 min of CPR. Group 1 EZ-IO® (Vidacare Corporation, San Antonio, TX) was placed in the proximal humerus (PH), Group 2 EZ-IO placed in the sternum (S). After 2 min of CPR post VF Evans blue 5mg/kg and indocyanine green 2.5mg/kg tracers were co-administered with epinephrine (2mg/kg) as a bolus to the S and PH, respectively. Post drug delivery arterial sampling was performed at 10s intervals for 8 min and analyzed by spectrophotometric assay to determine the arterial dose and time of drug delivery. Plasma was collected for HPLC analysis to determine arterial dose and time of delivery. **RESULTS:** Peak appearance times of tracers were  $S 32.5 \pm 4.1$  and  $PH 35 \pm 4.6$ , respectively. The total dose delivered to arterial blood averaged over 8 min was same for both the S and PH routes. **CONCLUSIONS:** This study suggests that IO proximal humerus is comparable to IO sternal for prompt drug delivery during CPR. Previous work from our laboratory determined that IO sternum was 90% as effective in the dose delivered as central venous drug delivery. IO delivery via the proximal humerus is an effective and efficacious alternative to IO sternal delivery.

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### Risk of Cardiopulmonary Arrest after Acute Respiratory Compromise

Henry Wang, Univ of Pittsburgh, Pittsburgh, PA; Benjamin Abella, Univ of Pennsylvania, Pennsylvania, PA; Clifton W Callaway; Univ of Pittsburgh, Pittsburgh, PA

**INTRODUCTION:** Many hospitalized patients experience acute respiratory compromise (ARC), with a portion developing cardiopulmonary arrest (CPA) despite emergent care. We sought to characterize the clinical course of ARC patients and their risk of developing CPA. We hypothesized that a substantial portion of ARC patients develop CPA and that CPA occurs rapidly after ARC onset. **METHODS:** We used ARC data from the National Registry of Cardiopulmonary Resuscitation (NRCPR), a multicenter registry describing in-hospital adults requiring emergency assisted ventilation. For each primary ARC event we identified patient characteristics (age, sex, race, ethnicity, weight), clinical presentation (ECG, conscious or breathing, witnessed event, location of event), suspected cause and acute interventions (airway, respiratory and medications). The primary outcome was the development of CPA. Secondary outcomes were time to CPA and survival to discharge. We also identified factors associated with developing CPA. We used descriptive statistics and multivariate logistic regression. **RESULTS:** Of 4,358 ARC events, CPA occurred in 726 (16.7%; 95% CI: 15.6–17.8%). Median time from ARC onset to CPA was 7 minutes (IQR: 3–14 min); CPA occurred within 10 minutes in 65.3% of these cases. Survival to discharge was lower for CPA patients than non-CPA patients; 14.3% vs. 58.4% (OR death 8.3, 95% CI: 6.7–10.4). Multivariate factors associated with CPA included failed invasive airway (OR 10.5; 95% CI: 6.9–16.1), tracheostomy or cricothyroidotomy (7.1; 2.4–21.6), pulmonary embolism (3.4; 1.9–6.0), hypotension (1.7; 1.4–2.1), ECG of bradycardia (2.4; 1.8–3.0), paced (2.7; 1.7–4.4) or idioventricular (2.7; 1.3–5.8), and use of magnesium sulfate (2.7; 1.2–6.0). CPA was less likely when patients were conscious (0.8, 0.6–1.0) or breathing (0.4, 0.3–0.6) or if sedative induction agents were used (0.4, 0.3–0.5). **CONCLUSIONS:** CPA occurs frequently and rapidly

after ARC and is associated with airway management complications, hypotension, bradycardias and pulmonary embolism. Survival to discharge after ARC-related CPA is low. Medical teams responding to ARC should prepare not only for airway management but also the possibility of CPA.

### 51 Potential Gradient Fields and Earliest Post Shock Activity Following External Defibrillation of Long Duration Ventricular Fibrillation in Swine

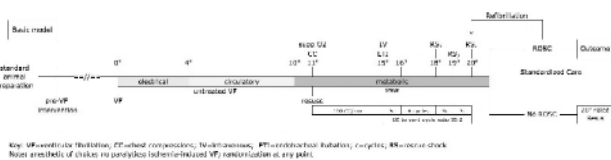
James D Allred, Cheryl R Killingsworth, Scott Allison, Derek J Dossdall, Sharon B Melnick, William M Smith, Raymond E Ideker, Gregory P Walcott; Univ of Alabama Birmingham, Birmingham, AL

**Background:** Though many studies have evaluated internal defibrillation during short duration VF (SDVF), the shock potential gradient (VV) field and activation immediately following external defibrillation of long duration VF (LDVF) has not been well studied. We tested the hypothesis that the timing of post-shock activation following LDVF is different than following SDVF and is due to shock gradient differences between shocks delivered following short and long duration VF. **Methods:** In 6 pigs, 115–120 plunge needles each with 3–6 electrodes were inserted throughout the ventricles. After the chest was closed, external defibrillation pads were placed in a left lateral to right lateral configuration. Defibrillation threshold (DFT) strength biphasic shock potentials were recorded during SDVF (20 s of VF) and LDVF (7 min of VF). A VV 3-D map was generated. Earliest activation following each shock was determined. **Results:** The shock size required for defibrillation of LDVF (1660±446 stored V) was not significantly different from the SDVF DFT strength shocks (1632±429 stored V). Comparison of recorded potential distribution generated by different shocks within the same animal was similar between SDVF and LDVF shocks ( $R^2 = 0.81-0.98$ ) also. The time from the shock until first recorded cardiac activation was significantly longer for LDVF (3845±451ms) than SDVF (841±1739ms)  $p<0.05$ . **Conclusions:** 1. Recorded potential distribution required for defibrillation is very similar between shocks delivered to animals in SDVF and LDVF. 2. The external defibrillation energy for LDVF is not greater than for SDVF; however, the time from the shock until first recorded activation is significantly longer. This difference is not due to a difference in shock field and likely represents changes in the tissue physiology secondary to the ischemia of long duration VF.

### 52 An Evidence Based Animal Model Of Prolonged Ventricular Fibrillation Cardiac Arrest

Timothy J Mader; Baystate Med Cntr/Tufts Univ Sch of Medicine, Springfield, MA

**Background:** Promising basic science findings in cardiac resuscitation often do not translate into improved outcomes when studied in humans. One explanation is that the current animal models do not adequately reflect the out-of-hospital cardiac arrest (OHCA) clinical trial environment. The author sought to review the literature and devise a new model of prolonged VF with time intervals that more accurately simulate OHCA conditions. **Methods:** A systematic review of the literature (01/90–12/06) was conducted using PUBMED and a comprehensive list of appropriate MESH headings. All OHCA human clinical trials were included. The most relevant studies underwent explicit and detailed review. Mean values with 95%CI were calculated for each specified interval. Suitable conditions and establishment of appropriate times were then devised. **Results:** Twenty-two papers with adequate detail for evaluation were examined, leading to the following recommendations: the duration of non-treatment (assuming no bystander CPR or first-responders) is 11" (3" for recognition and EMS activation, 7" response interval and 1" for paramedics to reach the patient); chest compressions are initiated immediately with passive oxygen insufflation; assuming they can be done simultaneously, IV access and intubation (ETI) are accomplished 4" after arrival; drugs are delivered by minute 16 - well into the metabolic phase; and 2" of CPR are needed to circulate the drugs for the first rescue shock (RS) at minute 18. **Conclusions:** This proposed evidence based experimental model of prolonged untreated VF cardiac arrest has conditions and time intervals that simulate those of human OHCA clinical trials.

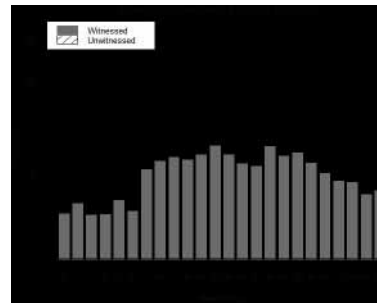


### 53 Evidence for Circadian Variability in the Frequency of Out-of-Hospital Cardiac Arrest

Steven C Brooks, Univ of Toronto, Toronto, Canada; Robert H Schmicker, Thomas D Rea, Univ of Washington, Seattle, WA; Tom P Aufderheide, Med College of Wisconsin, Milwaukee, Wisconsin, WI; Daniel P Davis, UC San Diego, San Diego, CA; Scott S Emerson, Univ of Washington, Seattle, WA; Ritu Sahni, Oregon Health & Science Univ, Portland, OR; Laurie J Morrison, Univ of Toronto, Toronto, Canada; Gena K Sears, Univ of Washington, Seattle, WA; Denise E Griffiths, Oregon Health & Science Univ, Portland, OR; Paul Dorian, Univ of Toronto, Toronto, Canada; The ROC Investigators

**Introduction:** Several sudden cardiac phenomena demonstrate circadian variability. It is not clear if there is also circadian variability in the frequency and outcome for out-of-hospital

cardiac arrest (OHCA). The Resuscitation Outcomes Consortium (ROC) Epistry is a large prospective cohort of OHCA. **Hypothesis:** The maximum frequency of OHCA occurs in the morning hours. **Methods:** We included adult patients from all 11 North American emergency medical services (EMS) systems participating in the ROC with OHCA of presumed cardiac cause between 12/1/2005 and 11/30/2006. We excluded cases of unwitnessed, untreated OHCA. The relation between time block (4 arbitrary 6-hour blocks) and survival to hospital discharge was analyzed using multivariate logistic regression adjusting for age, sex, witness status, bystander CPR, time from 911 call to EMS arrival and initial rhythm. **Results:** Of 15363 OHCA occurring during the study period, 8297 were included. The figure shows circadian variation of OHCA frequency by witness status. The highest frequency was observed between 0601–1200 hrs and the lowest during 0001–0600 hrs ( $p<0.001$ ). This pattern was observed regardless of initial rhythm, witness status, gender or location of arrest. The adjusted odds ratio with 95% CI for survival to hospital discharge (patients in the 0001–0600 time block as reference) was 1.00 (0.88, 1.15) for 0601–1200 hrs, 0.99 (0.91, 1.07) for 1201–1800 hrs, and 1.00 (0.91, 1.09) for 1801–2400 hrs. **Conclusions:** OHCA shows circadian variability in frequency but not in survival to hospital discharge. OHCA occurs more frequently in the daytime as compared to night.



### 54 Preliminary Results With The Use Of Stat•Padz Pacing Electrode For Treatment Of Symptomatic Bradycardia In Emergency Department.

Maria Margarita Gonzalez, Luis Augusto Dallon, Rogerio B Ramos, Evelinda Trindade, Sergio Timerman, Antonio P Mansur; Heart Institute (InCor), Univ of Sao Paulo Med Sch, Sao Paulo, Brazil

**Background:** Since the mid-1980's transthoracic pacing has been a common temporary treatment for arrhythmias. Present external pacing technology requires the application of both multifunction defibrillation electrodes and separate leads for electrocardiogram (ECG) monitoring. Separate ECG leads are required as the current from the pacing pulse creates artifact in the signal that prevents one from distinguishing between pace-captured and non-captured rhythms when using the defibrillation electrode alone. **Hypotheses:** We hypothesized that Stat•Padz MWP electrode, a transthoracic electrode that integrates the ECG electrodes into the defibrillation and pacing pad would be able to recognize captured and non-captured rhythms in a typical clinical setting of the symptomatic bradycardia. **Methods:** We conducted a prospective study at Emergency Department of a University Hospital. During October 2006 to April 2007, 28 patients with symptomatic bradycardia were included in the study. Comparison between monitoring by conventional electrode and Stat•Padz MWP electrode was performed. After that was selected Lead II, and adjusted pacing rate and milliamps for the stimulation. Records and comparison of electrical capture was performed with the three lead conventional electrodes and Stat•Padz MWP electrodes. **Results:** The mean electrocardiographic diagnoses was third degree atrio-ventricular block in 50% of patients, and the principal symptoms were presyncope in 82 %, symptoms of reduced cardiac output in 79% and syncope in 43%. Previous diagnoses were Hypertension in 57%, Chagas's heart disease in 21%, Valvar heart disease in 14% and Dilated Cardiomyopathy in 18 %. Monitoring of cardiac rhythm, electrical and mechanical capture were obtained in 100 % of patients. The mean energy for capture was 69±18 milliamps. When compared the records of electrocardiographic capture with Stat•Padz MWP electrode, it was equal than conventional electrodes in 46 % and better in 54 %. **Conclusion:** The Stat•Padz MWP electrode has the feasibility of recognize capture and non-capture rhythms and to perform pacing function effectively. It presents the possibility of providing rapid treatment in patients with symptomatic bradycardia avoiding monitoring by conventional electrodes.

### 55 Ventricular Fibrillation remains the Primary Presenting Rhythm: Results from the Wearable Cardioverter Defibrillator Human Study

Hao Wang, Wanchun Tang, Min-Shan Tsai, Yongqin Li, Max H Weil; Weil Institute of Critical Care Med, Rancho Mirage, CA

**Background:** Clinical studies during the last 2 decades have demonstrated a progressive decrease in the incidence of ventricular fibrillation (VF) as the presenting rhythm in settings of out-of-hospital sudden cardiac arrest (SCA). In the present study, we investigated the initial rhythm of SCA from data recorded in a wearable cardioverter defibrillator (WCD) which collected these events in real time. **Hypothesis:** In settings of out-of-hospital SCA, VF remains the leading cause. **Methods and Results.** The incidence and the type of arrhythmias were determined by reviewing stored electrocardiograms in the WCDs. Seventy-four consecutive WCD recipients and 108 events were analyzed. Patients with a previously implanted ICD that

required change due to infection were the most prevalent recipients of WCDs. Fifty-one percent were VF/VT patients and 43.8% were pulseless electrical activity (PEA) patients. VF/VT was the initial rhythm of SCA in 79.7% of patients and 86.1% of events while the PEA occurred in 20.3% of patients and 13.9% of events. 84.5% of patients survived VF/VT and 18.8% of patients survived PEA. There was no difference in the characteristics of patients with different initial rhythms. **Conclusions.** In out-of-hospital settings, VF remains the predominant initial rhythm when recorded immediately following SCA. .

## Spontaneous Body Temperature Is Associated With Survival Following In-hospital Cardiac Arrest And Return Of Spontaneous Circulation: A Report From The National Registry Of Cardiopulmonary Resuscitation

Brian Suffoletto, Clifton Callaway, Univ of Pittsburgh, Pittsburgh, PA; Mary Ann Peberdy, Virginia Commonwealth Univ Health System, Richmond, VA; Terry Vanden Hoek; Univ of Chicago Hosps, Chicago, IL

**Objective-** Spontaneous changes in body temperature after cardiac arrest are common, but their association with survival is not known. This study tested the hypothesis that temperature is associated with survival to hospital discharge. **Methods-**Included were adults with in-hospital cardiac arrest, enrolled in the National Registry of CPR who achieved return of spontaneous circulation between January 1, 2005 and November 7, 2006. Excluded were those who received induced hypothermia. The lowest (Tmin) and highest (Tmax) body temperature during the first 24 hours after ROSC were included in a multivariable logistic regression predicting survival to hospital discharge, adjusting for variables that were independently associated with outcome. Tdelta was defined as Tmax -Tmin, examined in a separate regression. Goodness of fit was measured using Hosmer-Lemeshow (HL) statistic. **Results-** 14,413 subjects were included. Of these, 5,319 (36.9 %) survived to hospital discharge. Tmin and Tmax were available for 8,005 (55.5%) and 7,872 (54.6%) of all patients. Tables exhibit the odds ratio (95% CI) of survival to discharge by Tmin and Tmax and Tdelta groups. **Conclusions-** Spontaneous hyperthermia and hypothermia following in-hospital cardiac arrest is associated with lower odds of survival to discharge. Liability of temperature  $>1^{\circ}\text{C}$  is also associated with lower odds of survival to discharge.

Tmin	Odds Ratio (95%CI)	p-value
<32°C	0.16 (0.03-0.93)	0.041
32-34°C	0.60 (0.35-1.06)	0.074
34-36°C	0.97 (0.79-1.19)	0.782
36-38°C	1.00	REF
>38°C	0.31 (0.16-0.59)	0.000
Tmax	Odds Ratio (95% CI)	p-value
<32°C	0.13 (0.01-1.48)	1.00
34-36°C	0.28 (0.17-0.46)	0.000
36-38°C	1.00	REF
>38°C	0.62 (0.50-0.76)	0.000
Tdelta	Odds Ratio (95% CI)	p-value
0-1°C	1.00	REF
1-2°C	0.78 (0.63-0.97)	0.024
2-3°C	0.67 (0.50-0.90)	0.007
3-4°C	0.63 (0.41-0.97)	0.036
4-5°C	0.22 (0.10-0.46)	0.000
>5°C	0.44 (0.17-1.14)	0.092

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## Ventilation Is Necessary During Cardiopulmonary Resuscitation In A Rat Model Of Cardiac Arrest Induced By Airway Obstruction

Akihide Kurita, Takumi Taniguchi, Ken Yamamoto; Kanazawa Univ, Kanazawa, Japan

Recent studies have showed that hypoventilation during cardiopulmonary resuscitation (CPR) improved the rates of return of spontaneous circulation (ROSC) and prognosis. However, there are few studies about the ventilation strategies during CPR in cardiac arrest caused by airway obstruction. To compare the effects of the three ventilation strategies during CPR in an animal model of cardiac arrest induced by airway obstruction, we investigated the rates of ROSC, survival rates, plasma cytokine levels, and lactate levels. thirty-six male Sprague Dawley rats were anesthetized with intraperitoneal injection of pentobarbital. Cardiac arrest was induced by airway obstruction. After 3 minutes of cardiac arrest, animals were randomized to receive one of the three ventilation strategies during CPR (n = 12 per group): normoventilation (28 breaths/min), hypoventilation (14 breaths/min), or no-ventilation. The rates of chest compression (CC) was 240-260 compressions/min and the depth of CC adjusted to maintain mean arterial pressure more than 25 mmHg in all groups. After 5 minutes of CPR, epinephrine (0.02 mg/kg) was administered, and all rats were ventilated at the rates of 28 breaths/min in FIO2 1.0. The rates of ROSC were 83%, 58%, 0% for the normoventilation, hypoventilation, and no-ventilation groups, respectively. The PaCO2 levels immediately after ROSC were 74mmHg and 88 mmHg for the normoventilation, and hypoventilation groups, respectively. The increases of plasma cytokine (TNF- $\alpha$ , and IL-6) levels and lactate levels after ROSC in the normoventilation group were significantly less than those in the hypoventilation group. The present study showed that normoventilation during CPR improved the rates of ROSC and the survival rates after ROSC in the animal cardiac arrest model induced by airway obstruction. Moreover, normoventilation attenuated the elevation of cytokine and lactate responses. These findings suggest that ventilation may be necessary during CPR in cardiac arrest caused by airway obstruction.

