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Editorial

Resuscitation highlights in 2018

The International Liaison Committee on Resuscitation (ILCOR) is now undertaking a continuous review of resuscitation science and the findings are published annually as consensus on cardiopulmonary resuscitation science with treatment recommendations (CoSTR) summary papers.[1] Papers published in *Resuscitation* continue to make a major contribution to this science. The editors have highlighted some of the key papers published in the *Journal* in 2018.

Epidemiology and outcome

It is common to assume that most out-of-hospital, and many in-hospital, cardiac arrests are caused by underlying cardiovascular disease. These assumptions were put to the test with a novel system for classifying arrest etiology among consecutive patients treated at a single centre after in- or out-of-hospital cardiac arrest (IHCA, OHCA respectively) over four years.[2] Two reviewers independently reviewed a random subset of 20% of cases and documented high inter-rater reliability. The cause of arrest was identifiable in most cases. The most common causes of OHCA were an acute coronary syndrome (ACS) (16%) followed by respiratory failure (12%) and a toxicological cause (11%). The most common causes of IHCA were respiratory failure (22%) followed by an ACS (8%). Rates of awakening and survival to hospital discharge differed across arrest etiologies, with survival ranging from 6% to 60% (both $P < 0.001$) and rates of favourable outcome ranging from 0% to 40% ($P < 0.001$). Timing and mechanism of death (e.g. multisystem organ failure or brain death) also differed significantly by cause; thus, 'cardiac' causes may be less common than thought previously.

Rapid response systems

The optimal system to identify clinical deterioration and prevent cardiac arrest has yet to be defined.[3] A computer generated electronic Cardiac Arrest Risk Triage (eCART) score was more accurate than commonly used paper-based tools [4]; thus an algorithm-based electronic risk identification tool may enable earlier detection. The potential commercial reward and interest in this approach is obvious, and a group of researchers affiliated to Philips presented their evidence for an Early Deterioration Indicator (EDI) using log likelihood risk of vital signs to calculate continuous risk scores for patients.[5] The EDI was compared with the Modified Early Warning Score (MEWS) and National Early Warning Score (NEWS). The EDI was trained using the most significant variables in predicting deterioration and it had the best performance among the 3 scores in this study. This is clearly an area for further investigation.

In a stepped wedge cluster randomised clinical trial (RCT), a rapid response system was introduced into 14 Belgian hospitals.[6] While finding no difference in death, cardiac arrest or unplanned ICU admission when adjusted for clustering and study time, the investigators, like those before them, found a lower than expected baseline incidence of unexpected death and cardiac arrest rates which resulted in a significantly underpowered study, and several methodological issues that are outlined in the accompanying editorial.[7]

Basic life support

All links in the chain of survival are not equally effective — those at the start of the chain of survival have the greatest potential to save the most lives.[8] The importance of the early links of the chain of survival are emphasised in the research gaps identified by the International Liaison Committee on Resuscitation.[9] This called for further research on dispatcher-assisted cardiac arrest recognition, dispatcher-assisted CPR and system configuration for public access defibrillation (PAD) programmes.

The initial telephone call to the emergency services represents the first point of healthcare contact in most OHCAs. The call handler (often called a dispatcher) is tasked with identifying whether a cardiac arrest has occurred, and initiating dispatcher-assisted CPR. The importance of time to recognition of cardiac arrest was emphasised in a cross-sectional study which examined the influence of cardiac arrest detection interval on survival with a favourable neurological outcome. The study found that the delayed detection of OHCA was associated with a 3% reduction in good neurological recovery with every 30 s delay.[10]

The Australian Resuscitation Outcomes Consortium (AUS-ROC) group applied linguistic analysis to a series of paramedic-confirmed OHCA calls.[11,12] The researchers focused on the conversations and interactions between caller and call-takers in relation to the initial diagnosis of cardiac arrest and uptake of dispatch-assisted CPR. This revealed that for cardiac arrest recognition, there were two types of affirmative responses to the question – is he/she breathing? – plain "yes" answers and qualified "yes but . . . " answers. Qualified "yes but" answers were more likely to be associated with abnormal (e.g. agonal) breathing and should prompt dispatchers to probe further rather than assume breathing is normal.[11] When the focus was turned to the way in which CPR instructions were presented to callers, the

researchers found the uptake of bystander-assisted CPR was lower when callers were asked "do you want to do CPR" (uptake 43%) compared to when dispatchers gave directive instructions "we are going to do CPR" (uptake 97%) and "we need to do CPR" (update 84%).[12]

