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Editorial

Resuscitation highlights in 2015

The 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (CoSTR) and the 2015 European Resuscitation Council (ERC) Guidelines were just some of the landmark publications in *Resuscitation* last year.[1,2] The editors have highlighted some of the other key papers that helped to further resuscitation science in 2015.

1. Epidemiology and outcome

The Utstein-style template for reporting outcomes from out-of-hospital cardiac arrest (OHCA) has been revised and updated.[3] This template facilitates reporting of the bystander-witnessed, shockable rhythm as a measure of emergency medical services (EMS) system efficacy and all EMS system-treated arrests as a measure of system effectiveness. Several additional important subgroups are identified that enable an estimate of the specific contribution of rhythm and bystander actions that are key determinants of outcome.

Several recent studies have indicated that survival rates for OHCA are slowly increasing. An analysis of the Resuscitation Outcomes Consortium study sites showed that unadjusted survival rates for 47,148 EMS-treated OHCA cases increased from 8.2% in 2006 to 10.4% in 2010.[4] In a sub-analysis of 111 U.S. and Canadian hospitals participating in the ROC-PRIMED study during 2007–2009, greater survival and favourable neurological status at discharge were associated with greater adherence to recommended hospital based post-resuscitative care guidelines.[5]

Four studies published in 2015 focussed on outcomes after cardiac arrest in the elderly.[6–9] Two studies documented an association between age and neurological outcome[7,8] but two others found no such association.[6,9]

In a study of seven North American cities, Pittsburgh had the highest crude rate of cardiac arrest deaths in patients 18–64 years of age, particularly in neighbourhoods with lower socioeconomic status (SES).[10] The authors retrospectively identified 415 patients aged 18–64 years treated for OHCA and in-hospital cardiac arrest (IHCA) at two Pittsburgh hospitals between January 2010 and July 2012. Socioeconomic factors strongly influenced the type, severity, and outcome of patients with OHCA but not those with IHCA.

The prognostic value of pregnancy in women receiving CPR in the emergency department was evaluated in a population-based, matched cohort study using the Nationwide Emergency Department Sample (NEDS) from 2006 to 2010.[11] The authors identified 157 pregnant women among 8162 women requiring CPR in the emergency department. Pregnancy was associated with better overall survival of 36.9% compared to 25.9% in non-pregnant women (OR 1.89 [1.32–2.70], $p < 0.01$). Traumatic injury was identified as a significant predictor of outcome in pregnancy. In non-trauma patients, pregnant women had significantly better odds of surviving CPR than non-pregnant women (OR 2.10 [1.41–3.13], $p < 0.01$). In cases of trauma, no significant difference was observed between groups.

Nehme and co-authors used data from the Victorian Ambulance Cardiac Arrest Registry to compare epidemiology, survival to hospital discharge and 12-month functional recovery in 8648 adult OHCAs occurring before and after paramedic arrival.[12] When compared to OHCA cases occurring before EMS arrival, EMS-witnessed arrests were associated with significantly higher survival to hospital discharge rates and favourable neurological recovery at 12-month post-arrest.

In a summary of nine studies included in a systematic review of OHCA in schools, it was confirmed that OHCA in children and adolescents is rare, with a minority of cases occurring at school.[13] However, when cardiac arrests occur on school property, it is more likely to affect an adult than a student. Outcomes are better than for arrests occurring at other out-of-hospital locations, probably due to the high proportion of witnessed arrests and high rates of bystander CPR.

Does the number of EMS personnel on scene affect cardiac arrest outcome? In a retrospective review of 16,122 EMS-treated OHCAs from Canada and the United States, the presence of 5 or 6, 7 or 8 EMS personnel on-scene was associated with a higher rate of survival to hospital discharge compared with fewer personnel on-scene (adjusted odds ratio 1.35 [95% CI: 1.05, 1.73]).[14] The authors concluded that more EMS personnel on-scene within 15 min of a 911 call is associated with improved survival from OHCA.

2. Rapid response systems

The publication of advanced life support (ALS) treatment recommendations in the 2015 CoSTR and 2015 guidelines by the ERC included continuing emphasis on the need for rapid response systems (RRS) of care to identify the deteriorating patient and prevent IHCA.[15,16] *Resuscitation* continues to publish important studies that aim to improve our understanding of RRS.

Jarvis and colleagues assessed the Royal College of Physicians of London (RCPL) National Early Warning Score (NEWS) system and compared workloads generated by the RCPL's escalation protocol with those for aggregate NEWS values alone.[17] The recommended

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NEWS escalation protocol produced additional work for the bedside nurse and responding doctor, disproportionate to the benefit in increased detection of adverse outcomes. Efficient staff resource allocation and avoiding alarm fatigue will be increasingly important to optimise RRS in evolution.

The performance of the NEWS in identifying 48 h and 30 day mortality, intensive care unit (ICU) admission, and a combined endpoint of 48 h mortality or ICU admission was evaluated in unselected prehospital patients.[18] All the endpoints were associated with higher NEWS scores and they concluded that calculation of prehospital NEWS may facilitate earlier recognition of deteriorating patients, and the early involvement of senior emergency department staff.