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## Alterations In Left Ventricular Function After High-voltage Electrical Injury Assessed By Two-dimensional Speckle Tracking Echocardiography

Seong Hwan Kim, Hong Euy Lim, Eung Ju Kim, Woo Hyuk Song, Yong Hyun Kim, Jeong Cheon Ahn, Korea Univ Ansan Hosp, Ansan, Republic of Korea; Wan Joo Shim, Korea Univ Anam Hosp, Seoul, Republic of Korea; Goo-yeung Cho, Hallym Univ Sacred Heart Hosp, Anyang, Republic of Korea; Min-Kyu Kim, Woo-Jung Park, Jong-Hyun Kim; Hallym Univ Hangan Sacred Heart Hosp, Seoul, Republic of Korea

Myocardial damage after exposure to high-voltage electrical current has been reported to result in a serious and often life-threatening situation. However, because the diagnosis of myocardial injury based on ECG findings, creatinine kinase MB (CK-MB), and myocardial pyrophosphate scans is not reliable, the changes in myocardial function after high-voltage electrical injury are not identified yet. We investigated the alterations in the left ventricular function using two-dimensional speckle tracking imaging after high-voltage electrical injury. A total of 11 male patients (mean age  $37 \pm 7$ ) with non-flash high-voltage ( $>22,900$  volts) electrical injuries were prospectively evaluated. Serial echocardiogram was obtained on days 1, 3, and 7 after admission. In addition, serum CK-MB and troponin I levels were drawn on admission and every 6 hours for the first 24 hours. All parameters of study patients were compared to age- and sex- and body mass index-matched healthy control (n=11). At admission and during follow up, there were no significant differences in left ventricular (LV) dimension, stroke volume index, cardiac output index, fractional shortening, ejection fraction, and peak strain (S) when compared to controls. In contrast to peak strain, peak systolic mitral annular velocity (Sa) and peak systolic strain rate (SR) were significantly increased and maintained throughout follow up in patient group (Table). No significant correlations were found between the increase of troponin I or CK-MB levels and all parameters of LV systolic function. In conclusion, these results demonstrate that the LV myocardial change after high-electrical injury is related to an increase of regional and global LV function through increased myocardial contractility rather than myocardial depression, and indicate changes of troponin I or CK-MB levels are not associated with myocardial damage.

	Control (n = 11)	Admission (n = 11)	3 days (n = 11)	7 days (n = 10)
Sa	7.7 $\pm$ 1.1	9.1 $\pm$ 1.4*	10.5 $\pm$ 1.9†	10.0 $\pm$ 1.4†
Longitudinal S	-20.1 $\pm$ 1.8	-19.6 $\pm$ 2.9	-20.1 $\pm$ 2.4	-20.3 $\pm$ 9.6
Longitudinal SR	-1.17 $\pm$ 0.13	-1.53 $\pm$ 0.31†	-1.49 $\pm$ 0.21†	-1.38 $\pm$ 0.16†
Circumferential S	-22.7 $\pm$ 9.3	-20.9 $\pm$ 3.9	-20.1 $\pm$ 2.3	-20.9 $\pm$ 3.9
Circumferential SR	-1.45 $\pm$ 0.24	-1.99 $\pm$ 0.31†	-2.06 $\pm$ 0.41†	-2.00 $\pm$ 0.39†
Radial S	56.7 $\pm$ 11.6	56.1 $\pm$ 15.7	51.5 $\pm$ 10.3	55.3 $\pm$ 6.3
Radial SR	2.07 $\pm$ 0.33	2.48 $\pm$ 0.49*	2.12 $\pm$ 0.67	2.36 $\pm$ 0.51

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## The Incidence Of Pulmonary Aspiration With Laryngeal Mask Airway Use During Cardiopulmonary Resuscitation And Positive Pressure Ventilation In Swine.

Brian Suffoletto, James Menegazzi, Eric Logue, David Salcido; Univ of Pittsburgh, Pittsburgh, PA

**Objective:** Pulmonary aspiration of gastric contents occurs 20-30% of the time during cardiopulmonary resuscitation (CPR) of cardiac arrest. This is due to loss of protective airway reflexes, pressure changes generated during CPR, and positive pressure ventilation (PPV). Even though the American Heart Association (AHA) has recommended the laryngeal mask airway (LMA) as an acceptable alternative airway for use by EMS personnel, concerns over the capacity of the device to protect from pulmonary aspiration remain. We sought to determine the incidence of aspiration after LMA placement, CPR and PPV. **Methods:** We conducted a prospective study on 16 consecutive post-experimental mixed-breed domestic swine of either sex (mean mass  $25.7 \pm 1.4$  kgs). A standard size-4 LMA was modified so that a vacuum catheter could be advanced into and past the LMA diaphragm. The LMA was placed into the hypopharynx and its position confirmed using End-tidal CO<sub>2</sub> and direct visualization of lung expansion. Fifteen milliliters of heparinized blood were instilled into the pharynx. After 5 PPVs with a mechanical ventilator, chest compressions were performed for 60s with asynchronous ventilations continuing at a rate of 12 per minute. After chest compressions, a suction catheter was inserted through the cuff and suction applied for approximately 1 minute. The catheter was removed and inspected for signs of blood. The LMA cuff was deflated and the LMA removed. The intima of the LMA diaphragm was inspected for signs of blood. In a validation cohort of 4 animals, the LMA was reinserted, a cricothyrotomy performed and 5 mL of blood instilled directly into the trachea. Results: There were 0/16 (95% CI=0-17%) with a positive tests for the presence of blood in both the vacuum catheter and the intima of the LMA diaphragm. In the validation cohort, all four were positive for blood in both the vacuum catheter and the intima of the LMA diaphragm. **Conclusions:** In this simple model of regurgitation of after LMA placement, there was no sign of pulmonary aspiration, and no evidence that blood had passed beyond the seal created by the LMA cuff. Concerns over aspiration with LMA use may be unfounded. Future studies should determine the frequency of pulmonary aspiration after LMA placement in the clinical setting.

## Prehospital induced hypothermia after out-of-hospital cardiac arrest: Emergency Medical Services State of the Practice in the US in 2007

Brian Suffoletto, James Menegazzi, David Salcido; Univ of Pittsburgh, Pittsburgh, PA

**Objective**—Post-resuscitation care of comatose survivors of cardiac arrest using induced hypothermia (IH) is recommended by the American Heart Association (AHA) and the International Liaison Committee on Resuscitation (ILCOR). However, the current rate of its use by Emergency Medical Services (EMS) in the US is not known. We sought to determine the prevalence of EMS agencies that initiate IH in the prehospital setting, and to identify perceived barriers to initiating IH. **Methods**—We conducted a prospective, anonymous, IRB-approved survey using a convenience sample of physician members of the National Association of EMS Physicians. We conducted the survey during the national conference, from January 11–13, 2007. **Results**—One-hundred forty-five of the 244 (59%) physician members in attendance completed the survey, representing 109 EMS Medical Directors and 36 non-Medical Director EMS Physicians from 92 regions of 34 US states. A total of 9/145 (6.2%) physicians stated that the EMS agency they are affiliated with have protocols for IH. The median (IQR) duration of having a protocol was 12 months (6–12) and all used either ice bags or cold IV fluid, or a combination of the two. Among those that reported prehospital use of IH, only 1/8 (12.5%) reported having cooled greater than 10% of eligible patients. Common perceived barriers to IH include: providers being overburdened with other tasks (62.1%), short transport times (60.7%), lack of refrigeration equipment (60.0%), and receiving hospitals' failure to continue therapeutic hypothermia (56.6%). Twenty-two percent incorrectly indicated that IH was not in the AHA guidelines and only 62% correctly identified 32–34 degrees C as the recommended target temperature range. **Conclusions**—Despite advisory statements from the AHA/ILCOR recommending the early implementation of post-resuscitation cooling of comatose survivors of cardiac arrest, prehospital initiation of IH in the US is rare. Infrequent use of prehospital IH seen in our sample may be due to the perceived barriers that were identified and/or incomplete understanding of guidelines by medical providers. Future studies should examine methods for overcoming barriers and improving guideline dissemination to EMS physicians.

## Resuscitation Science Symposium: Best of the Best (Oral Abstract Presentations Part II)

Sunday Morning  
Room 230ab  
Abstracts 61–65

### Acute Cardiac Catheterization in Survivors of Sudden Cardiac Arrest due to Ventricular Fibrillation is Associated with Improved Survival

Justin A Strote, Charles Maynard, Carol Fahrenbruch, Univ Of Washington, Seattle, WA; Michael Copass, Michele Olsufka, Leonard Cobb, Harborview Med Cntr, Seattle, WA; Francis Kim; Univ Of Washington, Seattle, WA

**Background:** Acute coronary lesions are present in patients with sudden cardiac arrest (SCA) between 10 and 90% in autopsy series, and chronic stenotic lesions are also present. Despite a report of patients with resuscitated SCA (rSCA) receiving acute catheterization, the efficacy of this strategy remains unknown. We hypothesized that acute cardiac catheterization of patients with rSCA would improve survival to hospital discharge. **Methods:** A retrospective cohort of 240 patients with out-of-hospital rSCA due to ventricular tachycardia or fibrillation was identified from 11 institutions in Seattle, Washington, between 1999 and 2002. Patients were grouped into those receiving acute catheterization within 6 hours (Group A, n = 61), and those either receiving delayed catheterization at greater than 6 hours, or those not receiving catheterization during the index hospitalization (Group B, n = 179). Outcome measures were survival to hospital discharge, neurologic status, extent of coronary artery disease (CAD), presenting electrocardiographic (ECG) findings, and pre-arrest symptomatology. **Results:** 46/61 (75%) survived in Group A, whereas 87/179 (49%) survived in Group B (p < 0.001). Neurologic status mirrored this pattern. Percutaneous coronary intervention (PCI) was performed in 38/61 (62%) of patients in Group A, and 13/42 (31%) in Group B who received delayed catheterization (p = 0.002 by Chi-square). Multivariate propensity scoring revealed that age, bystander CPR, daytime presentation, history of percutaneous coronary intervention, neurologic disease, and ST elevation were all positively associated with receiving cardiac catheterization (Table 1). **Conclusions:** Acute cardiac catheterization was associated with higher survival in patients with rSCA. This may be in part due to increased utilization of PCI in this population, however, selection bias is also a likely factor.

Table 1: Likelihood of undergoing acute catheterization and hospital discharge status

Propensity	Discharged Alive	% Undergoing Acute Cath
< 0.25	24/25 (96%)	12%
0.25–0.69	21/24 (87%)	50%
0.70–0.93	16/27 (59%)	85%
≥ 0.94	20/24 (83%)	92%

### Resuscitation with Actual Performance Integrated Debriefing (RAPID) Improves CPR Quality and Initial Patient Survival

Dana P Edelson, Barbara Litzinger, Vineet Arora, Deborah Walsh, Univ of Chicago, Chicago, IL; Salem Kim, Univ of Pennsylvania, Philadelphia, PA; Diane S Lauderdale, Terry L Vanden Hoek, Univ of Chicago, Chicago, IL; Lance B Becker, Benjamin S Abella; Univ of Pennsylvania, Philadelphia, PA

**Introduction** Recent investigations have documented poor cardiopulmonary resuscitation (CPR) performance in clinical practice. We hypothesized that a debriefing intervention using CPR quality data from actual cardiac arrests (Resuscitation with Actual Performance Integrated Debriefing, or RAPID) would improve CPR performance and initial patient survival. **Methods** Rescuers at a university teaching hospital underwent weekly RAPID sessions between March, 2006 and February, 2007. During the intervention period, facilitators led debriefing discussions using actual performance data, obtained from a CPR-sensing defibrillator with audiovisual feedback capability, and highlighted deficiencies in CPR quality and defibrillation. These data were compared to an historical control in which a similar defibrillator was used. The main outcomes were objective metrics of CPR performance and initial return of spontaneous circulation (ROSC). **Results** CPR quality and outcome data from 123 patients resuscitated during the intervention period were compared to 101 patients in the baseline cohort. Compared to the control period, CPR quality parameters and defibrillation accuracy were improved (table). These were associated with a significant improvement in the unadjusted rate of ROSC (table). After adjusting for shockable vs. non-shockable rhythm, time and location of arrest, and patient demographics, the RAPID intervention was associated with a significant increase in the adjusted odds of ROSC (OR 1.84 [1.06–3.20]; p=0.03). **Conclusions** The combination of RAPID and real-time audiovisual feedback improved CPR quality over the use of feedback alone, and was associated with an increased rate of ROSC. CPR sensing and recording devices allow for methods of debriefing that were previously available only for simulation based education; such methods have the potential to fundamentally alter resuscitation training and improve patient outcomes.

Resuscitation Performance and Patient Outcomes by Cohort

	Baseline	RAPID	p value
Compression depth (mm)	44 (11)	50 (10)	0.0001
Compression rate (/min)	100 (13)	105 (10)	0.003
Ventilation rate (/min)	18 (8)	13 (7)	<0.0001
No-flow fraction	0.20 (0.13)	0.13 (0.10)	<0.0001
Pre-shock pause (sec)	16.0 (8.5–24.1)	7.5 (2.8–13.1)	<0.0001
Post-shock pause (sec)	7.1 (2.7–14.8)	2.4 (1.9–3.6)	<0.0001
Appropriate shocks	110/151 (72.8%)	104/117 (88.9%)	0.001
ROSC	45/101 (44.6%)	73/123 (59.4%)	0.03

### Hands-On Defibrillation: An Analysis of Current Flow Through Rescuers In Contact With Patients During Biphasic External Defibrillation

Michael S Lloyd, Eric L Krivitsky, Paul F Walter, Jonathan J Langberg; Emory Univ, Atlanta, GA

**Background:** During cardiopulmonary resuscitation, the need for rescuers to stand clear before a shock is delivered invariably interrupts chest compressions. Brief interruptions like these reduce the efficacy of defibrillation in animal models. Current flow through a rescuer in contact with a patient being shocked with modern biphasic waveforms and adhesive patch electrodes has not been investigated. We hypothesized that leakage current is low through a rescuer performing chest compressions at the time of shock delivery. **Methods:** During 18 elective cardioversions using truncated exponential biphasic waveforms (median energy 200 joules, range 100–360 joules), an investigator serving as the rescuer placed a gloved hand on the patient's anterior chest immediately adjacent to the defibrillating patch with approximately 20lbs of pressure to simulate chest compressions. Skin electrodes were used to connect the rescuer's thigh to the patient's posterior shoulder, simulating a worst-case return current pathway. During shock delivery, voltage and current through the rescuer (hand to thigh) were recorded using a digital storage oscilloscope during the shock delivery. **Results:** In no cases were shocks perceptible to the rescuer. Mean patient transthoracic impedance was 57 +/- 14 ohms (range 36–79 ohms). Potential differences in volts (V) between the rescuer's wrist and thigh ranged from 1.7 to 14 V (mean 6.7 +/- 2.7 V). Calculated impedances through rescuers ranged from 8,190 to 100,400 ohms (mean 30,100 +/- 20,400 ohms). The average leakage current flowing through the rescuer's body for each phase of the shock waveform was 273 +/- 191 microamperes (range 1 to 910 microamperes). All measured values in our series were well below 2,500 microamperes, an accepted safety standard for earth-leakage current in medical devices. **Conclusions:** Even in a simulated worst-case scenario, a rescuer performing chest compressions during biphasic external defibrillation is exposed to low levels of leakage current. Our findings demonstrate the safety and feasibility of uninterrupted chest compressions during shock delivery, which may enhance the efficacy of defibrillation and cardiocerebral perfusion.

### A Tale of Seven EMS Systems: An Impedance Threshold Device and Improved CPR Techniques Double Survival Rates After Out-of-Hospital Cardiac Arrest

Tom P Auferheide, Med College of Wisconsin, Milwaukee, WI; Marvin Birnbaum, Madison Fire Dept, Madison, WI; Charles Lick, Allina Med Transportation, Anoka County, MN; Brent Myers, Wake County EMS, Raleigh, NC; Laurie Romig, Pinellas County EMS, Largo, FL; Joseph Stothert, Omaha Fire Dept, Omaha, NE; Levon Vartanian; Cypress Creek and Harris County EMS, Cypress Creek, FL

**Introduction:** Maximizing outcomes after cardiac arrest depends on optimizing a sequence of interventions from collapse to hospital discharge. The 2005 American Heart Association (AHA)

Guidelines recommended many new interventions during CPR ('New CPR') including use of an Impedance Threshold Device (ITD). Hypothesis: The combination of the ITD and 'New CPR' will increase return of spontaneous circulation (ROSC) and hospital discharge (HD) rates in patients with an out-of-hospital cardiac arrest. Methods: Quality assurance data were pooled from 7 emergency medical services (EMS) systems (Anoka Co., MN; Harris Co., TX; Madison, WI; Milwaukee, WI; Omaha, NE; Pinellas Co., FL; and Wake Co., NC) where the ITD (ResQPOD<sup>®</sup>, Advanced Circulatory Systems; Minneapolis, MN) was deployed for >3 months. Historical or concurrent control data were used for comparison. The EMS systems simultaneously implemented 'New CPR' including compression/ventilation strategies to provide more compressions/min and continuous compressions during Advanced Life Support. All sites stressed the importance of full chest wall recoil. The sites have a combined population of ~ 3.2 M. ROSC data were available from all sites; HD data were available as of June 2007 from 5 sites (MN, TX, Milwaukee, NE, NC). Results: A total of 893 patients treated with 'New CPR' + ITD were compared with 1424 control patients. The average age of both study populations was 64 years; 65% were male. Comparison of the ITD vs controls (all patients) for ROSC and HD [Odds ratios (OR), (95% confidence intervals), and Fisher's Exact Test] were: 37.9% vs 33.8% [1.2, (1.02, 1.40), p=0.022] and 15.7% vs 7.9% [2.2, (1.53, 3.07), p<0.001], respectively. Patients with ventricular fibrillation had the best outcomes in both groups. Neurological outcome data are pending. Therapeutic hypothermia was used in some patients (MN, NC) after ROSC. Conclusion: Adoption of the ITD + 'New CPR' resulted in only a >10% increase in ROSC rates but a doubling of hospital discharge rates, from 7.9% to 15.7%, (p<0.001). These data represent a currently optimized sequence of therapeutic interventions during the performance of CPR for patients in cardiac arrest and support the widespread use of the 2005 AHA CPR Guidelines including use of the ITD.