Methods for remote communication are constantly evolving and the number of video calls are increasing. A systematic review identified nine studies which compared the quality of CPR with audio versus video dispatch-assisted CPR.[13] Meta-analysis of six studies showed that chest compression rates were faster (and closer to guideline recommendations) in the video group, but no improvement in the other CPR quality metrics. By contrast, initiation of chest compressions was slower (median delay 31.5 s; 95% CI: 10.94–52.09) for video calls. This provides a focus for future audit and quality improvement as these technologies become embedded in the emergency response system.

In a cross-sectional study in Korea, researchers showed that communities with high CPR awareness were more likely to recognise cardiac arrest (adjusted odds ratio (aOR) 1.05 (1.01–1.10), receive dispatcher CPR instructions (aOR 1.11 (1.06–1.16) and perform bystander CPR (aOR 1.07 (1.03–1.11).[14] This adds further weight to the importance of equipping communities with the knowledge and skills to deliver effective CPR.

During 2018, ILCOR launched the World Restart a Heart initiative.[15] Building on the success of the European Restart A Heart projects and other initiatives around the world, ILCOR's regional Resuscitation Councils came together to provide a unified global message that 'All Citizens of the world can save a life'.[16,17]

Defibrillation

Bystander defibrillation improves survival with favourable neurological outcome.[18] Several new observational studies add insights into some of the barriers to successful public access defibrillation. Bystanders can struggle to find the location of PADs due to poor signage and lack of staff knowledge of locations.[19,20] Defibrillators may be inaccessible because of the host facility opening hours or may be too far away to reach the victim in time.[21] In a simulation model, identifying alternative strategies to facilitate emergency services access to railway stations can reduce time to defibrillation.[22] Use of the behaviour change wheel conceptual framework has been proposed as a way of improving bystander defibrillation based on enhancing bystander capability, opportunity and motivation.[23]

The relationship between no-flow duration (time interval from 911 call to EMS arrival) and initial cardiac rhythm was examined in 2532 witnessed OHCA victims for whom there was no bystander CPR. Overall survival was 14%, and 34% had initial shockable rhythms.[24] The odds of a shockable initial rhythm declined with each additional minute of no-flow time. Among those found with initial shockable rhythms, 94% (95% CI 92–96%) had a no-flow time under 10 min, which is of importance regarding unwitnessed arrest patient candidacy for eCPR.

A method has been developed to accurately discriminate pulsatile rhythms from pulseless electrical activity (PEA) during analysis intervals non-invasively using the ECG and the transthoracic impedance (TI) acquired from automated external defibrillator (AED) pads.[25] The algorithm analyzed 167 segments and found a sensitivity (ability of detecting pulsatile rhythms) of 98.3% (95% CI 95.1–100%) and a specificity (ability to detect pulseless electrical activity) of 98.4% (95% CI 97.1–99.8%) in a validation subset. Absence of pulsatile rhythm was confirmed during the first AED analysis interval in 98.9% of the episodes, and presence of a pulse was confirmed in the first 3 s of all intervals with annotated ROSC. This technology has future potential to help lay and professional rescuers as they try to determine if ROSC has occurred during resuscitation.

Advanced life support

In 2018, ILCOR ranked the role of vasopressors and advanced airway interventions during CPR as the leading knowledge gaps and research priorities for advanced life support (ALS).[9] Subsequently, the largest RCT to date of adrenaline compared with placebo for OHCA,[26] and airway RCTs that compared bag mask with tracheal intubation, the laryngeal tube with tracheal intubation, and the i-gel with tracheal intubation were published.[27–29] All suggest limited or uncertain benefit of the more complex intervention (adrenaline, tracheal intubation) during CPR, in particular for improving longer term functional outcomes.