Abbott and colleagues conducted a prospective observational cohort study of all adult general medical patients admitted to a single hospital over a 20-day period.[19] They aimed to compare the newly introduced NEWS to the early warning score currently used – the Patient at Risk Score (PARS). Physiological data and early warning scores recorded in bedside charts were collected on admission and a NEWS score was retrospectively calculated. The primary outcome was a composite of critical care admission or death within 2 days of admission. The secondary outcome was hospital length of stay. NEWS was more strongly associated with the primary outcome than PARS, and a NEWS of 3 or more was associated with the primary outcome (odds ratio 7.03, $p = 0.003$). Neither score was correlated with hospital length of stay. They suggested that current guidelines advocating a threshold of 5 for triggering a clinical review should be reviewed since a score of 3 or more was associated with a poor outcome. Both scores were poor predictors of hospital length of stay.

To add weight to this suggestion a further study evaluated the weightings and calculations used for early warning scores (EWS) where calculation errors may potentially impact on hospital efficiency and patient care.[20] They truncated 36 published 'standard' EWSs so that, for each component, only two scores were possible: 0 when the standard EWS scored 0 and 1 when the standard EWS scored greater than 0. They found that binary EWSs had lower Area under the Receiver Operating Characteristics (AUROCs) than the standard EWSs in most cases, although for some the difference was not significant. The binary form of the NEWS, had significantly better discrimination than all standard EWSs, except for NEWS. Overall, Binary NEWS at a trigger value of 3 would detect as many adverse outcomes as are detected by NEWS using a trigger of 5, but would require a 15% higher triggering rate. The balance between fewer errors and a potentially greater workload needs further investigation.

Capan and colleagues studied optimal patient-centred rapid response team (RRT) activation rules using electronic medical records (EMR)-derived Markovian models.[21] NEWS was used and statistical tests identified 12 statistically significant subpopulations which differed clinically, as measured by length of stay and time to re-admission. They suggest the full potential of EWS for personalising acute care delivery is yet to be realised.

3. Basic life support

Delivering high-quality CPR to all victims of cardiac arrest remains a key priority identified by the ILCOR review of science and treatment recommendations[22] and ERC Guidelines[23] Despite clear evidence of benefit from bystander CPR,[24] the rates of bystander CPR remain sub-optimal in many communities.

In 2015 the World Health Organization endorsed the "Kids save lives" campaign which promotes CPR in schools.[25] This strategy is logical as school children are a captive audience, training is more efficient,[26] eager to learn and the future generation of adults. The timing of what to teach and when in the school curriculum is assisted by the findings from a systematic review by De Buck et al.[27] Evidence from 30 studies showed that children as young as 5 can learn some skills and those over 11 are likely to help in an emergency. An evidence-based educational pathway for CPR and first aid for different age groups is presented.

4. Defibrillation

The issue of whether it is safe to defibrillate when properly-gloved rescuer hands are touching the patient sparked considerable interest and discussion in 2015.[28–31] The ability of electrical insulating gloves to protect the rescuer during hands-on defibrillation was tested using a 'worst case' electrical scenario.[28] Data from 61 shocks applied to 43 different patients were recorded. Rescuer leakage current was significantly below the 1 mA safe threshold, enabling the authors to conclude that hands-on defibrillation is safe if the rescuer makes only one other point of contact with the patient and uses Class 1 electrical insulating gloves.

Public access defibrillation (PAD) deployment rates remain low: 1% in Asia,[32] 3.8% in Copenhagen,[33] and 16% in Stockholm.[34] An analysis of the cost effectiveness of PAD programmes and other studies suggests cost effectiveness would be improved by identifying locations with the highest incidence of OHCA and investing in interventions to increase AED utilisation.[35–37]

For example, there is a volunteer-based automated external defibrillator (AED) network in Copenhagen which provided a unique opportunity to assess AED use. Investigators found that an AED was applied before ambulance arrival in only 3.8% of all OHCA cases even though 15.1% of all events occurred within 100 m of an accessible AED.

In contrast, in a retrospective analysis of OHCAs from 2006-12 in Stockholm, one-month survival was 31% ($n = 101$) for cases defibrillated by the EMS, 42% ($n = 22$) when defibrillated by first responders, and 70% ($n = 52$) when defibrillated by a public AED.[34] AEDs within the PAD programme constituted 2.6% of all public AEDs and were used in 28% ($n = 21$) of cases when a public AED was used.

A critical determinant of whether PAD programmes are successful hinges on matching deployed AED location with where cardiac arrests are likely to occur in the community. The location of 654 OHCAs were compared with 1704 non-medically placed AEDs in metropolitan Phoenix, Arizona during 2010–12.[36] Events occurred most frequently at locations categorised as 'In Cars/Roads/Parking lots' (190/654, 29.1%) and there were no identified AEDs for these areas. AEDs were placed most frequently in 'Public business/office/workplace' locations and cardiac arrests occurred with the second highest frequency in this location type. The authors found only a weak correlation between events and deployed AEDs even though it was possible to identify areas where OHCAs occurred frequently.

Public use of AEDs also depends on their knowledge of the devices and willingness to use them. A survey of 514 bystanders in two high-volume train stations in Philadelphia, Pennsylvania found that 66% were able to correctly identify an AED and its purpose, and 58% reported willingness to use an AED in an emergency.[37] However, less than 10% of respondents presented with a hypothetical cardiac arrest scenario spontaneously mentioned using an AED when asked what actions they would take.

Mobile phone technology can link incident location, nearest PAD and a nearby first responder. One system, Pulsepoint, has been deployed to over 600 communities in the US. A user survey found 63% ($n = 813$) had received a notification of a nearby suspected cardiac arrest, of whom 189 (23%) had responded. Of those who did respond, one third did not make it to the scene of the incident. 44 (32%) found a victim who was unconscious and not breathing normally and CPR was provided in 11 cases.[38]