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### Improvement in Survival to Discharge of Cardiac Arrest Patients Using Novel Out of Hospital Treatment Protocol

Alex Garza, Washington Hosp Cntr, Washington, DC; Matthew Gratton, Truman Med Cntr, Kansas City, MO; Daniel Lindholm, Kansas City Missouri Health Dept, Kansas City, MO; Joseph Salamone, Ill, Truman Med Cntr, Kansas City, MO; Rex Archer, Kansas City Missouri Health Dept, Kansas City, MO

Cardiac arrest continues to have poor survival in the U.S. despite wide distribution of AED's to out of hospital providers. Recent studies in time dependent myocardial responsiveness to therapy, myocardial perfusion in post arrest patients, and effect of ventilation, question current practice in resuscitation. Our EMS system made significant changes in the adult cardiac arrest resuscitation protocol, including minimizing chest compression disruptions, using a 50:2 compression\ ventilation ratio, deemphasizing and delaying intubation, and performing an aggressive round of chest compressions before initial counter-shock. Treatment protocols prior to these changes were consistent with the Advanced Cardiac Life Support (ACLS) algorithm. Methods Setting: Midwest, urban, Public Utility Model, all ALS ambulance service with AED equipped BLS fire department first response. Design: Retrospective, observational, cohort study reviewing all adult primary, witnessed cardiac arrests with an initial rhythm of ventricular fibrillation 39 months pre protocol change (pre-c) and 12 months post protocol change (post-c). The outcome of interest was survival to discharge from the hospital. Analysis: Chi Square analysis was performed and Relative Risk with 95% CI were calculated. P value less than 0.05 was considered significant. Results There were 1096 primary cardiac arrest patients of which 150 met the inclusion criteria in the pre-c cohort with 32 (21.3%) patients surviving to discharge. There were 339 cardiac arrest patients of which 52 met inclusion criteria in the post-c cohort. Of these, 23 (44.2%) survived to discharge. There was a significant increase in survival to discharge in the post-c cohort ( $\chi^2 = 7.07$ ,  $p < 0.01$ , RR, 1.82, 95% CI 1.19, 2.00). Discussion The changes to our pre-hospital protocol for adult cardiac arrest optimized chest compressions and reduced disruptions for intubation and ventilation and required compressions before a single counter-shock producing significant increases in survival to discharge in our patient population. These changes should be considered for improving survival of out of hospital cardiac arrest patients.

## Resuscitation Science Symposium: Best Original Resuscitation Science (Moderated Poster Session II and Reception)

Sunday Afternoon  
Room W224  
Abstracts 66–115

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### Effectiveness Of Cardiac-only CPR Training by Self-learning Video, a 1-hour program, or Both

Chika Nishiyama, Taku Iwami, Takashi Kawamura, Masahiko Ando, Kyoto Univ Sch of public health, Kyoto, Japan; Robert A Berg, The Univ of Arizona College of Medicine, Arizona, AZ; Naohiro Yonemoto, Kyoto Univ Sch of public health, Kyoto, Japan; Risa Fukuda, Osaka Univ Graduate Sch of medicine, Osaka, Japan; Haruyuki Yuasa, Kinki Univ Sch of Medicine, Osaka, Japan; Akiko Kada, Hiroyuki Yokoyama, Hiroshi Nonogi, J-PULSE Investigators; National Cardiovascular Cntr, Osaka, Japan

[Introduction]Despite present efforts to train the general public in CPR, the proportion of bystander CPR is still low. Length of CPR training program and complexity of CPR skills may

be barriers to bystander CPR performance. Recently, simple video self-learning has been shown to be an effective CPR training technique. [Objective]To evaluate the effectiveness of cardiac-only CPR training program by a self-learning video, a 1-hour practical course, or both. [Method]Designs: A randomized controlled trial. Participants: General public aged 18 years or older. Intervention: In the video (V) group, participants received the self-learning video before CPR training and then attended a 1-hour cardiac-only CPR training program; in the control (C) group participants attended the training program without a self-learning video. Data collection: Before and immediately after the training, a 2 minute scenario-based test was conducted and CPR skills were recorded. Outcomes: The primary outcome measure was the number of correct chest compressions immediately after the training. We also calculated the achievement of correct chest compressions, which meant the proportion of correct chest compressions in relation to the ideal number of chest compressions based on 2005 CPR guideline. [Result]214 participants were randomly assigned to V (108) and C (106) groups. Before the training, the proportion of attempting chest compression, attempting AED operation, and calling for an AED, and the total number of chest compressions were significantly greater in the V group. After the training, all measured CPR skills of both groups improved substantially compared with pre-training skills, but there were no differences between groups (Table). [Conclusion]A self-learning video improved CPR skills. However, a 1-hour practical training course was substantially more effective and the addition of a self-learning video did not improve its effectiveness.

Table: CPR Skills of Pre- and Post-training

	Pre-training			Post-training		
	V (n=95)	C (n=87)	p-value	V (n=95)	C (n=87)	p-value
Call for help (119), n (%)	52 (54.7)	22 (25.3)	<0.001	93 (97.7)	85 (97.9)	1.000
Call for an AED, n (%)	40 (42.1)	3 (3.4)	<0.001	90 (94.7)	84 (96.6)	0.720
Attempts of chest compressions, n (%)	88 (92.6)	56 (66.7)	<0.001	95 (100)	87 (100)	1.000
Total number of chest compressions, n	92.8±64.8	49.0±57.3	<0.001	161±31.8	159.0±35.7	0.628
Number of correct chest compressions, n	23.8±39.1	12.9±27.0	0.031	74.7±65.9	88.8±67.0	0.196
Achievement of correct chest compressions, %	13.0±21.4	7.0±14.8	0.031	40.8±36.0	48.5±36.6	0.196
Attempts of AED operation, n (%)	71 (74.7)	25 (28.7)	<0.001	95 (100)	87 (100)	1.000
Correct position of the defibrillator pad, n (%)	57 (60.0)	16 (18.4)	<0.001	90 (94.7)	85 (97.7)	0.450

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### Vasopressin impairs Brain, Heart and Kidney Perfusion in Acute Heart Failure

Stig Müller, Ole-Jakob How, Stig E Hermansen, Truls Myrnes, Univ Hosp North Norway, Tromsø, Norway

Arginin Vasopressin (AVP) is increasingly used to restore mean arterial pressure (MAP) in various circulatory shock states including cardiogenic shock. This is potentially deleterious since AVP is also known to reduce cardiac output by increasing vascular resistance. Aim: We hypothesized that restoring MAP by AVP improves vital organ blood flow in experimental acute cardiac failure. Methods: Cardiac output (CO) and arterial blood flow to the brain, heart, kidney and liver were measured in nine pigs by transit-time flow probes. Heart function and contractility were measured using left ventricular Pressure-Volume catheters. Catheters in central arteries and veins were used for pressure recordings and blood sampling. Left ventricular dysfunction was induced by intermittent coronary occlusions, inducing an 18 % reduction in cardiac output and a drop in MAP from  $87 \pm 3$  to  $67 \pm 4$  mmHg. Results: A low-dose therapeutic infusion of AVP (0.005 u/kg/min) restored MAP but further impaired systemic perfusion (CO and blood flow to the brain, heart and kidney reduced by 29, 18, 23 and 34 %, respectively). The reduced blood flow was due to a 2.0, 2.2, 1.9 and 2.1 fold increase in systemic, brain, heart and kidney specific vascular resistances, respectively. Contractility remained unaffected by AVP. The hypoperfusion induced by AVP was most likely responsible for observed elevated plasma lactate levels and an increased systemic oxygen extraction. Oxygen saturation in blood drawn from the great cardiac vein fell from  $31 \pm 1$  to  $22 \pm 3$  % dropping as low as 10 % in one pig. Finally, these effects were reversed forty minutes after weaning the pigs from the drug. Conclusion: The pronounced reduction in coronary blood flow point to a potentially deleterious effect in postoperative cardiac surgical patients and in patients with coronary heart disease. Also, this is the first study to report a reduced cerebral perfusion by AVP.

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### Transthoracic Application of Medium Voltage Therapy for Treatment of Cardiac Arrest

Hao Wang, Wanchun Tang, Min-shan Tsai, Shijie Sun, Yongqin Li, Carlos Castillo, Jun Guang, Max H Weil; Weil Institute of Critical Care Med, Rancho Mirage, CA

Background. Previous studies suggest that transthoracic stimulation voltage in the range of 200 V produces coronary arterial blood pressure waveforms. This electrical therapy might represent a new approach to generate and maintain forward blood flow prior to defibrillation in victims of cardiac arrest. The present study investigated efficacy of the medium voltage therapy (MVT) waveform on coronary and cerebral perfusion during ventricular fibrillation (VF) in a porcine model of cardiac arrest. Hypothesis. After a short interval of untreated cardiac arrest, MVT may be effective in producing threshold levels of coronary perfusion pressure (CPP), carotid artery blood flow (CBF) and end-tidal CO<sub>2</sub> (EtCO<sub>2</sub>), at least equal to that produced by manual chest compressions (MCC). Methods and Results. In 5 domestic male pigs

weighing  $40 \pm 2$  kg, VF was electrically induced and untreated for 10 seconds. Animals were then randomized to receive either MVT or MCC. MVT or MCC was applied for 20 seconds. For MVT, pulsed packet durations were 200 ms, the pulsed packet rate was 120 per minute, intra-packet pulse durations were 0.15 ms and the intra-packet pulse period was 15 ms. A biphasic shock was then delivered. Aortic blood flow and the kinesis of the left ventricle wall were measured by transesophageal echo-Doppler technique. Ten series of each treatment were performed. During MVT, visible transaortic valve flow was observed. However, no kinesis of the left ventricle wall was observed. The CPP, CBF and  $\text{EtCO}_2$  during MVT were comparable to that of MCC (Table). **Conclusion.** MVT was effective in the production of threshold levels of CPP, forward CBF and  $\text{EtCO}_2$  comparable to that produced by MCC following a short interval of untreated cardiac arrest.

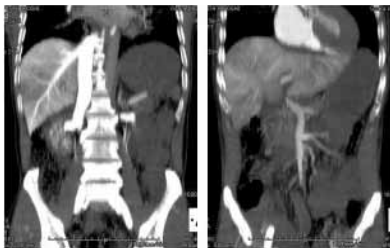
GROUP	NO	CPP(mmHg)	CBF (ml/min)	$\text{EtCO}_2$ (mmHg)
MVT	10	$20.9 \pm 8.1$	$70.4 \pm 26.2$	$32.1 \pm 21.1$
MCC	10	$25.6 \pm 8.7$	$61.8 \pm 24.9$	$42.4 \pm 10.6$
P value		NS	NS	NS

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### Evaluation Of Abdominal Blood Flow During Chest Compression In Cardiac Arrest Patients Using Enhanced Computed Tomography (CT)

Yasumasa Oode, Kentarou Shimizu, Asako Matsushima, Kentarou Kajino, Yuukou Nakagawa, Osamu Tasaki, Tadahiko Shiozaki, Hiroshi Ogura, Yasuyuki Kuwagata, Hiroshi Tanaka, Takeshi Shimazu, Hisashi Sugimoto; Osaka Univ Hosp, suite, Japan

Background: The mechanism of blood flow during chest compression in cardiac arrest patients remains under investigation. We often experience that cardiac arrest patients suffer severe diarrhea after successful cardiopulmonary resuscitation(CPR), which would be attributable to intestinal ischaemia during cardiac arrest and resuscitation. However, few studies have been made to evaluate abdominal blood flow during chest compression in cardiac arrest patients. Patients and Methods: The study was made in four patients immediately after termination of cardiopulmonary resuscitation. A 100ml bolus of 300 mg/ml contrast medium was injected from a short femoral vein catheter, followed by continuous chest compression at a rate 100/min. In order to evaluate the distribution of contrast medium, CT images of the chest and abdomen were taken after 100 and/or 200 chest compressions, respectively. Results: CT scans showed similar enhance patterns in the patients. After 100 chest compressions, enhancement values were higher at inferior vena cava(IVC) regions compared to ascending aorta and main arteries. After 200 compressions, enhancement values of the arteries were increased by two to four times. However, significant enhancement of hepatic veins and limited enhancement of portal veins suggest impaired perfusion of the liver and the bowel. Conclusion: One hundred or 200 chest consecutive compressions are not sufficient to enhance abdominal organs including the liver and bowel. Figures: Typical MPR(Multiplanar reconstruction) images after 100 compressions at two different coronal planes; hepatic vein and IVC(left), portal veins(right) are depicted.



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### Improving the Prehospital Trauma Triage Guidelines for Physiologic Derangement: Can We Do Better?

Craig D Newgard, Oregon Health & Science Univ, Portland, OR; Kyle Rudser, Univ of Washington, Seattle, WA; Jerris R Hedges, Oregon Health & Science Univ, Portland, OR; Eileen Bulger, Univ of Washington, Seattle, WA; Ian G Stiell, Univ of Ottawa, Ottawa, Canada; Daniel Davis, Univ of California at San Diego, San Diego, CA; Laurie J Morrison, Univ of Toronto, Toronto, Canada; Jeffrey Kerby, Univ of Alabama, Birmingham, AL; Thomas E Terndrup, Penn State Milton S. Hershey Med Cntr, Hershey, PA; Joseph P Minei, Univ of Texas Southwestern Med Cntr, Dallas, TX; Scott Emerson, Univ of Washington, Seattle, WA; Resuscitation Outcomes Consortium

**Introduction:** The American College of Surgeons (ACS) recommends immediate transport to a trauma center for all injured persons with field physiologic derangement (ACS Step 1 trauma triage criteria). However, it remains unclear whether these criteria could be refined to identify high-risk trauma patients with improved predictive value. **Hypothesis:** We assessed the hypothesis that an easily applied, prehospital, clinical decision rule could be developed to better identify high-risk injured persons meeting ACS Step 1 criteria. **Methods:** We conducted a prehospital prospective cohort study of injured adults  $\geq 15$  years where field resuscitation was attempted and ACS physiologic criteria were present: SBP  $\ll 26 > 90$ , RR  $\ll 10$  or  $> 29$  breaths/minute, GCS  $\ll 26 > 12$ , or field intubation. Population-based data were collected from December 1, 2005 through November 30, 2006 by 268 EMS agencies transporting to 287

acute care hospitals (trauma and non-trauma centers) in 11 sites across the U.S. and Canada. Ten prehospital variables were assessed: SBP, RR, GCS, pulse, pulse oximetry, shock index (pulse/SBP), mechanism of injury, penetrating injury, age, and gender. High risk injured persons included: death (before or after admission) or hospital LOS  $> 2$  days. 60% of the sample was randomly selected for rule derivation and analyzed using classification and regression tree analysis. The remaining 40% were used for rule validation. The final rule was based on a targeted sensitivity of  $> 90\%$ . **Results:** Of 4,983 eligible patients, 4,326 injured persons had complete outcome information and were included in the analysis. The sample included 2,495 (58%) persons with death or LOS  $> 2$  days, as well as 1,061 (25%) patients that did not require admission. The final rule included the following variables (in order): field intubation, GCS  $< 8$ , shock index  $> 1.4$ , mechanism of injury, and age  $\geq 70$  years. Rule validation demonstrated the following accuracy measures: sensitivity 94.9% (95% CI 93.5–96.3%), specificity 14.1% (95% CI 11.6–16.6%). **Conclusions:** While we were able to generate a highly sensitive decision rule, the rule appears too complex for field application and is non-specific. Further refining ACS physiologic triage criteria to increase predictive value remains an ongoing challenge.

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### Is the new Basic Life Support protocol (2005) easier to learn?

Jozsef Betlehem, Gabor Nagy, Jozsef Marton, Univ of Pecs, Pecs, Hungary; Zsigmond Gondocs; National Ambulance Service, Budapest, Hungary

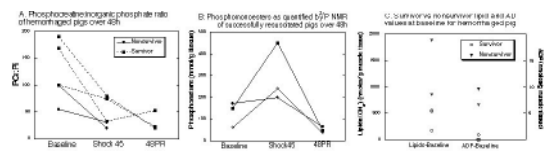
Objectives: The effective learning of basic life support (BLS) skills in the process of training is always an important expectation during the course. Each assessment of BLS training is a complex, continuous action where the evaluation should not be subjective by using the examiner's experiences only. In order to reach the reliable standard of pedagogical assessment, our department developed a score to ensure more objectivity on BLS examination. Methods: The developed scoring tool which is consistent with the steps of 2000 and 2005 ERC BLS protocols was introduced at the faculty. After a trial period we assessed in a cross sectional study design 156 students in 2005/2006 first semester based on 2000 ERC BLS, and 207 students in 2006/2007 first semester based on 2005 ERC BLS protocol. The volunteers are between the age 18 and 25 years, and all students studied the same BLS protocol in 28 hours/semester. The data were analyzed by Chi Square test and cross tabulation with SPSS 11.00. Results: The positive results in all steps of 2005 BLS protocol were correlating with successful of BLS exams significantly. Comparing the five steps of 2005 BLS protocol to 2000 BLS protocol, the checking for responsiveness ( $p=0.001$ ), shouting for help ( $p=0.013$ ), checking for breathing ( $p=0.000$ ; Phi 0.068 vs 0.459), chest compression ( $p=0.000$ ; Phi: 0.443 vs 0.472), breathing ( $p=0.000$  Phi: 0.360 vs 0.764), seemed to be influencing the successful exams in the 2005 ERC BLS protocol significantly, which made it easier to learn the new protocol, too. There was not significant correlation between the genders in case of 2000 or 2005 BLS protocol. Conclusions: Our earlier developed score is useful in evaluating the 2005 BLS protocol and the new protocol can be learned more successfully.

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### Muscle Metabolomic Changes in a Porcine Model of Hemorrhagic Shock and Resuscitation

Nancy Witowski, Greg Beilman; Univ of Minnesota, Minneapolis, MN

Introduction: Treatment of hemorrhage shock remains a clinical challenge despite decades of study. Investigation of metabolism during hemorrhagic shock and resuscitation may yield novel approaches for intervention strategies. Methods: Pigs underwent a standardized hemorrhagic shock protocol after general anesthesia and instrumentation. Animals were hemorrhaged via IVC cannula, then resuscitated to a goal of 80 mm Hg systolic blood pressure after 45 minutes. Animals were fully resuscitated after 8 hours and weaned and euthanized at 24 hours after beginning experiment. Survivors were sacrificed at 48 hours post-hemorrhage. Muscle samples were obtained at baseline (prior to hemorrhage), shock45 (after 45 min of shock), and 8, 23, and 48 h post resuscitation (PR). Muscle samples were processed using a dual-phase extraction process and the water-soluble metabolites examined by 1H and 31P NMR. Results: The phosphocreatine:inorganic phosphate ratio decreases with shock and remains below baseline values at 48 h PR (A). Phosphoesters (glycolytic intermediates) increase during shock and return to levels below baseline at 48PR in successfully resuscitated pigs (B). Non-survivors exhibited higher levels of 1H NMR-visible lipids and of 31P NMR-visible ADP at baseline when compared to survivors (C). Conclusions: Hemorrhage shock induces metabolic changes observable with NMR spectroscopy. Survivors exhibited persistent metabolic changes not resolved at 48 hours. Response to hemorrhage and risk of mortality may be dependent on initial metabolic state.