Health-related quality of life assessed as a minimum at 90 days was rated as a core outcome by the ILCOR Core Outcome Set for Cardiac Arrest in Adults (COSCA) collaborative which included the views and experiences of patients, the public, clinicians, policy makers, and researchers.[30] The North American ROC reported the relative benefits of basic life support (CPR and automated external defibrillation) compared with ALS (advanced airway, manual defibrillation, or intravenous drugs). Among 35,065 patients with OHCA, ALS with or without initial BLS was associated with increased adjusted ROSC and survival to hospital discharge unless delivered greater than 6 min after BLS arrival. Regardless of when it was delivered, ALS care was not associated with significantly greater functional outcomes (defined as modified Rankin score of 1, 2 or 3 at hospital discharge).[31]

Drugs during CPR

In 2018 we had a greater insight into the role of drugs during CPR for OHCA. In a RCT of 8014 adults with OHCA in the United Kingdom, in comparison with placebo adrenaline use increased 30-day survival but not good neurological outcome; more survivors had severe neurologic impairment in the adrenaline group.[26] An observational study of 2255 OHCA patients showed reducing the adrenaline dose (0.5 mg) was not associated with a change in survival to hospital discharge or favourable neurological outcome.[32] The 2018 ILCOR International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (CoSTR) Summary focused on the role of antiarrhythmic drugs during CPR.[1] The main recommendation was that amiodarone or lidocaine could be used for shock refractory cardiac arrest in adults and children. The systematic review that informed the ILCOR CoSTR showed that any benefit of amiodarone or lidocaine were similar, occurred when they were given early, and limited to shorter term outcomes such as ROSC.[33] In addition, post-hoc analysis from a key RCT showed that amiodarone or lidocaine did not decrease the incidence of re-arrest after ROSC when compared with placebo.[34]

Mechanical devices

The authors of a Bayesian network meta-analysis on the efficacy and safety of mechanical chest compression devices (AutoPulse and

LUCAS) with manual chest compressions concluded that for survival and neurological outcomes to discharge / 30 days, manual compressions were similar to LUCAS but more effective than AutoPulse.[35] The rates of pneumothorax and hematoma were higher with the AutoPulse compared to manual CPR. Variation in the rates of reporting serious adverse events in the index trials should be taken into account when considering these findings.[36] Following prolonged use of mechanical CPR, patients should be systematically monitored for injuries, e.g. where mechanical CPR is used as an adjunct to establish extracorporeal CPR.[36]

Extracorporeal CPR (E-CPR)

Interest in the use of extracorporeal-CPR (E-CPR) techniques continues to grow. A systematic review identified no RCTs of E-CPR, included 25 observational studies (15 studies of adult OHCA, seven studies of adult IHCA, three studies of paediatric IHCA), found the quality of evidence to be very low and concluded that evidence to support or refute the use of E-CPR for OHCA and IHCA in adults and children was inconclusive.[37] This and another systematic review highlight the need for RCTs of E-CPR.[38] One thing that is certain is that E-CPR requires considerable resource, organisation and effort to implement.[39,40]

Ultrasound during CPR

Point-of-care cardiac ultrasound (POCUS) is becoming a core emergency skill. During CPR, POCUS in a focused manner and integrated into the ALS protocol to minimise interruptions and delays in chest compression has the potential to identify reversible causes, and help inform decisions to start and stop CPR, and also identify correct tracheal intubation.[41–45] Whether POCUS during CPR actually improves patient outcomes remains to be determined.

Paediatric resuscitation

A sub-analysis of the Therapeutic Hypothermia after Paediatric Cardiac Arrest (THAPCA) trials found a high risk for unfavourable outcomes among 125 one-year survivors, with the majority demonstrating declines in neurobehavioral functioning, across multiple functional domains, with similar functioning at 3 and 12 months.[46] In an additional paper that included some members of the same group, the clinical characteristics associated with 12-month survival and neurobehavioral function were identified.[47]