### Rapid Whole Body Cooling in Large Swine: Effects on Heart Rate and Arterial Blood Pressure

William Ohley, Univ of Rhode Island, Kingston, RI; Robert B Schock, Life Recovery Systems, Kinnelon, NJ; Cathy Klock, Univ of Rhode Island, Kingston, RI; Lorraine Schofield, Rhode Island Hosp, Providence, RI; Marc Cote, Robert Freedman; Life Recovery Systems, Kinnelon, NJ

There have been recent reports of a variety of cooling methods for reducing the body temperature of victims of post resuscitative syndrome. In the work reported here we cooled a series of large (> 60 kg) domestic swine (n=6) using a whole body approach. The animals were anesthetized using propofol and buprinorphine and instrumented with arterial pressure monitoring and ECG, and thermocouple sensors in the pulmonary artery (PA), carotid artery, tympanic membrane and esophagus. With an initial average PA temperature at 37 ( $\pm$  0.3) °C, the swine underwent a rapid cooling sequence. This was performed with a flexible surround suit system that provided for a thin 0.5 cm layer of circulating ice water in direct skin contact held between 0.5° and 1.5 °C. A pumping system was used to circulate the water volume of 20 liters at a rate of 15 liters per minute. The average PA temperature at the start was 37 ( $\pm$ 0.3) °C. Cooling was targeted at 34 °C with an average value of 34.1 ( $\pm$ 0.3) °C. Time to fall 3°C was 13.0 ( $\pm$ 3.0) min. At the same time, heart rate dropped (although not significantly) from 71  $\pm$  7.9 BPM to 59.5  $\pm$  11.4 BPM while mean carotid pressure dropped from 100.3  $\pm$  16 mmHg to 77.3  $\pm$  14.9 mmHg (p<.05). We interpret these changes as beneficial reductions in cardiac work while the subject is kept cool. It is hypothesized that this is due to a reduction in total body metabolic demands. Thus it is possible, in addition to positive neurological effects, that the process of rapid whole body cooling also may be effective in reducing total workload seen by the heart, and thus may aid in salvaging myocardium in such patients.

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### Prognostic markers in Myocardial Infarction complicated by Cardiogenic Shock

Roland Prondzinsky, Henning Lemm, Michael Swyter, Nicholas Wegener, Susanne Unverzagt, Justin M Carter, Axel Schlitt, Ute Buerke, Martin Russ, Karl Werdan, Michael Buerke; Dept of Medicine III, Halle/Saale, Germany

**Objectives.** Despite aggressive therapy (including PCI and IABP use), survival following acute myocardial infarction complicated by cardiogenic shock (MI-CS) is poor. Early identification of survivors from non-survivors enables better, patient tailored therapy. We hypothesized that APACHE II scoring and other common markers may provide prognostic information in patients receiving contemporary, PCI based therapy for MI-CS. **Methods.** We conducted the IABP-shock-trial (a monocentric, prospective, randomized, controlled, IABP intervention trial) and analysed potential prognostic markers amongst the whole study population. Forty consecutive patients with acute MI-CS were enrolled and APACHE II scores, Cardiac index (CI), BNP and IL-6 levels were measured at enrolment and daily for 4 days before correlation with subsequent 28 day mortality. **Results.** The mean age was 64  $\pm$  1.9 years, 52% were mechanically ventilated, the mean ejection fraction was 27  $\pm$  2.1% and overall 28 day survival was 67%. The initial (on admission to hospital) and serial (over the 4 days) APACHE II scores successfully discriminated between survivors and non-survivors (initial APACHE II scores, 18.1  $\pm$  1.66 and 29.9  $\pm$  2.88, respectively, p<0.05). Following receiver operating curve (ROC) analysis, APACHE II scores were most predictive of survival followed (in order of predictive value) by CI, IL-6 and BNP (Table 1). Values for APACHE II scores and cardiac index were significantly predictive of survival. **Conclusions.** We conclude that both initial and serial APACHE II scores provide reliable prognostic information for MI-CS patients treated with contemporary, PCI centred therapy. Cardiac index was also of some predictive value. However, in contrast to previous data (applicable mainly to chronic heart failure patients), serial BNP values were not predictive of mortality in this cohort of patients.

Table 1: ROC analysis

Variable (initial timepoint)	Area under curve	Standard error	Asymptotic significance	Lower limit*	Upper limit*
APACHE II score	0.850	0.074	<0.001	0.705	0.995
Cardiac Index	0.771	0.088	0.008	0.598	0.944
IL-6	0.769	0.092	0.011	0.589	0.950
BNP	0.502	0.111	0.987	0.284	0.719

\* of 95% Asymptotic confidence interval

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### Electronic Integrated Monitoring of Medical Emergency Team Calls to a Step Down Unit

Marilyn Hravnak, Univ Pittsburgh Acute T Care, Pittsburgh, PA; Leslie Edwards, Molly Foster-Heasley, Amy Clontz, Cynthia Valenta, Univ of Pittsburgh Med Cntr, Pittsburgh, PA; Michael DeVita, Michael Pinsky; Univ Pittsburgh, Pittsburgh, PA

**Purpose:** Early discharge from intensive care units (ICU) to lower acuity monitoring units (step-down units or SDU) is increasing to improve care throughput. However, the ability of minimally invasive monitoring via electronic integrated monitoring systems (IMS) in SDUs to identify cardiopulmonary deterioration in order to activate Medical Emergency Team (MET) response is unknown. We evaluated the ability of an IMS index value to detect clinically significant events which might trigger activation of the MET earlier than called. **Methods:** Patients were monitored on a 24 bed trauma SDU according to prevailing policy and bedside decision making. An IMS (BioSign™) was inserted into the monitoring system and IMS data were collected in a blinded fashion for 8 weeks from all patients. The IMS uses 4 parameters

(heart rate [HR], respiratory rate [RR], blood pressure [BP], peripheral oxygen saturation [SpO<sub>2</sub>]) to develop a single neural networked signal known as the BioSign Index (BSI). Data were analyzed for patient deterioration according to both BSI trigger value and local MET criteria (DeVita, Qual Safety Health Care 2004). **Results:** Data from 333 patient admissions were evaluated reflecting 18,692 hours of continuous monitoring. SpO<sub>2</sub> monitoring data were absent in 38.5% of monitored hours, despite being mandatory. Most patients were stable throughout their SDU stay. MET activation occurred on 10 occasions (4 respiratory cause [2 SpO<sub>2</sub>, 2 SpO<sub>2</sub>+RR], 2 cardiac (BP), 1 mixed respiratory + cardiac, and 3 other (1 chest pain, 2 acute mental status change). All 7 MET events of respiratory and/or cardiac cause were detected by BSI in advance (mean advanced detection time prior to MET activation was 6.33 hours). Cardiopulmonary deterioration was generally characterized by progressive increases in BSI over time, not step increases. **Conclusion:** In this population, cardiopulmonary deterioration requiring MET activation was uncommon but always preceded by IMS index elevations which would have alerted the nursing staff in advance. Continuous monitoring of physiological variables may be augmented by integrating information from multiple parameters to create a new variable. The new index parameter may detect patient deterioration earlier than single parameter monitoring.

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### Are There Gender Differences on Admission Time, Disease Severity and Treatment at Emergency Room for Acute Coronary Syndrome?

Antonio P Mansur, Larissa C Roza, José Fabri Jr, Rogério B Ramos, Sergio Jallad, Solange D Avakian, Sergio Timerman, Jose A Ramires; Heart Institute (INCOR), Sao Paulo, Brazil

Controversies exist in relation to admission hours at emergency room (ER) and treatment used in women and men with acute coronary syndromes (ACS). Women supposed to be treated inadequately or later to explain higher mortality after acute myocardial infarction (AMI). **Methods:** from January 2003, we prospectively analyzed admission time, clinical characteristics, laboratory, angiographic findings and hospital mortality in 579 patients with ACS in a tertiary hospital ER setting. Admission hours were categorized in four daily periods each one of 6 hours. Traditional risk factors were analyzed; severity of atherosclerosis was based in the number of coronary involved with greater than 50% reduction in lumen size at angiography; and treatment used was classified in clinical, angioplasty plus stent placement and surgical myocardial revascularization. **Results:** age (59.8  $\pm$  11.8 vs 63.2  $\pm$  11.9 years; p<0.01), smoking (16% vs 6%; p=0.026), hypertension (47% vs 31%; p=0.032), diabetes (16% vs 13%; p=0.013) and dyslipidemia (24% vs 18%; p=0.030) were greater in men. Admission times were similar in women and men for all daily periods [0:01h-6:00h: 16% vs 13%; 6:01h-12:00h: 30% vs 30%; 12:01h-18:00h: 32% vs 28%; 18:01-24:00h: 25% vs 26%; (p=NS)]. Severity of coronary disease was greater in men and underwent to more angioplasty with stent placement (39% vs 17%; p<.01). Clinical (20% vs 18%; p=NS) and CABG (4% vs 2%; p=NS) treatments showed no gender differences. Multivariate analysis disclosed body mass index [OR=0.91 (IC95%:0.85-0.98); p=0.01], monocytosis [OR=0.83 (IC95%:0.75-0.92); p<0.01] and CK mass peak [OR=0.99 (IC95%: 0.99-1.00); p=0.02] as independent variables associated with ACS in men. Nevertheless, hospital mortality (3% vs 2%) was similar for all admission times in both women and men. In conclusion, there were no gender differences in arrival time at ER and severity of coronary disease was greater in men justifying more percutaneous intervention in them.

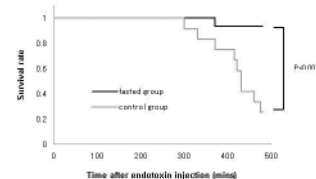
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### Effects Of Short-term Fasting On Mortality, Inflammatory And Coagulation Responses To Endotoxin-induced Shock In Rats

Kyoko Kobayashi, Takumi Taniguchi, Ken Yamamoto; Kanazawa Univ, Kanazawa, Japan

Obesity is a common problem in sepsis. We evaluated the effects of short-term fasting on the mortality rate, inflammatory and coagulation response in rats with endotoxin-induced shock. Male Wistar rats (n=30) were used. Animals were randomly assigned to one of two groups: control group (n=15), receiving intravenous Escherichia coli endotoxin (15 mg/kg over 2 mins); fasted group (n=15), short-term fasting for 3 days before endotoxin injection. The mortality rates, hemodynamics, arterial blood gases, plasma cytokine concentrations and coagulation parameters were measured. The mortality rates at 8hrs after endotoxin injection were 75% and 7% for control and fasted groups, respectively. Hypotension and the increases of TNF-alpha and interleukin-6 concentrations were less for the fasted group than the control group. Moreover, the increase of the prothrombin-time and thrombin-antithrombin III complex were less for the fasted group than the control group. The present study showed that short-term fasting inhibited hypotension and elevations in cytokine concentrations, reducing the mortality rate of rats with endotoxin-induced shock. Moreover, short-term fasting inhibited the elevation of coagulation parameters. These findings suggest that short-term fasting may exert favorable effects during sepsis and septic shock.

Survival curves for fasted and control groups



## Cardiopulmonary and Automatic External Defibrillator handling skills evaluation in lay persons

Thiago L. Silva, Luana D. Olival, Ana P. Quilici, Maria Margarita Gonzalez, Sergio Timerman; Heart Institute (InCor), Univ of Sao Paulo Med Sch, Sao Paulo, Brazil

**Background:** Since the public access of defibrillation law was approved in Sao Paulo city in 2005, it has been increasing the number of lay people who demand for cardiopulmonary resuscitation (CPR) and Automatic External Defibrillator (AED) training courses. According to the law, subway stations should have an AED and 30 per cent of the Agents should be trained in Heartsaver AED. The American Heart Association advises a Basic Life Support (BLS) refresh every two years. However, recent published papers demonstrated a significant decrease in CPR skills only 6 months following a BLS course. **Hypothesis:** we hypothesized that retention of skills in CPR and AED use considerably diminish after 8 month of training in Heartsaver AED course. **Methods:** This is an observational prospective study on the retention of CPR and AED handling skills. Twenty Subway Agents who were previously trained in these maneuvers were evaluated. The evaluation of the skills retention was performed 8 months after the success completion of the first Heartsaver AED course, consisting in a cardiopulmonary arrest simulation in a training mannequin. An experienced Heartsaver AED instructor evaluated the following performed skills: 1) Check for response; 2) Activate Emergency Response System and Get an AED; 3) Open airway; 4) Check breathing; 5) Give two breaths; 6) Perform compressions hard and fast in a correct hands position; 7) AED operation. **Results:** It was observed that the totality of the participants did not fill, at least, one of the requirements of the evaluation: 85% of the participants checked response, 55% asked for help after check response, 45% asked for help at another moment, 45% opened correctly the airway, 30% checked breathing, 50% gave two breathings, 80% performed 30 compressions, 35% performed compressions in a correct frequency and 60% had performed correct chest place CPR. Concerning the AED use, 30% powered the AED in an appropriated manner and 15% correctly attached the pads but 15% removed the pads after the chock. **Conclusion:** The results suggest a possible necessity of a continuous CPR and AED training in view of a significant decreasing in the performance of these skills 8 months following the first training course.

## Emergency Medical Services Utilization in ST-Elevation Myocardial Infarction: Significant Urban Versus Rural Differences

Katie M. Menssen, Timothy D. Henry, Barbara T. Unger, Jeanne M. Oelfke, Christopher E. Kapsner, Jeffrey Meland, Joan Krikava, David M. Larson; Minneapolis Heart Institute Foundation at Abbott Northwestern Hosp, Minneapolis, MN

**Background:** National practice guidelines and strategies for reperfusion recommend pre-hospital ambulance triage of STEMI patients en route to PCI hospitals. Unfortunately, Emergency Medical Services (EMS) have been underutilized which could limit this strategy and cause treatment delays. **Objective:** To assess the prevalence of EMS use by ST-segment myocardial infarction (STEMI) patients and its impact on door to balloon times in a regional STEMI network. **Methods:** Data were obtained from a prospective registry of 1,464 consecutive STEMI patients admitted or transferred to a regional PCI center. **Results:** EMS use by STEMI patients was stratified by gender, age and rural vs urban (table). Only 40% of rural STEMI patients utilize EMS versus 65% of urban patients. In the urban setting there were no significant age group ( $p=0.50$ ) or gender ( $p=0.64$ ) differences. In contrast, in the rural setting, males ( $p<0.0001$ ) and age  $<65$  ( $p<0.0001$ ) are less likely to use EMS. Median door to balloon times were shorter for those using EMS in both urban (60 vs 77 minutes;  $p<0.0001$ ) and rural settings (103 vs 107 minutes,  $p=0.006$ ). **Conclusion:** In contrast to patients in the urban setting, significant gender and age differences are present in rural EMS utilization. Door to balloon times are faster when STEMI patients use EMS in both settings, but less time is saved in rural patients. These findings may impact current reperfusion strategies and should direct public educational efforts towards those subgroups who are least likely to use EMS in the event of an acute myocardial infarction.

Percent of STEMI Patients Using EMS

	Urban	Rural	P-value
Total (n=1,464)	64.8%(199/307)	40.4%(468/1,157)	<0.0001
Male	65.6%(145/221)	37.3%(316/846)	<0.0001
Female	62.8%(54/86)	48.9%(152/311)	0.022
<65 years	63.4%(123/194)	34.0%(228/670)	<0.0001
≥65 years	67.3%(76/113)	49.3%(240/487)	0.001

## Role of Vascular Beta 2-adrenoceptors In Endotoxemic Shock

Bertrand Rozec, Thuy Tran Quan, Emmanuelle Lavazais-Blancou, Leslie Audigane, Institut du Thorax-INSERM U533, Nantes, France; Yvonnick Blanloeil, Anesthesiology-Intensive Care Dept-Laënnec Hosp, Nantes, France; Chantal Gauthier-Erfanian; Institut du Thorax-INSERM U533, Nantes, France

Although it is known that during endotoxemic shock the use of  $\beta$ -adrenergic agonists can improve organs blood flow independently of cardiac output increase, there is no study in the literature concerning the remodelling of the vascular  $\beta$ -adrenoceptors ( $\beta$ -AR),  $\beta_1$ ,  $\beta_2$  and  $\beta_3$ . Male Sprague-Dawley rats received either 5 mg/kg of lipopolysaccharide (LPS) or the same volume of the vehicle (C) intravenously. Three hours later, the thoracic aorta rings were harvested to perform functional and mRNA expression studies. To take into account the failure of the vascular constriction in sepsis, aortic rings were precontracted with an appropriate concentration of phenylephrine ( $\alpha_1$ -adrenergic agonist) in order to obtain 80% of the maximal

contraction in both groups. Concentration-relaxation curves were then constructed with several  $\beta$ -AR agonists: isoproterenol (ISO), a non selective agonist; dobutamine (DOBU), salbutamol (SALBU) and SR 58611A (SR) respectively  $\beta_1$ -,  $\beta_2$ - and  $\beta_3$ -AR agonists. The quantification of the three  $\beta$ -AR mRNA subtypes was monitored by real time quantitative RT-PCR in thoracic aorta of 5 rats in each group. Results were expressed in percentage of expression of a reference gene (HPRT, Hypoxanthine PhosphoribosylTransferase). The relaxation ISO-induced was significantly reduced by 29.4% in LPS treated rats.  $\beta_1$ - and  $\beta_3$ -AR induced-relaxations were also significantly reduced by 18.5 and 32.6% respectively, whereas  $\beta_2$ -AR-induced vasorelaxation was not modified (Table). In LPS treated rats,  $\beta_1$ - and  $\beta_3$ -AR mRNA abundance was significantly reduced by 40 and 64% ( $p<0.05$ ) respectively, without modification of  $\beta_2$ -AR mRNA. In conclusion, our work suggests, for the first time, a differential regulation of the 3 vascular  $\beta$ -AR at the early stage of endotoxemic shock. Moreover, as vascular  $\beta_2$ -AR function and mRNA expression are preserved during endotoxemia, it strengthens the putative effect of  $\beta_2$ -AR agonists to maintain blood flow in septic shock.