A report on the epidemiology and outcome of paediatric OHCAs from the Pan-Asian resuscitation outcomes study (PAROS) included 974 children and demonstrated bystander CPR rates ranging from 53.5% in Korea to 11.8% in UAE.[48] Overall, 8.6% survived to discharge from hospital. Adolescents (aged 13–17) had the highest survival rate of 13.8% but only 3.7% survived with good neurological outcomes (CPC 1 or 2). A study of the trends in the incidence and outcome of paediatric OHCA over 17 years in Victoria, Australia included 1301 events attended by emergency medical services (EMS) of which 73% received a resuscitation attempt.[49] Survival of the event increased from 23.3% in 2000 to 33.3% in 2016 and survival to hospital discharge increased from 9.4% to 17.7%. Increased survival to hospital discharge was driven largely by initial shockable arrests, which increased from 33% in 2000 to 60% in 2016 — survival was higher if the first shock was delivered by either first responder or public AED compared with EMS.

It is clearly critically important to develop interventions that can reduce the burden of neurological injury in children after hypoxic ischaemic brain injury. A study on the potential role of transcutaneous doppler (TCD) demonstrated that patients with favourable neurological outcomes had flow velocity near normal and intermittently intact cerebral autoregulation, while unfavourable outcomes had more extreme flow velocity.[50] An area for future research is the use of continuous TCD for goal directed management of blood pressure targeted to intact cerebral autoregulation.[51] In a pilot randomized control trial involving 34 children who had survived cardiac arrest, 24 h versus 72 h of targeted temperature management (TTM) had a differential impact on the concentrations of neuron specific enolase (NSE) and S100b.[52] In an analysis that pooled data from the in-hospital and out-of-hospital THAPCA trials, in comparison with normothermia, hypothermia did not confer a significant benefit in survival with favourable functional outcome at one year.[53]

Using propensity score-matching, an analysis of 6810 children (<18 years) in a Japanese cardiac arrest registry (2007– 2014) showed that in the majority of the paediatric subgroups, conventional CPR was associated with improved outcomes compared with CC-CPR.[54] CC-CPR was associated with 30-day neurologically intact survival similar to conventional CPR for children with OHCA aged ≥8 years, for children aged 1–17 years with cardiac aetiology or initial shockable rhythm, and for infants with cardiac aetiology or witnessed arrest. Cluster randomised trials on a National/Regional Resuscitation Council basis have been suggested, whereby some councils are randomised to using one form of CPR whilst another region/council is randomised to the change from one to the other for the same time period.[55]

Neonatal resuscitation

An anatomical investigation of intraosseous (IO) access in stillborns compared different devices and concluded IO access for premature infants and neonates is best achieved with a manually twisted butterfly needle.[56] A RCT of umbilical cord milking in preterm neonates requiring resuscitation found preterm neonates requiring resuscitation who had umbilical cord milking had higher haemoglobin and ferritin values at 6 weeks.[57] The authors recommended the technique as a placental transfusion method with no significant adverse effects. Another study has demonstrated that it is feasible to provide resuscitation to term and near-term infants during delayed cord clamping (DCC), after both vaginal and caesarean births, clamping the umbilical cord only when the infant is physiologically ready.[58]

An analysis of 14,731 breaths in 101 spontaneously breathing infants has provided reference ranges for exhaled carbon dioxide, exhaled tidal volumes, and respiratory rate for the first ten minutes after birth in term infants who transition without resuscitation.[59]

Trauma

Unmanned aerial vehicles (UAVs or drones) may be useful to prevent drowning by delivering a flotation device to a swimmer safely and quickly. The addition of a UAV in rescue operations could improve the quality and speed of response while keeping lifeguards away from dangerous sea conditions.[60] Although the majority of the media and

publishers focus on the resuscitation of drowning, the incidence of resuscitation being performed is only one in every 112,000 of interventions by lifeguards (0.0009%).[61]

An analysis of the French national registry for traumatic cardiac arrest showed that in comparison with medical OHCAs (n=40,878) trauma victims (n=3209) were younger, more likely to be male and away from home at the time and less likely to be resuscitated. The survival odds for traumatic OHCA were 2.4 times lower at admission and 6 times lower at day 30 than medical OHCA.[62]