Emax: maximal relaxation induced by 30  $\mu$ M of agonist (% of phenylephrine contraction)

$\beta$ -AR agonists	ISO	DOBU	SALBU	SR
C (n=6)	86.8 $\pm$ 2.6%	77.8 $\pm$ 2.8%	57.5 $\pm$ 5.3%	55.9 $\pm$ 6.9%
LPS (n =6)	61.3 $\pm$ 2.4%	63.4 $\pm$ 4.2%	54.9 $\pm$ 5.2%	37.7 $\pm$ 6.0%
	$p<0.001$	$p<0.05$	NS	$p<0.001$

## How Rapidly Can People find an AED?

Hiroshi Kaneko, Nagoya City Fire Dept, Nagoya, Japan; Tetsuo Hatanaka, Emergency Life-Saving Technique Academy, Kitakyushu, Japan; Aki Nagase, Niigata College of Nursing, Niigata, Japan; Hiroko Noguchi, Musashino Univ, Tokyo, Japan; Atsuko Nagatani, Nagasaki Univ Hosp of Medicine and Dentistry, Nagasaki, Japan; Seishiro Marukawa; Hyogo Med Sch, Kobe, Japan

Success of public defibrillation program (PAD) depends in part on the rapidity for lay people to find an AED. The aim of the present study was to investigate how rapidly lay people can find an AED in international airports, and to uncover the factors that facilitate rapid detection of an AED. **[Methods]** In 20 randomly selected locations in each of the airports (8 AEDs / 38000 m<sup>2</sup> and 6 AEDs / 14760 m<sup>2</sup>), 2 people (total of 80) were asked to find an AED as rapidly as possible, and the time (Ta) needed to find an AED and the routes they followed were recorded. The theoretical time (Tt) needed to find an AED was calculated on the diagram assuming that people would reach the nearest AEDs. **[Results]** When combined over the 2 airports, Ta was 168 (140–450) seconds (median, IQR) and was significantly longer than Tt of 36.4 (17.1–51.8) seconds. Ta was significantly shorter when people reached the nearest AEDs that occurred only on 60% of the trials: 147 (62 – 212) seconds for the nearest AEDs vs 349 (169 – 651) seconds for non-nearest AEDs. Whether or not people had advance knowledge about an AED did not affect Ta: 160 (94 – 387) vs 177 (94 – 387) seconds, respectively with vs without advance knowledge. It was similar for 2 airports: 38.8 (17.1 – 44.2) vs 29.8 (14.9 – 63.5) seconds. Despite the considerable inter-airport difference in the configuration of the on-site AED signs (protruding with AED pictogram vs non-protruding without pictogram), Ta was not significantly different between the airports: 163.3 (104.5 – 342.0) vs 194.5 (91.5 – 424.5) seconds. Neither of the airports had off-site signs that showed directions to the nearest AEDs. **[Conclusions]** The theoretical prediction of the time based on the diagram of the facilities significantly underestimates the actual time required to find an AED, partly because it ignores the fact that people fail to reach the nearest AED in about 40% of the cases. This suggests that presence of off-site signs showing the direction to the nearest AED is an important factor for rapid detection of an AED. Configurations of the on-site AED signs and the advance knowledge on an AED appeared to be minor factors.

## Awareness of Guidelines of Automated External Defibrillator Use in Children within Emergency Medical Services

Sarah E. Haskell, Melanie A. Kenney, Sonali Patel, Univ of Iowa, Iowa City, IA; Teri L. Sanddal, Critical Illness and Trauma Foundation, Bozeman, MT; Katrina L. Altenhofen, Iowa Bureau of EMS, Iowa Dept of Public Health, Des Moines, IA; Nels D. Sanddal, Critical Illness and Trauma Foundation, Bozeman, MT; Dianne L. Atkins; Univ of Iowa, Iowa City, IA

**BACKGROUND.** Ventricular fibrillation occurs in 10–20% of pediatric cardiac arrests. Survival rates in children with ventricular fibrillation can be as high as 30% when the rhythm is identified and treated promptly. In the last five years, recommendations have been made for the use of automated external defibrillators (AED) in children 1–8 years of age. **OBJECTIVE.** The goal of this study was to determine the awareness of American Heart Association (AHA) guidelines and statewide protocols concerning AED use in children ages 1–8 among emergency medical providers after new guideline release. Availability of pediatric capable AED equipment was also assessed. **METHODS.** Surveys were distributed to EMS providers in Iowa and Montana within one year of the AHA advisory statement in 2003 recommending use of AEDs in children ages 1–8, and again approximately one year after the 2005 AHA guidelines on cardiopulmonary resuscitation were published. In Iowa, there were concentrated efforts to disseminate information about AED use in children, while there were minimal efforts in Montana. **RESULTS.** Awareness of AHA guidelines for use of AEDs in children was low in both states in 2003 (29% in Iowa vs 9% in Montana,  $p<0.001$ ). After release of the 2005 guidelines, awareness improved significantly in both states but was still significantly greater in Iowa (83% vs. 60%,  $p<0.002$ ). In 2003, less than 20% of respondents in both states reported access to pediatric capable AEDs. Availability of pediatric pads and cables increased significantly in 2006 but remained low in Montana (74% in Iowa vs 37% in Montana,  $p<0.001$ ). **CONCLUSIONS.** At the present time, publication of new or interim guidelines in the scientific literature alone is insufficient to ensure that awareness among providers and that new

protocols are implemented. An effective and efficient method to disseminate new pediatric out-of-hospital protocols emergency care to become standard of care in a timely matter should be developed.

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### Preconditioning With Periodic Acceleration (pGz) Prior To Whole Body Ischemia Reperfusion Injury Ameliorates Myocardial Stunning And Arrhythmias

Jose A Adams, Jorge Bassuk, Heng Wu, Jaqueline Arias, Dongmei Wu, Vinod Jorapur, Gervasio Lamas, Mt Sinai Med Cntr, Miami Beach, FL; Paul Kurlansky; Florida Heart Rsch, Miami, FL

Periodic acceleration (pGz) consists of sinusoidal, head to foot motion of the supine body achieved with a motion platform. pGz produces pulsatile shear stress on the vascular endothelium *in vivo* and *in vitro* thereby inducing release of endothelial derived NO (eNO) and prostaglandins. Additionally, pGz when applied as a sole means for CPR decreases myocardial stunning and improves outcome from ventricular fibrillation (VF). VF followed by resuscitation (CPR) is a model of whole body ischemia reperfusion injury (I/R). Pharmacological and ischemic preconditioning prior to I/R have been shown to ameliorate global and focal cardiac ischemia, reduce arrhythmias, and improve myocardial function after reperfusion. This study tests whether pGz applied prior to CPR, also ameliorates reperfusion injury. Twenty male swine (40–50lbs) were anesthetized, intubated and instrumented to measure blood gases and hemodynamics. They were placed on a motion platform and randomized to 1 hr of active pGz (3 Hz and Gz ± 0.4) (PRE) or no activation for the same time period, control(C). VF was electrically induced and unsupported for 8 min, followed by continuous manual chest compression and defibrillation until return of spontaneous circulation (ROSC) or 10 min. Echocardiograms to measure ejection fraction (EF%), fractional shortening (FS%) and wall motion score index (WMSI) were performed at baseline (BL), after pGz or control (BL2) and 30, 120 mins after ROSC (ROSC30, ROSC120). All animals had ROSC after a median of 4 defibrillation attempts. There were no differences between groups in defibrillation attempts, time to ROSC, arterial blood gases or hemodynamics over time. PRE animals had less hemodynamically significant arrhythmias in the first 30 mins ROSC; C (35) vs PRE (7) (p < 0.05) and less myocardial stunning. Data mean ± SD \* p < 0.05 C vs PRE † p < 0.05 time vs BL pGz applied prior to I/R is cardioprotective and a novel means to precondition the myocardium.

	EF%		FS%		WMSI	
	C	PRE	C	PRE	C	PRE
BL1	64(4)	63(3)	28(2)	30(4)	1	1
BL2	64(4)	64(4)	28(2)	31(4)	1	1
ROSC30	32(4)†	43(4)*†	16(3)†	26(2)*†	2.8(0.4)†	2.0(0.2)*†
ROSC120	34(7)†	48(3)*†	11(4)†	25(2)*†	3.0(0.2)†	1.8(0.4)*†

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### Coronary Perfusion Pressure Augmentation by Sustained Abdominal Compression: Comparison with Vasopressor Drugs

Aaron E Lottes, Ann E Rundell, Leslie A Geddes, Andre E Kemeny, Michael P Otlewski, Charles F Babbs; Purdue Univ, West Lafayette, IN

**Objectives:** This study investigated sustained abdominal compression as a means to improve coronary perfusion pressure (CPP) during cardiopulmonary resuscitation (CPR) and compared the resulting CPP augmentation with that achieved using vasopressor drugs. **Method:** During electrically induced ventricular fibrillation in anesthetized, 30 kg juvenile pigs, Thumper® CPR was supplemented at intervals either by constant abdominal compression at 100 to 500 mmHg using an inflatable contoured cuff or by the administration of vasopressor drugs (epinephrine, vasopressin, or glibenclamide). CPP before and after cuff inflation or drug administration was the end point. **Results:** Sustained abdominal compression at >200 mmHg increases CPP during VF and otherwise standard CPR by 8 to 18 mmHg. The effect persists over practical ranges of chest compression force and duty cycle and is similar to that achieved with vasopressor drugs. Constant abdominal compression also augments CPP after prior administration of epinephrine or vasopressin. **Conclusions:** During CPR noninvasive abdominal compression with the inflatable contoured cuff rapidly elevates the CPP, sustains the elevated CPP as long as the device is inflated, and is immediately and controllably reversible upon device deflation. Physical control of peripheral vascular resistance during CPR by abdominal compression has some advantages over pharmacologic manipulation and deserves serious reconsideration, now that the limitations of pressor drugs during CPR have become better understood, including post-resuscitation myocardial depression and the need for intravenous access.

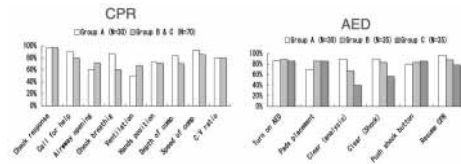
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### The Effectiveness of a Short Course in CPR and AED Usage for Lay Persons

Tetsuya Sakamoto, Teikyo Univ, Tokyo, Japan; Jerry Potts, American Heart Association, Dallas, TX; Ichiro Kaneko, Yasuo Takeuchi, Teikyo Univ, Tokyo, Japan; Tetsuo Hatanaka, Eemergency Life Saving Technique Academy, Kyusyu, Japan; Naoki Shimizu, National Cntr for Child Health and Development, Tokyo, Japan; Seishiro Marukawa; Hyogo College of Medicine, Hyogo, Japan

The objective of this study is to compare the effectiveness of a 30 minute, video-based course in CPR-AED to the standard 2.5 hour adult CPR-AED course being provided for lay persons. Methods: One hundred volunteers (over 18 years old) were randomly assigned to one of the

three study groups. (Group A) 30 participants received the traditional 150-minute adult CPR-AED course. (Group B) 35 participants received the video-based 30-minute CPR course. CPR skills were learned by watching the DVD practicing independently using a personal CPR training manikin in a practice-while-watching format. AED use was learned during an additional 20-minute practice period with a supplemental tool (simulated AED, AED pads, and patient poster) supplied to each participant. (Group C), 35 participants received the same CPR course as used for Group B. AED instruction was provided only by 10-minute DVD (no physical hands-on AED training). All subjects were given a practical exam at the conclusion of the course. The evaluators had not participated in the instructional component of the course. A standardized evaluation scale were used to grade the performance of 9 critical elements of CPR and 6 critical elements of AED. All AED trainers were programmed for the Japanese guidelines, 1-shock protocol. Results: The CPR evaluations of Group B & C were almost equal to that of Group A. Exceptions were: Group A was better than B and C in checking breathing. Group C was worse than A at clearing the patients before analysis and before shock, and resuming compressions immediately after analysis/shock. Group B was almost equal to Group A, except for clearing the patients before analysis.



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### Cyclosporin A does not Prevent Myocardial Dysfunction after Resuscitation from Cardiac Arrest in Rats

lyad M Ayoub, Jeejabai Radhakrishnan, Raúl J Gazmuri; Rosalind Franklin Univ of Medicine and Science, North Chicago, IL

**Objective:** We have previously reported in a rat model of VF and closed-chest resuscitation that cytochrome c is released into the bloodstream after resuscitation from cardiac arrest attaining plasma levels inversely proportional to survival. Recent evidence indicates that release of cytochrome c during ischemia and reperfusion may be a manifestation of prolonged opening of the mitochondrial permeability transition pore (mPTP). In this study, we investigated whether cyclosporin A (CsA, an inhibitor of mPTP opening) can prevent post-resuscitation (PR) myocardial dysfunction and improve survival. **Methods:** VF was electrically induced and left untreated for 10 mins. Resuscitation was attempted by 8 mins of chest compression followed by biphasic waveform defibrillation. Rats were randomized to received a bolus CsA (10 mg/kg) five minutes before inducing VF (n=6), immediately before starting chest compression (n=6), or to receive vehicle control before inducing VF (n=3) or before starting chest compression (n=3). CsA-treated (n=12) and vehicle-treated (n=6) rats were pooled for this analysis after noticing no differences between subgroups. Resuscitated rats were monitored for up to 6 hours. **Results:** All rats were successfully resuscitated. Treatment with CsA did not improve PR myocardial function (Table). Survival time was comparable between CsA-treated (321 ± 67 mins) and vehicle-treated (331 ± 67 mins) rats. **Conclusions:** In our rat model of VF and

resuscitation, CSA failed to prevent PR myocardial dysfunction and improve survival. These data contrast with numerous studies demonstrating a protective effect in isolated heart models of ischemia and reperfusion. Two possible explanations are 1) the mPTP does not open in this unique setting of cardiac arrest and resuscitation, and 2) the optimal *in vivo* dose of CSA needs to be determined as the protective effects of CSA are dose dependent.

#### Hemodynamic and Left Ventricular Function

	Baseline	PR120-mins	PR240-mins	PR360-mins
Mean Aortic Pressure, mmHg				
Cyclosporin A (n=12)	141 ± 14	102 ± 14	110 ± 31 [10]	75 ± 30 [9]
Vehicle (n=6)	136 ± 11	105 ± 17	112 ± 14 [5]	97 ± 35
Cardiac Index, ml·min <sup>-1</sup> ·kg <sup>-1</sup>				
Cyclosporin A (n=12)	155 ± 19	63 ± 15	56 ± 9 [10]	46 ± 15 [9]
Vehicle (n=6)	154 ± 16	62 ± 20	58 ± 13 [5]	52 ± 10
Left Ventricular Stroke Work Index, mmHg·mL·kg <sup>-1</sup>				
Cyclosporin A (n=12)	1.1 ± 0.2	0.3 ± 0.1	0.3 ± 0.1 [10]	0.2 ± 0.1 [9]
Vehicle (n=6)	1.0 ± 0.2	0.3 ± 0.1	0.3 ± 0.1 [5]	0.2 ± 0.0

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#### Alterations in Pulmonary Vasoreactivity Following Lung Contusion in Rats

Satyam Lakshminrusimha, Bruce A Davidson, Rita M Ryan, Jadwiga D Helinski, Krishnan Raghavendran; SUNY, Buffalo, NY

Lung contusion, a common complication of blunt chest trauma is an independent risk factor for ALI/ARDS. Using a recently described rat model for isolated bilateral lung contusion from blunt chest trauma (Anesth Analg 2005;101:1482), studies suggested an inconsistent correlation between the extent of inflammation and hypoxia. We set out to investigate the alteration in pulmonary arterial (PA) reactivity in lung contusion. **Methods:** Lung contusion was induced in anesthetized spontaneously breathing adult male rats by dropping a hollow aluminum cylindrical weight (300 g) onto the chest with a protective shield placed on the precordium. Rats were allowed to recover and sacrificed at 4h and 24h (n=6-9) and compared to uninjured controls. Third generation PA rings were dissected and placed in a bath with modified Krebs solution, connected to a transducer and bubbled with 21% O<sub>2</sub> + 6% CO<sub>2</sub>. Some rings were pretreated with a non-specific NO synthase (NOS) inhibitor, L-nitro arginine (LNA 10<sup>-3</sup> M). Rings were constricted with norepinephrine (NE) and relaxed with either a NOS agonist (A 23187) or NO donor (SNAP) at 10<sup>-6</sup> M. **Results:** Rats were hypoxic at 4h post-contusion (A-a gradient 337 ± 49 mmHg, mean ± SE) compared to controls (196 ± 29), but recovered 24h after contusion (217 ± 22). Pretreatment with LNA increased baseline tension significantly more in control PA compared to 4h or 24h post-contusion PA (130 ± 14, 112 ± 22 and 66 ± 16 g/g respectively). Constriction response to NE in the presence of LNA was significantly higher 4h after contusion compared to controls (671 ± 114 vs 392 ± 77 g/g). Relaxation to A23187 (73 ± 5 vs 33 ± 7%) and SNAP (88 ± 7 vs 45 ± 12%) were significantly impaired 24h after contusion compared to controls. Pretreatment with LNA improved relaxation to SNAP in PA isolated from contused lungs. **Conclusions:** Hypoxemia and increased PA contractility are observed 4h after lung contusion in rats with recovery by 24h. Production of and response to NO are significantly diminished in PA following lung contusion. **Speculation:** Uncoupling of NOS with reduced production of NO and increased production of superoxide may be observed in PA following lung contusion. Therapy with inhaled NO and antioxidants such as superoxide dismutase may alleviate hypoxemia following lung contusion.

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#### The Prognostic Factor of Patients with Asystole on Arrival

Tomoki Shokawa, Koichi Tanigawa, Hideya Yamamoto; Hiroshima Univ, Hiroshima, Japan

**Background:** Patients with asystole on arrival (AOA) at hospital have a poor prognosis. However, little is known about the prognostic factor of patients with AOA. **Objective:** The purpose of this study was to determine predictors for 24 hours survival in patients with AOA. **Methods and results:** Consecutive patients with AOA admitted to the Hiroshima University Hospital (Hiroshima, Japan) from April 2002 to January 2007 were retrospectively analyzed. Patients were divided into two groups according to the outcomes, i.e. non-survivors vs. survivors at 24 hours after admission. Data including blood gas analysis, lactate levels, and levels of minerals on admission were obtained and analyzed. Of 102 (male; 60) patients with AOA, fourteen patients survived for 24 hours. Univariate analysis found that pH, PaO<sub>2</sub>, PaCO<sub>2</sub>, base excess, lactate, and serum potassium concentration were associated with survival (p < 0.05) (Table). Multivariate analysis determined that serum potassium concentration independently affected 24 hours survival. **Conclusions:** These results suggested that the serum potassium level on admission is a strong, independent predictor of survival of patients with AOA.

#### survivors vs. non-survivors

Variable	survivors(n=14)	non-survivors(n=88)	p value
pH	7.12 +/- 0.125	6.86 +/- 0.23	0.0007
PaO2(mmHg)	205.4 +/- 166.1	103.5 +/- 121.2	0.005
PaCO2(mmHg)	50.4 +/- 28.2	78.0 +/- 43.4	0.016
BE(mmol/L)	-14.6 +/- 7.1	-18.2 +/- 11.4	0.0118
Lactate(mmol/L)	15.5 +/- 18.5	16.7 +/- 6.1	0.0022
Serum potassium(mEq/L)	5.1 +/- 1.6	7.7 +/- 2.7	0.0001

#### Inhospital Outcome of 458 Patients with Acute Myocardial Infarction Requiring Mechanical Ventilation. Results of the BEAT Registry of the ALKK.

Uwe Zeymer, Kleopatra Kouraki, Steffen Schneider, Herzzentrum Ludwigshafen, Ludwigshafen, Germany; Rainer Uebis, Klinikum Aschaffenburg, Aschaffenburg, Germany; Ulrich Tebbe, Klinikum Lippe-Deimold, Detmold, Germany; Hermann Klein, Klinikum Idar-Oberstein, Idar-Oberstein, Germany; Uwe Janssens, St. Antonius Hosp, Eschweiler, Germany; Jochen Senges, Herzzentrum Ludwigshafen, Ludwigshafen, Germany; ALKK-Study Group

**Background:** There is only limited information about characteristics and clinical outcome of patients with acute myocardial infarction (AMI) requiring endotracheal intubation and mechanical ventilation. Therefore we sought to evaluate the clinical course of a large cohort of patients with AMI and mechanical ventilation. **Methods:** The BEAT Registry of the ALKK prospectively enrolled all consecutive patients requiring mechanical ventilation, who were admitted to an internal intensive care unit (ICU) of 45 participating German centers. Patient characteristics, treatment and complications until discharge were collected. For this analysis we created a subgroup of patients admitted with ST-segment elevation or non-ST segment elevation myocardial infarction. **Results:** During the 9-month study period 458 consecutive patients with AMI were included. The mean age was 68 ± 8 years and 71% were men. While 40% of the patients were intubated in the prehospital phase, 60% were intubated in the hospital. The initial cause for intubation was in 48% of the cases ventricular fibrillation/ tachycardia or sudden cardiac death, in 39% congestive heart failure and in 13% of the cases non-cardiac. Of the 458 patients 256 (56%) developed cardiogenic shock, 86 (19%) acute renal failure, 76 (17%) coma or brain damage, 64 (14%) severe infection, 46 (10%) sepsis, 28 (6%) MODS and 17 (4%) gastrointestinal bleeding. 204 (45%) patients underwent coronary angiography, 38% were treated with PCI and 5% with coronary artery bypass grafting. The inhospital mortality in the total group was 48% and in the subgroup of patients with cardiogenic shock 69%. **Conclusion:** Patients requiring mechanical ventilation as complication during the early phase of an AMI constitute a high risk subgroup with a mortality of 50%. Further research is necessary to improve the outcome of these patients.

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#### Written Evaluation in Advanced Cardiovascular Life Support is not a Predictor for Cardiac Arrest Performance

David L Rodgers, Rudy D Pauley, Marshall Univ, South Charleston, WV; Barbara R McKee, David J Matics, Louis. E Robinson; CAMC Health Education and Rsch Institute, Charleston, WV

**Objectives:** Successful completion of American Heart Association (AHA) Advanced Cardiovascular Life Support (ACLS) requires passing both a written cognitive knowledge evaluation and a practical evaluation that tests psychomotor skills, cognitive knowledge, and affective behaviors such as leadership and team skills. Previous evidence has indicated little to no correlation between written and practical skills in Basic Life Support courses. There is limited data on the correlation between written and practical evaluations in advanced level courses or on the ability of the written test to predict performance following an ACLS course. **Methods:** 34 senior nursing students from four nursing programs participated in ACLS. Each participant completed the written and practical evaluations. Immediately after completing the course, all participants served as team leader for a simulated cardiac arrest event that was video recorded. A panel of expert ACLS instructors who did not participate as instructors in the ACLS course reviewed each video and independently scored team leaders' performances. **Results:** There was no significant correlation between written evaluation scores and practical skills performance as rated by the expert instructor panel. Paired samples correlation was .219 (p = .213). **Conclusions:** The ACLS written evaluation was not a reliable predictor of participant success in managing a simulated cardiac arrest event immediately following an ACLS course. The ACLS performance evaluation tests a narrow portion of ACLS course while the ACLS written evaluation tests a much broader spectrum of course content. Both work in concert to define participant knowledge and neither should be used exclusively to determine participant competence.

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#### Evaluation Of Knowledge And Practice Of Cardiopulmonary Resuscitation Of Children And Infants By An Out-of-hospital Emergency Care Team

Nathalie S Goddet, François Dolveck, Alexis Descatha, Samu 92, Garches, France; Noella Lode, Samu pédiatrique 75, Paris, France; Jean-Louis Chabernaude, Samu pédiatrique 92, Clamart, France; Thomas Loeb, Samu 92, Garches, France; Céline Farges, Samu pédiatrique 75, Paris, France; Patrick Lagron, Laurent Stenger, Samu 92, Garches, France; Géraldine Baer, Sch of medicine, Sacramento, CA; Michel Baer, Dominique Fletcher, Samu 92, Garches, France

**Introduction:** The French emergency response system in life threatening situations is the deployment of fully equipped ambulances with paramedic, nurse and emergency physician. The 2005 ILCOR and ERC guidelines concerning cardiopulmonary resuscitation (CPR) have led to significant changes, especially in terms of basic life support (BLS). We aimed to review fundamental knowledge and practice by our personnel concerning CPR in children and infants to determine current training needs for our teams. **Materials and methods:** Paper questionnaires were filled out by our personnel and immediately collected. **Inclusion criteria:** physicians, nurses, and paramedics (refusals to fill out questionnaire were not included). We recorded: profile of personnel, knowledge of 2005 guidelines, basic CPR and advanced CPR parameters.

Majors results were compared based on job title. **Results** Sixty-one questionnaires were filled out (25 paramedics, 13 nurses, and 23 physicians). Personnel was mostly aged under 40 (70.5%, n=43), with over 2 years experience in prehospital emergency care(75.4%, n=46); 47.5% (n=29) had no training in pediatrics; 68.9% (n=42) had BLS certification and 31.1% (n=19) reported regular participation in first aid training programs. A minority of subjects declared knowing the 2005 Guidelines (11.5%, n=7), even among physician (17.4%, n=4). Table 1 shows major results about CPR parameters according to job title. **Conclusion** This study emphasizes the lack of knowledge and the repeated changes which require more frequent and more extensive training for entire personnel on the team, focusing on basic CPR for physicians and advanced CPR for paramedics and nurses.

**Table 1 : Answers according to job title AED : Automatic External Defibrillator**

	2005 guideline	Infants			Children			Total
		Paramedics	Nurses	Physicians	Paramedics	Nurses	Physicians	
Basic CPR :								
Transition age child/adult	Puberty	-	-	-	12,0% (n=3)	7,7% (n=1)	0%	6,6% (n=4)
Compression / ventilation ratio One rescuer	30/2 15/2	16,0% (n=4)	15,4% (n=2)	17,4% (n=4)	16,4% (n=10)	12% (n=3)	30,8% (n=4)	34,8% (n=8)
Two rescuer		36,0% (n=9)	15,4% (n=2)	13,0% (n=3)	23,0% (n=14)	56,0% (n=14)	15,4% (n=2)	21,7% (n=5)
AED Age for use	One year old	-	-	-	44% (n=11)	30,8% (n=4)	21,7% (n=5)	32,8% (n=20)
<b>Advanced CPR :</b>								
Interosseus line	Priority	20,0% (n=5)	7,7% (n=1)	34,8% (n=8)	23,0% (n=14)	0%	0%	0%
External shock	2 - 4 J/kg	12,0% (n=3)	53,9% (n=7)*	65,2% (n=15)*	41,0% (n=25)*	**	**	**
First one Next ones	4 J/kg	0%*	7,7% (n=1)*	34,8% (n=8)*	14,8% (n=9)			

\* p<.05 in Fischer exact test \*\* results for external shock dose were asked for infants and children

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### The Potential Mechanisms of Reduced Incidence of VF as the Presenting Rhythm

Hao Wang, Wanchun Tang, Shijie Sun, Min-shan Tsai, Yongqin Li, Tong Wang, Max H Weil, Weil Institute of Critical Care Med, Rancho Mirage, CA

**Background.** In our previous studies, we have demonstrated that the administration of both beta-adrenergic receptor blocker ( $\beta$ -blocker) and angiotensin converting enzyme (ACE) inhibitor significantly shortened the duration of ventricular fibrillation (VF). In the present study, we investigated the potential mechanisms of shortened VF durations by pre-treatment of  $\beta$ -blocker and ACE inhibitor. **Hypothesis.** Both  $\beta$ -blocker and ACE inhibitor increase the duration of monophasic action potential (MAP) and ventricular fibrillation threshold (VFT) which accounted for the decreased duration of VF. **Methods and Results.** Three groups from a total of 15 Sprague-Dawley rats weighing 450–550 g were fed  $\beta$ -blocker propranolol (40 mg/kg/day), ACE inhibitor captopril (100 mg/kg/day), or diluent placebo continuously for 30 days prior to the experiment. MAP90 were measured by self-made contact electrophysiology catheter in an open chest rat model. VFT was determined as the lowest current intensity at which two consecutive stimuli precipitated VF using a previously reported method. Both propranolol and captopril significantly increased the VFT and MAP90 in comparison with placebo controls (Table). **Conclusions.** Increased VFT and MAP90 in a rat model pretreated with propranolol and captopril may be the potential mechanisms of reduced duration of VF.

GROUP	No	VFT (ma)	MAP90(ms)
PLACEBO	5	2.4±0.5	180.5±9.4
PROPRANOLOL (40 mg/kg/day)	5	4.1±1.1*	197.6±8.9*
CAPTOPRIL (100 mg/kg/day)	5	5.6±1.3*	198.2±10.0*

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### Difference of Clinical Characteristics of Sudden Cardiac Arrest and Syncope Related to Coronary Vasospasm

Ikuko Togashi, Toshiaki Sato, Kyoko Soejima, Shunichiro Miyoshi, Koujiro Tanimoto, Hiroataka Yada, Koutaro Fukumoto, Hikaru Nakamizo, Satoshi Ogawa; Keio Univ, Tokyo, Japan

Patients with coronary vasospasm generally have a good prognosis although lethal arrhythmia can result in sudden cardiac arrest (SCA) or syncope. Clinical predictors of SCA related to coronary vasospasm were not clear. We investigated the differences of clinical characteristics and outcome of pts with SCA and syncope related to coronary vasospasm. **Method and results;** Out of consecutive 47 pts with coronary vasospasm, pts presented SCA(n=13) and syncope(n=26) were enrolled in the study. Pts complicated with 5 idiopathic VF/VT and 3 neurally-mediated syncope were excluded. All pts had a normal LV function except 1 pt with ACS. One pt had coronary artery disease. SCA was experienced during first cardiac event in 77% of SCA group, whereas syncope in 31% of syncope group (p=0.04, as shown in Table). In SCA group, 2 pts resulted in hospital death after DC-resistant VF, 1 pt died suddenly at home after medical-refractory angina. ICD was implanted in 3 survivors. Ca channel blockers were administered in all pts of each group. After discharge of hospital, during a follow-up period of 3.7±4.1yrs, survivors of SCA group did not experience any additional arrhythmic events and all pts of syncope group were alive while 1 pt had recurrent syncope. **Conclusion;** Coronary vasospasm can result in SCA during a first cardiac event. The prognosis of the survivors and pts with a history of syncope may be favorable under good medical control of spasm.

	SCA (n=13)	Syncope (n=26)	p
Age(yrs)	47±15	57±14	0.21
Male/Female	11/2	21/5	0.95
Familial History of SCA (%)	0	4	0.99
Smoking (%)	69	54	0.98
SCA or syncope during first cardiac event (%)	77	31	0.04
Silent ischemia (%)	23	8	0.98

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### A Sternal Accelerometer Does Not Impair Hemodynamics During Piglet CPR

Mathias Zuercher, Ronald W Hilwig, Sarver Heart Cntr, Tucson, AZ; Jon Nysaether, Laerdal Med Corp, Stavanger, Norway; Vinay M Nadkarni, Children's Hosp, Philadelphia, PA; Marc D Berg, Univ of Arizona College of Medicine, Tucson, AZ; Gordon A Ewy, Karl B Kern, Sarver Heart Cntr, Tucson, AZ; Robert A Berg; Univ of Arizona College of Medicine, Tucson, AZ

**Background:** Previous studies suggest that cardiopulmonary resuscitation (CPR) hemodynamics can be adversely affected by sternal CPR pressure transducers, presumably because of inadequate chest recoil or other effects on manual CPR performance. Such devices can be very helpful for monitoring and directing CPR performance. **Aim** To determine the effect of a 260g sternal accelerometer/force-measurement device on CPR hemodynamics with manual compressions. **Methods:** 10 piglets (10.8±1.9 kg) were anesthetized with isoflurane and instrumented with micromanometer-tipped catheters in the right atrium and aorta. Left ventricular myocardial blood flow (MBF) and cardiac index (CI) were determined by fluorescent, color-microsphere technique. After electrical induction of ventricular fibrillation, four 3-minute epochs of manual metronome-guided chest compressions at a rate of 100/minute were randomly performed with or without the sternal device (D or noD). Aortic systolic pressure (AoS) was targeted at 80–90 mmHg. Statistics: t-test, p<.05 considered as statistically significant. **Results:** Baseline normal sinus rhythm (NSR) CI was 3.1 L/min/m2 and MBF was 0.63 L/g. Hemodynamics during CPR were not worse with device use, as reported in table 1. In both groups, CI was ~40% of NSR, and LVMBF was ~40–75% of NSR. **Conclusions:** Use of a 260g sternal accelerometer/force-measurement device with manual chest compressions did not have adverse effects on CPR hemodynamics.

**Table 1**

CPR time	1–3 min	4–6 min	7–9 min	10–12 min
CI D	1.5±0.4	1.4±0.3	1.3±0.2	1.4±0.3
CI noD	0.8±0.2	1.1±0.1	1.0±0.2	1.2±0.3
MBF D	0.5±0.1	0.4±0.1	0.3±0.1	0.3±0.1
MBF noD	0.4±0.1	0.4±0.1	0.3±0.1	0.3±0.1
AoS D	83±1	83±2	83±1	86±1
AoS noD	85±2	86±0	89±3	87±2
CPP D	17±4	15±1	17±4	17±2
CPP noD	16±2	17±3	17±2	16±5

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### Dual Pathway Defibrillator Shocks Produce Less Hemodynamic Compromise than Standard, Single Pathway Shocks

Mark Niebauer, John Lof, Elizabeth Stolze, Michael Petrocchi, Gretchen Fry; Nebraska Med Cntr, Omaha, NE

Emergency ventricular defibrillation is conventionally performed using a single pair of external electrodes. We have shown that the use of two defibrillators, discharged simultaneously, or sequentially (dual pathway; DP), during ventricular defibrillation can convert the heart to sinus rhythm with significantly lower total energy using similar waveforms compared to single pathway (SP) shocks. Studies have also shown that high energy SP biphasic waveform shocks can produce immediate, post-shock hypotension, although less than monophasic shocks. This study was designed to determine if high energy DP shocks produce a similar hemodynamic effect as SP biphasic shocks at the same energy. **Methods:** Defibrillator testing was performed using eight pigs of either sex (range 32–41 kg). Animals were anesthetized with isoflurane and instrumented with surface ECG to monitor rhythm and arterial cannula to monitor systemic blood pressure. Self adhesive defibrillation electrodes (Zoll Medical) were placed on the shaved torso in an anterior-posterior orientation in both SP and DP configurations. High energy defibrillator shocks (total energy 200J for RLB and BTE waveforms) were delivered in sinus rhythm to compare a DP rectilinear biphasic waveform (DP-RLB; Zoll Medical) to a SP-RLB waveform and an SP biphasic truncated exponential (BTE; Physio-Control) waveform. The immediate post shock reduction in mean arterial blood pressure (as percent of pre-shock value) were recorded and compared. The 200J shock strength was chosen due to its high shock efficacy in this population (approximately 3 times defibrillation threshold). **Results:** The DP-RLB waveform configuration produced a post-shock reduction of 5.4 ± 9.6% in mean arterial pressure, while the SP-RLB waveform reduction was 14.1 ± 8.4% and the SP-BTE waveform reduction was 13.0 ± 6.0% at the same 200J total energy (p<0.03). **Conclusions:** The DP shock configuration using the RLB waveform produces less reduction in mean arterial pressure following high energy shocks than both the RLB and the BTE waveforms using a single pathway configuration. Further studies would need to be performed to determine if this hemodynamic benefit would be greater following a period of ventricular fibrillation, as would be seen clinically.

### Spontaneous Refibrillation Following External Defibrillation of Long Duration Ventricular Fibrillation in Swine

James D Allred, Cheryl R Killingsworth, Scott Allison, Derek J Dossdall, Sharon B Melnick, William M Smith, Raymond E Ideker, Gregory P Walcott; Univ of Alabama Birmingham, Birmingham, AL

**Background:** Following successful defibrillation of the long duration ventricular fibrillation (LDVF) associated with sudden cardiac arrest (SCA), refibrillation occurs in over half of resuscitation attempts. In experimental animals with normal hearts, refibrillation almost never occurs following short duration VF lasting < 1 min (SDVF). It is not known if refibrillation following LDVF is due to the cardiac disease that caused the initial LDVF of SCA or if the LDVF itself causes abnormalities that can initiate VF. Further, the mechanism of refibrillation initiation is unknown. We tested the hypothesis that refibrillation occurs frequently following LDVF in previously normal hearts and propagates from a common area within the heart. **Methods:** In 6 pigs, 115–120 plunge needles containing 3–6 electrodes each were inserted throughout the heart. With the chest closed, external defibrillation pads were placed in a left lateral to right lateral configuration. Following successful defibrillation of 20 s of SDVF, the animal was observed for spontaneous VF for at least 4 min. After termination of 7 min of LDVF, the animal was placed on cardiopulmonary bypass and observed for 15 min for spontaneous VF. **Results:** Following LDVF, 1.33 ± 0.8 episodes of spontaneous VF occurred in each animal. The mean time to VF was 71 s (range 5 - 139 s) following defibrillation of LDVF. Three animals had a second episode of VF within 3 min of termination of LDVF. Earliest sites of origin of spontaneous VF occurred equally in the LV (3), RV (3), and septum (2) and arose equally from the endocardium (3), epicardium (2), and myocardium (3). Refibrillation originated in the posterior half of the ventricles 75% of the time. The first refibrillation cycle appeared focal in 75% of cases and reentrant in 25%. Premature ventricular beats arising out of the posterior RV base immediately preceded 75% of VF episodes. **Conclusions:** 1. Spontaneous VF is common after defibrillation of LDVF but not SDVF in previously health swine, indicating that refibrillation does not require preexisting cardiac disease but can be caused by the detrimental effects of LDVF. 2. Most episodes of refibrillation begin as focal activity within the posterior half of the ventricles.

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### Differences of B-Type natriuretic peptide and N-terminal pro B-type natriuretic peptide levels in Patients With Cardiogenic Shock

Michael Buerke, Roland Prondzinsky, Martin-Luther-Univ, Halle/Saale, Germany; Alexander Geppert, Rudolf Jaral, Kurt Huber, Wilhelminen Hosp, Viena, Austria; Martin Russ, Henning Lemm, Axel Schliitt, Karl Werdan; Martin-Luther-Univ, Halle/Saale, Germany

**Background** B-Type natriuretic peptide (BNP) and N-terminal proBNP (NT-proBNP) are frequently used in diagnosing and monitoring patients with heart failure. Recent studies have demonstrated that BNP and NT-proBNP concentrations reflect LV function and prognosis. However, the role of natriuretic peptides in patients with cardiogenic shock is unclear. **Methods.** In 40 patients with cardiogenic shock due to acute myocardial infarction treatment with primary percutaneous transluminal coronary angioplasty (PCI) was performed initially with subsequent medical treatment and intraaortic balloon pump (IABP) counterpulsation. Cardiac catheterization was performed in all patients. Creatinine, Creatinine clearance, LVEDP, and survival were determined, and BNP and NT-proBNP obtained at the start, 24, 48 and 72 hours thereafter. **Results.** BNP was able to detect differences in treatment regarding LV-unloading. Interestingly, NT-proBNP levels were able to differentiate between survivors and non survivors (4590 ± 1230 vs 14370 ± 4886pg/ml, p<0.05). However, there was no significant difference between survivors and non survivors with regard to BNP levels. Clearly, elevated levels of NT-proBNP in patients with cardiogenic shock were more dependent on decreased renal function which might reflect additional organ dysfunction (24965 ± 9567pg/ml vs 7246 ± 2650, p<0.05). **Conclusions** In myocardial infarction complicated cardiogenic shock patients concentrations of BNP and NT-proBNP provide additional information. Our data suggest that the cardiac status and improvement upon therapy can be monitored with BNP. However, NT-pro-BNP is a valuable indicator for prognosis in patients with cardiogenic shock.

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### Feasibility of Selective Brain Cooling during Cardiac Arrest: A Novel Nasopharyngeal Approach

Manuel C Boller, Joshua Lampe, Lance B Becker; Univ of Pennsylvania, Philadelphia, PA

**Introduction:** In patients with cardiac arrest, selective brain cooling may improve neurological outcome, especially if applied prior to reperfusion. Thus it is important to develop practically feasible, non-invasive cooling methods for out-of-hospital use. **Purpose:** Pilot study to test whether a novel nasopharyngeal cooling device leads to selective brain cooling during cardiac arrest. **Methods:** Domestic swine (35 kg) were anesthetized and routine respiratory and cardiovascular parameters were monitored and recorded. Temperature data were collected from various sites including the forebrain and rectum. After preparation, the cooling device was activated for a duration of 60 minutes. The device consists of two capped plastic tubes that are advanced through the nostrils so that the tip is located in the nasopharynx. A mixture of oxygen (40 L/min) and perfluorocarbon (0.28 ml/L oxygen) is conducted through the tubes and escapes through small openings in the nasopharyngeal area as perfluorocarbon mist. Rapid evaporation of the perfluorocarbon leads to cooling of the area. Thermokinetic properties of the device were examined in two animals during stable anesthesia and in one animal during untreated cardiac

arrest. **Results:** In the animal with cardiac arrest, the brain temperature decreased by 4.82°C within 60 minutes, while rectal temperature decreased only by 0.37°C. In the two animals with intact circulation a comparable decrease in brain temperature (4.86°C and 4.66°C) with a more marked drop in the rectal temperature (2.66°C and 2.78°C) were achieved. The brain cooling rate remained constant in the animal with cardiac arrest (-0.08°C/min), but was biphasic in the animals with intact circulation: rapid during the first 5 minutes (-0.29°C/min; -0.31°C/min), slower thereafter (-0.04°C/min; -0.05°C/min). **Conclusion:** Initial data from this pilot study examining a novel non-invasive cooling method in an experimental setting suggests that cooling of the brain in large animals with cardiac arrest is possible. The cooling process is expected to be preferential to the brain in the no-flow condition, while mild systemic hypothermia may be achieved during normal blood flow. Further testing of this method is warranted and will be conducted in our laboratory.

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### Gender Differences in the Timing of Access to the Prehospital Phase of STEMI Care

Robert O'Connor, Christiana Care Health System, Newark, DE; Ross Megargel, Delaware Office of EMS, Dover, DE; Angela DiSabatino, William Weintrub, Charles Reese, IV; Christiana Care Health System, Newark, DE

**Introduction:** The purpose of this study is to determine the degree of gender differences in lay person recognition, emergency medical services (EMS) activation, and the prehospital management of STEMI. **Methods:** Data were gathered prospectively from May 1999 to January 2007 on consecutive patients with STEMI who presented to a tertiary care hospital emergency department. Patients arriving by ambulance and private vehicle were included. Data collection included determining symptom duration, whether a prehospital ECG was obtained, whether the cardiac interventional lab was activated prior to patient arrival at the hospital, patient age, and hospital length of stay. Prehospital activation of the cath lab was done by emergency medicine based on paramedic ECG interpretation in consultation with cardiology. Statistical analysis was performed using the Mann-Whitney U test, the Yates-corrected chi-square test, and linear regression. **Results:** A total of 3260 cases were studied, of which, 3097 had complete data for analysis. Only EMS cases were included in the ECG analysis, and only patients having a prehospital ECG were included in the prehospital activation of cath lab analysis. Regression analysis showed that older age and female gender were significant predictors of access and arrival by EMS. The mean age in years was higher for EMS arrival (69 women; 59 men) than for private vehicle (62 women; 56 men). **Conclusion:** Women with STEMI tend to use EMS more frequently than men, but are older and wait longer before seeking treatment. Whether these factors contribute to the longer length of stay remains to be determined.

Gender	n	Proportion arriving by ambulance	Symptom Duration (minutes)	ECG obtained in the field	Prehospital activation of Cath Lab	Age	Inpatient Length of Stay
male	2086	0.69	269.40	0.58	0.60	59.38	4.79
female	1011	0.74	305.49	0.74	0.51	67.33	5.26
p-value		0.003	0.045	0.0000	0.0001	0.0000	0.038

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### Randomized Comparison Of The Airway Scope And The Macintosh Laryngoscope For The Tracheal Intubation In Manikin Study

Haruyuki Yuasa, Hiroyuki Yokoyama, Naohiro Yonemoto, Akiko Kada, Yoichiro Kasahara, National Cardiovascular Cntr, Suita, Japan; Yoshihisa Koga, Kinki Univ Sch of Medicine, Osaka-Sayama, Japan; Hiroshi Nonogi; National Cardiovascular Cntr, Suita, Japan

[Background] Failed or difficult tracheal intubation is an important cause of morbidity and mortality during emergency. However, conventional direct laryngoscope is a difficult skill, and proficiency deteriorates over time if it is not regularly clinical practice. The Airway Scope (AWS, Pentax, Tokyo, Japan) is a novel intubation device, which allows visualization vocal cords without alignment of the oral, pharyngeal and tracheal axes. We hypothesized that, in the hands of poor laryngoscopists, a like of residents, the AWS would prove equal or superior to the Macintosh laryngoscope (ML) in the normal and simulated difficult airway. [Methods] Designs: Cross-over trial in manikin study. Participants: 34 residents (female: 4, mean age: 29 yo) in Cardiology and Internal medicine were attempted to intubate to the trachea in each seven scenarios using a Laerdal AirMan. Intervention: group A: the first procedures using the AWS and then the second procedures using the ML, group B: the first procedures using the ML and the second procedures using the AWS. Outcomes: The primary outcome was successful to intubate in normal scenario. The secondary outcomes were successful in difficulty 6 scenarios, and elapsed times for each procedure and dental trauma of intubation in all scenarios. [Result] In normal scenario, all intubations using the AWS were successfully finished and one intubation using the ML was failed. The AWS (max-min: 4.68–29.34 sec, median 12.3 sec) was superior to the ML (max-min: 5.49–51.51 sec, median 12 sec) in successful time (log rank test P = 0.05). AWS had less frequency of dental trauma than the ML (P < 0.01). [Conclusions] In the simulated airway scenarios, the AWS was more successful in achieving tracheal intubation, required less time to intubate successfully comparing with the ML. Those findings suggest that the AWS is an alternative airway management in the situations, which need an advanced airway to minimize complications and interruption of chest compressions.

### Predictors of Transfusion in Acute Myocardial Infarction: Insights from APEX-AMI (Assessment of Pexelizumab in Acute Myocardial Infarction) Trial

Marc E Jolicoeur, Duke Clinical Rsch Institute, Durham, NC; William W O'Neil, Univ of Miami, Miami, NC; Paul W Armstrong, VIGOUR Cntr, Univ of Alberta, Edmonton, Canada; Karen Pieper, Duke Clinical Rsch Institute, Durham, NC; Christian Hamm, Kerckhoff Heart Cntr, Naheim, Germany; David R Holmes, Mayo Clinic, Rochester, MN; Frans Van de Werf, Frans Van de Werf, Univ Hosp Gathuisberg, Leuven, Belgium; Christopher B Granger, Duke Clinical Rsch Institute, Durham, NC

**Introduction:** We previously demonstrated that blood product transfusion strongly and independently predicts death in a population of STEMI patients treated with primary percutaneous coronary intervention (PCI). Using multivariable regression analyses, we explored which baseline and in-hospital factors predicted transfusion. **Methods:** Stepwise variable selection was performed from the database of the APEX-AMI trial, a phase 3 trial that compared pexelizumab to placebo in 5,736 patients with STEMI treated with primary PCI in 17 countries between 2004 and 2006. In-hospital CABG patients were excluded from the analysis (n=141). **Results:** Of the 4429 non-CABG pts with complete baseline and in-hospital covariates, 211 (4.6%) were transfused. Most transfused pts (81%) experienced moderate or severe bleeding. Baseline independent predictors of transfusion are presented in the table. After 24 hours, intra-aortic balloon pump use (OR: 6.05 95% CI 3.62–10.09,  $\chi^2 = 47.4$ ) and nadir hemoglobin (OR: 2.57 95% CI 1.62–4.08,  $\chi^2 = 16.0$ , per 10 mg/dL) were identified independent predictor of transfusion. Landmark analyses for the first 5 days maintained all predictors. Interestingly, transfusion rates were not increased in patients treated with Gp IIb/IIIa inhibitors or recatheterization. **Conclusions:** In this contemporary acute MI population treated with PCI, baseline characteristics (c-statistic: 0.823) coupled with additional factors emerging during the hospital course effectively discriminate the risk of receiving blood transfusion. These data will be useful in developing strategies to reduce the need for blood transfusions so as to avoid their long term adverse effects.

#### Baseline Predictors of Transfusion

Baseline Variables	OR	95% CI	$\chi^2$
Hemoglobin (per 10 gm/L)	0.67	[0.62–0.72]	101.5
North America (enrolment site)	2.40	[1.78–3.24]	32.8
Heart rate > 65 (per 10 BPM)	1.19	[1.11–1.28]	21.0
Diastolic blood pressure > 80 (per 10 mmHg)	0.77	[0.68–0.87]	18.3
Age (per 10 y)	1.38	[1.13–1.45]	15.8
Female Gender	1.85	[1.35–2.53]	14.9
Creatinine > 85 (per 10 $\mu$ mol/L)	1.03	[1.02–1.05]	14.8

### Transferring Images via the Wireless Messaging Network using Camera Phones Shortens Time Required to Diagnose Acute Coronary Syndrome

Masashi Ohtsuka, Eiji Uchida, Toru Nakajima, Hiroyuki Yamaguchi, Seirei Yokohama General Hosp, Yokohama, Japan; Hiroyuki Takano, Issei Komuro; Chiba Univ Graduate Sch of Medicine, Chiba, Japan

The speed at which reperfusion treatment can begin is critical in cases of acute coronary syndrome. Electrocardiograms (ECG) are used to make the diagnosis. In the absence of a cardiologist in the emergency room (ER), the ECG image data must be sent to a cardiologist on stand-by outside the hospital. Up until now, ECG images were sent from the hospital to the cardiologist by fax, but if a fax machine is not readily available to the cardiologist, they must look for one in order to receive the image data. More recently, camera phones have become very advanced and are able to send and receive high quality images by e-mail. In this study, we examined whether sending ECG images to a cardiologist by camera phone was more efficient than by fax. ECG images were taken of 20 patients suspected to have acute coronary syndrome. Patients were divided alternately into two groups of ten patients each; the F group and the CP group. The F group's ECG images were sent to a cardiologist by fax (n=10) and the CP group's ECG images were sent by camera phone (n=10). We measured the time taken in transmitting the images from the ER to a cardiologist, the time taken to analyze that image and the total time elapsed from image transmission to diagnosis by the cardiologist. All data presented are mean  $\pm$  SD. Group comparisons were based on the Student's t-test. The amount of time taken in transmitting the images from the ER to the cardiologist was longer in the F group (163.8  $\pm$  5.1 sec) than that taken by the CP group (71.5  $\pm$  4.6 sec). However, the amount of time taken by the cardiologist to analyze those images was shorter in the F group (12.9  $\pm$  1.8 sec) than that of the CP group (24.1  $\pm$  4.3 sec). Total time elapsed from image transmission to diagnosis was shorter in the CP group (95.6  $\pm$  8.4 sec) than that of the F group (176.7  $\pm$  4.9 sec). In conclusion, using camera phones to transmit ECG images to the cardiologist shortens the time taken to diagnose acute coronary syndrome. Furthermore, camera phones are more advantageous in regards to availability and cost in comparison to fax machines because of the recent popularization of camera phones. Therefore, image transmission by camera phones is more efficient in sending image data to a cardiologist than by fax.

### Surface Cooling Induced Therapeutic Hypothermia Following Pediatric Cardiac Arrest

Alexis A Topjian, Troy Dominguez, Janet Boyce, Rebecca Ichord, Mark Helfaer, Vinay Nadkarni; The Children's Hosp of Philadelphia, Philadelphia, PA

**Introduction:** Induced therapeutic hypothermia protocols following clinical pediatric cardiac arrest have not reported efficacy or compared core temperature (T) monitoring sites. An

effective cooling protocol is necessary before outcome trials can be performed. **Hypothesis:** Therapeutic hypothermia to goal range 32–34C for 24 hours will be maintained with overshoot hypo- or hyperthermia in <10% of values, using a standardized surface cooling protocol. Further, T monitored from rectum, esophagus and foley will equivalently reflect core body T. **Methods:** With IRB approval and parental consent, 5 patients were cooled by standard protocol to goal rectal T 32–34 C using ice packs and servo controlled cooling blanket, with prospectively designated rescue protocols. T's were recorded every 30 min from rectum, esophagus, foley and skin. Overshoot hypothermia was defined as T < target range and overshoot hyperthermia was defined as T > target range during cooling maintained for 24 hours. Excellent T stability was prospectively defined as <10% T values outside range. Data reported median [range]. Analysis by Kruskal-Wallis, Wilcoxon Rank Sum, and Spearman rank correlation for differences between T modalities. **Results:** Of 1613 T measurements, 854 were during 32–34C maintenance. Time to achieve rectal T 34C was 1 [0,6] hour from initiation of cooling and 7 [1.5,9.5] hours from arrest. During maintenance, rectal T showed overshoot hypothermia <32C in 44 (21%) measures, overshoot hyperthermia >34C in 14 (7%) measures, and within goal 32–34C in 149 (72%). There was no significant difference between rectal 33.7 °C [30.3, 37.8] T, esophageal 34.1 °C [30.2, 37.9] T and foley 33.6°C [30.4, 37.9] T, but each were significantly different from skin 33.1C [28.2, 37.9] T (p<0.005). Rectal T correlated well with esophageal (R<sup>2</sup> = 0.96, p<0.001) and foley (R<sup>2</sup> = 0.98, p<0.001) T sites. **Conclusions:** This clinical pediatric cardiac arrest surface cooling protocol can rapidly induce hypothermia. During maintenance, overshoot hypothermia is common (>20%), but overshoot hyperthermia is rare (<10%). During surface cooling, rectal, esophageal, and foley T's are equivalent to assess core T, but significantly higher than skin T.

### Community Public Access Defibrillation Sites: Compliance with American Heart Association Recommendations

Michael J Post, Peter Cram, Dianne L Atkins; Univ of Iowa, Iowa City, IA

**Introduction** The Public Access Defibrillation (PAD) Trial demonstrated improved survival of cardiac arrest victims when automated external defibrillators (AEDs) were combined with CPR by lay responders. These PAD sites incorporated American Heart Association (AHA) recommended elements of a PAD site and the volunteer responders received refresher CPR/AED training. It is unknown if typical community PAD sites maintain these elements after initial program development. The Johnson County Early Defibrillation Task Force (JCEDTF) in Johnson County, IA distributed AEDs throughout the county in 2002. CPR training was provided at program initiation. The purpose of this study was to evaluate the PAD sites 5 years later to assess compliance with AHA recommendations. **Methods** A 25 point scoring system was developed to assign numerical values to the components of a PAD site: planned and practiced response, links with local EMS, and training of rescuers. Surveys were mailed to all 39 PAD sites. Site visits with tours were conducted at each site to confirm the survey. Sites were grouped into educational, community, or business sites. **Results** Thirty two surveys were returned (response rate 82%): 5 educational sites, 13 business and industrial sites and 14 community sites. The Table shows the percentage of points that each group achieved for the components of an AED program. No site had incorporated all the recommended elements: the best sites included only 2/3 of the recommendations. There was a statistical difference in CPR training, with business and industrial sites performing best. Community sites were particularly weak with CPR training. **Conclusions** PAD sites incorporate approximately half of the elements of an effective PAD program. Business and industrial sites perform slightly better than educational or community sites. CPR training and EMS links are the poorest areas of compliance. These results may indicate that the effectiveness of a PAD site may diminish with time.

Table: Percentage of Achieved Points

	Planned Response	CPR Training	EMS Links	Total
Possible Points	15	7	3	25
Educational Sites n=5	56 $\pm$ 8%	53 $\pm$ 9%	47 $\pm$ 51%	54 $\pm$ 11%
Business and Industrial n=13	59 $\pm$ 18%	63 $\pm$ 95%	36 $\pm$ 35%	61 $\pm$ 13%
Community Sites n=14	65 $\pm$ 19%	41 $\pm$ 28%	26 $\pm$ 30%	55 $\pm$ 18%
p Value for each column	ns	0.022	ns	ns

### Effect of a Medical Decision Support Device on Quality of Basic Life Support

Elizabeth A Hunt, Kristen L Nelson, Margaret Heine, Nicole A Shilkofski; Johns Hopkins Univ Sch of Medicine, Baltimore, MD

**Background:** As cardiopulmonary arrest (CPA) can occur anywhere, laypersons may need to initiate CPR. However, recent literature reveals the quality of basic life support (BLS) provided during CPA is poor. There is increasing interest in whether devices can support laypeople, as well as others, to manage medical emergencies. **Methods:** We performed a prospective, randomized, controlled trial of simulated out of hospital CPA in which each subject was asked to manage a standardized event using the Laerdal Resusci-Anne simulator. A study member played a second rescuer to help as directed. The intervention was a device with audiovisual prompts designed to assist with decision making. Study subjects included laypeople and nursing and medical students. The primary outcome measure was the proportion of subjects who performed compressions and ventilations at a 30:2 ratio. Secondary outcome measures were proportion of subjects who insisted on switching roles with the second rescuer after 2 minutes and other measures of quality BLS. **Results:** Thirty-one subjects were enrolled, 16 in the intervention arm and 15 in the control arm, with similar baseline characteristics. Subjects in the intervention arm were more likely to perform compressions to ventilations at a ratio of 30:2 than controls, [15/16 (94%) vs. 4/15 (27%), p<0.001], even with stratification by rescuer background: laypeople [8/9 (89%) vs. 0/4 (0%), p=0.02], medical or nursing student [7/7

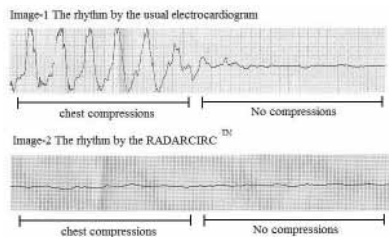
(100%) vs. 4/11 (36%),  $p=0.01$ ). Intervention subjects were also more likely to insist that the second rescuer switch roles with them than controls, [12/16 (75%) vs. 2/15 (13%),  $p=0.001$ ]. However, there was a delay in mean time ( $\pm$  standard deviation) to initiation of compressions in the intervention arm, [159.5 ( $\pm$  53) vs. 78.2 ( $\pm$  20) seconds,  $p < 0.001$ ] and the no-flow fraction was very high in both arms, [72.2% ( $\pm$  0.1) vs. 75.4 ( $\pm$  0.8),  $p = 0.35$ ]. **Conclusions:** The device resulted in a behavior change as intervention subjects were more likely to perform 30:2 and switch providers. Unfortunately, the device slowed the initial response time. These results are promising, but future studies should concentrate on decreasing latency time, periods without compressions and possible incorporation into automated external defibrillators.

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### The Comparison The Artifact By The Usual Electrocardiogram Versus The Dynamic Monitorizer (RADARCIRC™) During Chest Compressions Of Cardiac Arrest Patients

GENJI SHIMPUKU; Teikyo Univ Sch of Medicin, Tokyo, Japan

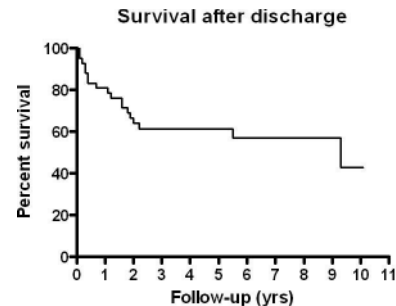
[Background] The 2005 American Heart Association (AHA) guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC), increased emphasis on importance of the chest compressions. These guidelines developed that rhythm checks should be very brief. The dynamic monitorizer (RADARCIRC™) was developed to reduce the artifact, but there is no study for the artifact during chest compressions of cardiac arrest patients. Our purpose was to compare the effect of the artifact by the usual electrocardiogram versus RADARCIRC™. [Materials and methods] We observed rhythms during chest compressions of 20 cardiac arrest patients by the usual electrocardiogram and the RADARCIRC™. [Results] Almost of all rhythm by the RADARCIRC™ reduced artifact. Image-1 is a typical rhythm (asystole) by the usual electrocardiogram. Image-2 is a typical one by the RADARCIRC™. [Conclusions] RADARCIRC™ will be able to shorten the time checking rhythm, because of reduce the artifact during CPR. Image-1: A typical rhythm (asystole) by the usual electrocardiogram Image-2: A typical rhythm (asystole) by the RADARCIRC™.



### In-hospital Cardiac Arrest: Predictors Of Long Term Survival After Being Discharged Alive

Wessel Keuper, Hendrik-Jan Dieker, Marc A Brouwer, Freek W Verheugt; Radboud Univ Med Cntr, Nijmegen, The Netherlands

**Background** Long term survival of patients discharged alive after cardiopulmonary resuscitation (CPR) for an in-hospital cardiac arrest (IHCA) has not been extensively studied. It is also largely unknown which of these patients are at high risk for poor survival. Therefore we studied survival and predictors of survival for these patients. **Methods** We retrospectively studied patients who suffered from an IHCA between 1997–2004 and who survived to discharge. Data were collected using an Utstein form. A Kaplan Meier curve was calculated for survival. Survivors were compared with non-survivors and Cox regression analysis was performed to determine predictors of survival. **Results** In this period 222 patients had an IHCA and 19% ( $n=42$ ) was discharged alive. Known predictors of survival to discharge were confirmed, primarily initial rhythm. In the discharged patients, survival after a median follow-up of 2.9 years (IQR 1.5–7.2) was 57% ( $n=24$ ). Non-survivors were significantly older, median age 69.3 (IQR 59.6–75.2) versus 56.7 (IQR 48.1–68.8) years and had significantly more often diabetes mellitus, arrhythmias, valvular disease and cancer in their medical history than survivors. Initial rhythm did not differ between groups. After adjustment for baseline differences it was found that cancer independently predicted a lower chance of survival (HR 2.8; 95% CI 1.1–7.5). Older age tended to predict a lower chance of survival as well. **Conclusion** Whenever a patient is discharged alive after an IHCA, the chance of survival is evidently reduced. Only cancer independently predicted a lower chance of survival. Long term survival seems to be determined more by comorbidity than arrest variables.



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### Asymmetric Dimethylarginine Predicts Outcome and Time of Stay in Hospital in Patients Attending an Internal Medicine Emergency Room

Friedrich Schulze, UnivHosp Hamburg-Eppendorf, Hamburg, Germany; Joern Vollert, Charité - Universitätsmedizin Berlin, Berlin, Germany; Renke Maas, UnivHosp Hamburg-Eppendorf, Hamburg, Germany; Reinhold Mueller, James Cook Univ, Townsville, Australia; Christian Mueller, Charité - Universitätsmedizin Berlin, Berlin, Germany; Rainer H Boeger, UnivHosp Hamburg-Eppendorf, Hamburg, Germany; Martin Moeckel; Charité - Universitätsmedizin Berlin, Berlin, Germany

**Introduction** For patients attending the emergency room (ER) valid diagnostic criteria which give information about further progress are needed. We investigated the predictive value of asymmetric dimethylarginine (ADMA), an independent cardiovascular risk factor, in unselected patients attending the internal medicine ER of a university medical center regarding outcome of the patients and duration of stay in the hospital. **Patients and Methods** Patients ( $n=417$ ) attending the ER were classified according their primary diagnosis in six groups: cardiovascular ( $n=156$ ), pulmonary ( $n=31$ ), CNS/neurological ( $n=42$ ), gastrointestinal ( $n=84$ ), cancer related ( $n=26$ ), other diagnosis ( $n=78$ ). Routine laboratory tests were performed and ADMA was determined by LC-MS from plasma. A primary endpoint of in hospital death and complicated outcome (need for continuous hospital based support) was defined. **Results** ADMA levels were highest in patients with cancer related diagnosis ( $0.84 \pm 0.36 \mu\text{mol/L}$ ) and in patients with cardiovascular diagnosis ( $0.71 \pm 0.19 \mu\text{mol/L}$ ) (ANOVA;  $p < 0.001$ ). In patients with cardiovascular diagnosis those reaching the primary endpoint had significantly higher ADMA levels than those without complications ( $0.88 \pm 0.22 \mu\text{mol/L}$  vs.  $0.69 \pm 0.18$ ;  $p < 0.001$ ). We found increasing proportions of patients experiencing the primary endpoint over the quartiles of ADMA (4.6%, 8.2%, 9.6%, and 15.8%;  $p=0.007$ ). ADMA was an independent predictor of the primary endpoint in a multivariate linear regression model (odds ratio 16.8;  $p=0.038$ ) after correction for age, gender, laboratory parameters, and chronic cardiovascular diseases. In a Cox proportional hazard model correcting for gender, BMI, diabetes, hypertension, CHD, and heart failure, ADMA was an independent predictor of the length of hospitalization (hazard ratio (HR) 0.49 (95% CI: 0.30–0.81);  $p=0.005$ ) beside age (HR 0.99 (0.98–0.99);  $p=0.031$ ), creatinine (HR 0.87 (0.77–0.99);  $p=0.035$ ), and CRP (HR 0.94 (0.91–0.96);  $p < 0.001$ ) in patients with cardiovascular diagnosis, respectively. **Conclusion** We conclude that ADMA independently predicts future complications and hospitalization in patients attending an ER.

### Importance of Mechanical Circulatory Support and Immediate Reperfusion of Occluded Coronary Artery in Patients with Acute Coronary Syndrome and Metabolic Phase of Ventricular Fibrillation

Hiroyuki Hanada, Takumi Higuma, Naoki Abe, Shin Saito, Masahiro Yamada, Ken Okumura; Hirosaki Univ Sch of Med, Hirosaki, Japan

Spontaneous circulation can not be obtained only by electrical shocks when ventricular fibrillation (VF) persisted for  $>10$  minutes. This is referred as a metabolic phase, but the effective treatment during this phase has not been established. In the year of 2005, we had two male patients with acute coronary syndrome (ACS) and with incessant VF refractory to shocks  $>$ three times. They were treated with extracorporeal circulation (percutaneous cardiopulmonary support (PCPS) and intra-aortic balloon pumping) and reperfusion of occluded coronary artery with percutaneous coronary intervention (PCI), and both of them recovered without any brain damage. Subsequently, we used the same therapeutic strategy in 8 patients with ACS and cardiac arrest (7 men and 1 woman, mean age 66 years old, ranging from 47 to 82). Two patients had pulseless electrical activity (PEA), one asystole, and the other 5 incessant VF refractory to multiple shocks. In 5 of the 8 patients (63%), spontaneous circulation returned after reperfusion by PCI. All 5 patients had incessant VF. The other 3 patients died within 48 hours, one of whom had asystole due to left main trunk occlusion, and the remaining 2 PEA due to occlusion of three coronary arteries or coronary occlusion caused by ascending aortic dissection. All of the 5 recovered patients were treated with hypothermia for 48 hours after reperfusion, and successfully released from the mechanical and medical circulatory support. One of the 5 patients had his right leg amputated because of necrosis caused by cannulation of PCPS. Four of the 5 patients (50% of all patients with cardiac arrest) were discharged from the hospital without any neurological deficits. The longest period from the cardiac arrest to full neurological recovery was 45 days. The 5 patients with spontaneous circulation recovery were suggested to be in the metabolic phase of VF, and immediate extracorporeal support and direct approach to the cause of VF were considered to be a key for return of spontaneous circulation. Effective and continuous chest compressions and extracorporeal circulation followed by hypothermia would be important for neurological recovery.



### Ventilation is not Necessary During Cardiopulmonary Resuscitation in a Rat Model of Hemorrhagic Cardiac Arrest

Takumi Taniguchi, Hideo Inaba; Kanazawa Univ, Kanazawa, Japan

Recent studies showed that arterial blood pressure during hemorrhagic shock is made worse with hyperventilation and improved with hypoventilation. However, there are few studies about the ventilation during cardiopulmonary resuscitation (CPR) in hemorrhagic cardiac arrest. To compare the effect of three ventilation strategies during CPR in an animal model of hemorrhagic cardiac arrest. Thirty-six male Sprague Dawley rats were anesthetized with pentobarbital ip. Hemorrhagic cardiac arrest was induced with removing of blood. After 3 minutes of cardiac arrest, animals were randomized to receive one of three ventilation strategies during CPR (n = 12 per group): normoventilation (20 breaths/min, FiO2 1.0), hypoventilation (10 breaths/min, FiO2 1.0), or no-ventilation. The rate of chest compressions (CC) was 240–260/min and depth of CC was titrated to maintain diastolic arterial pressure between 25–30 mmHg in all groups. After 5 minutes of CPR, the all removing blood and epinephrine (0.02 mg/kg) were administered. There were no other therapies before, during or after CPR. The rates of return of spontaneous circulation (ROSC) were 92%, 83%, and 92% for normoventilation, hypoventilation, and no-ventilation groups, respectively. The survival rates at 2hrs after ROSC were 67%, 58%, and 67% for normoventilation, hypoventilation, and no-ventilation groups, respectively. The PCO2 levels immediately after ROSC were 70mmHg, 74 mmHg, and 80 mmHg for normoventilation, hypoventilation, and no-ventilation groups, respectively. The increases of plasma cytokine (TNF-alpha and IL-6) and lactate concentrations after ROSC were not significantly differences between all groups. Moreover, the elevations of coagulation parameters after ROSC were not significantly differences between all groups. The present study showed that there were no significantly different on ROSC and the changes of cytokines and lactate and coagulation parameters between the three ventilation strategies during CPR in the hemorrhagic cardiac arrest model. These findings suggest that ventilation during CPR in hemorrhagic cardiac arrest may not be necessary.

### Use Of Medical Hyperspectral Imaging in the Evaluation of Blunt Chest Trauma and Hemorrhagic Shock in a Porcine Model

Andriy Batchinsky, Institute of Surgical Rsch, Brook Army Med Cntr, San Antonio, TX; Jenny Freeman, Svetlana Panasyuk, HyperMed, Inc., Waltham, MA; Bryon Jordan, David Martini, Institute of Surgical Rsch, Brook Army Med Cntr, San Antonio, TX; Marie Neverov, Kevin Schomacker, HyperMed, Inc., Waltham, MA; Leopoldo Cancio; Institute of Surgical Rsch, Brook Army Med Cntr, San Antonio, TX

**INTRODUCTION:** Hyperspectral Technology cutaneous Oxygenation Monitoring (HTcOM) provides scans that quantify oxyhemoglobin (HT-Oxy) and deoxyhemoglobin (HT-Deoxy) on a pixel by pixel basis. In monitoring mode, a series of sequential scans show oxygen delivery to the tissue and oxygen extraction by the tissue of interest. In this study, we tested the feasibility of using HTcOM to monitor tissue oxygenation changes during blunt chest trauma and hemorrhage. **METHODS:** 16 female Yorkshire pigs (~35kg, 10 bleed, 6 controls) are undergoing a combined blunt chest trauma & hemorrhage protocol implementing blunt right chest trauma with a modified captive-bolt humane stunner under anesthesia. Severity of pulmonary contusion is documented by arterial & venous blood gases & CT scans at 0, 15, 30, 60, & 120 min. Injury is followed 120 min later by constant-rate, fixed-volume hemorrhage of 40 ml/kg in 2 stages, with 20 min between stages. Hyperspectral imaging of the anterior lower extremities (near infrared system) and the lower abdomen (visible light system) is continuously performed. **RESULTS:** To date, 3 pigs have been studied. With chest trauma HT-Deoxy levels increased on average by 50% (range 14–112). Following 1st bleed, changes to HT-Oxy & HT-Deoxy were small while following 2nd bleed, HT-Oxy dropped 15% (range 11–20) & HT-Deoxy increased 4% (range 2–7). Using ANOVA, with HT-Oxy & HT-Deoxy as the outcomes & measurements made between 5 min before & 5 min after the event (injury, bleed 1, bleed 2, & death) as the predictive factors, changes in the 2 outcomes associated with the events

(p<0.001). Changes in HT-Oxy correlated with systolic BP for event periods (r = 0.47 to 0.97). HT-Oxy & HT-Deoxy also correlated with blood lactate values [r = -0.64 to -0.89 for HT-Oxy, 0.36 to 0.66 for HT-Deoxy], PvO2 [r = 0.62 to 0.88 for HT-Oxy, -0.78 to -0.81 for HT-Deoxy]. **CONCLUSIONS:** Quantitative measures of HT-Oxy & HT-Deoxy were extracted from HTcOM data & used to determine skin microvascular changes as a local manifestation of systemic hemodynamics in injured swine. Consistent trends of HTcOM responses were noted and found to be different with injury vs hemorrhage. HTcOM provides information that may be useful in the clinic & in the field to aid in the assessment of trauma patients.

### Relationship of Body Mass Index (BMI) to Minimum Distance from Skin Surface to Myocardium: Implications for Neuromuscular Incapacitating Devices (NMID)

Gregory G Bashian, Gabriel A Wagner, Don W Wallick, Patrick J Tchou; Cleveland Clinic, Cleveland, OH

**Introduction:** It is controversial whether NMIDs can induce cardiac arrhythmias in humans. Studies in swine models have shown varying results. Two reported no induced VF, while a third showed 1 case of induced VF during epinephrine infusion. Two studies showed site sensitivity of cardiac capture depending on location of NMID electrodes. Human studies have not shown any induced arrhythmias. However, it is unclear whether electrodes were placed at the most vulnerable regions of the chest. This study sought to assess the thoracic location and range of minimum skin-to-heart distances (mSHD) and its relationship to BMI. **Methods:** Forty-five patients who had undergone cardiac CT scans were randomly selected for evaluation. These scans were analyzed to determine the mSHD and the location of this point on the chest surface relative to anatomic landmarks (horizontal distance from midsternum and vertical distance from sternal insertion of the lowest left rib). Linear regression analysis was performed using BMI and mSHD. **Results:** mSHD ranged from 1.8 cm to 6.4 cm. FIGURE 1 shows the linear regression of mSHD vs. BMI. mSHD was to the left of mid sternum (2.5 ± 2.5 cm) and slightly inferior (0.5 ± 2.0 cm) to the lowest left rib sternal insertion. The area of myocardial contact with the anterior chest wall averaged 51 ± 25 cm<sup>2</sup>, and was unrelated to BMI. **Conclusions:** In this study of adults, the average location of the site of mSHD was slightly to the left of mid sternum and just below the lowest rib insertion. There is a linear relationship between BMI and mSHD. The size of a person and the anatomic relationship of the heart to the anterior chest wall can influence the potential cardiac capture by NMIDs at the site of mSHD.

Figure 1: mSHD vs. BMI