Post-resuscitation care

Targeted temperature management

The optimal method for inducing and maintaining targeted temperature management (TTM) remains unclear. In 2018, two studies compared and contrasted a wide variety of TTM techniques. In a prospective study of 120 patients in 10 intensive care units (ICUs) in Pittsburgh, PA, intravascular cooling and gel-adhesive pads enabled more rapid hypothermia induction and less temperature fluctuation than that achieved with water-circulating cooling blankets.[63] In a study involving more than 4000 OHCA patients from Korea, there was no significant difference in neurological outcome among the TTM techniques used; however, intracavitary cooling was associated with lower survival to discharge than external surface cooling.[64] Although intravascular cooling enables precise temperature control, there has been some concern that the cooling catheters might be associated with an increased risk of thrombosis and infection. In a propensity-matched cohort study, 12 of 75 (16%) patients with endovascular cooling catheters versus 0 of 75 (0%) with femoral central venous catheters (p = 0.005) had thrombotic complications (at the catheter insertion site or in the inferior vena cava).[65]

The optimal target temperature is also uncertain and continues to be the subject of investigation. In a nationwide observational study from Japan involving 738 OHCA patients, there was no difference in neurologically favourable outcome among those receiving TTM with a target temperature of 33 °C, 34 °C, 35 °C, and 36 °C.[66]

Delayed awakening occurs in up to 30% of OHCA patients treated with TTM who make a good neurological recovery and several studies have documented an association with the type of sedation used. Among 460 OHCA patients treated at Cochin Hospital, Paris, France, awakening was delayed in 6% of 134 patients who had been sedated with propofol-remifentanil compared with 29% of 326 patients who were sedated with midazolam-fentanyl.[67] The target temperature used during TTM may also influence the incidence of late awakening: in a subanalysis of the TTM trial, it was documented that awakening occurred later in the TTM33 group than in the TTM36 group (p = 0.002) with no difference in neurological outcome, or cumulative doses of sedative drugs.[68]

Haemodynamics

Several investigators have showed an association between higher mean arterial blood pressure (MAP) better neurological outcome among comatose OHCA patients. Using blood pressure-over-time plots, the area below pre-specified incremental MAP thresholds (ABT; mmHg*hours) between 65 and 86 mmHg was compared with neurological outcome among 122 consecutive OHCA patients.[69] Increased rates of severe neurological dysfunction were associated with higher ABT when using MAP thresholds <75 mmHg, which supports the use of MAP targets ≥75 mmHg in these patients. In another observational study, among 170 comatose post-cardiac arrest patients, the lowest diastolic pressure (DAP) value during the first six hours after ICU admission was the only haemodynamic parameter independently associated with unfavourable three-month neurological outcome.[70] Other investigators found no relationship between the time weighted average MAP over 48 h and epileptiform electroencephalogram (EEG) activity in 195 comatose OHCA patients.[71]

Post-cardiac arrest oxygen and carbon dioxide

Lung protective ventilation strategies are known to improve outcomes among patients with acute respiratory distress syndrome (ARDS) and there is some evidence of an association between low tidal volumes and better neurological outcome in comatose OHCA patients.[72] In a subanalysis of 567 of the 950 patients in the TTM study, 60% were ventilated with a tidal volume (V_T) ≤8 mL/kg. In multivariate analysis, increased respiratory rate, but none of the other ventilation parameters, was independently associated with 28-day mortality.[73] An observational study of 185 IHCA patients receiving mechanical ventilation also failed to document an association between V_T and neurological outcome.[74]

Several animal studies and clinical observational studies have documented an association between high post-ROSC partial pressure of oxygen (PaO_2) and poor neurological outcome. In a small pilot study, 61 patients were randomised post-ROSC to titrated inspired oxygen versus 10 L min of oxygen.[75] Post-ROSC titration of oxygen was considered to be feasible and a large clinical RCT (the EXACT trial) is about to start.

Coronary revascularisation

During 2018, several more observational studies published in *Resuscitation* have documented an association between immediate coronary angiography (CAG) and improved outcome after OHCA. A propensity score analysis of 4046 patients in the French National Cardiac Arrest registry documented an association between immediate coronary angiography after OHCA and both survival and favourable neurological recovery.[76] In a similar study of 599 OHCA patients from Pittsburgh, PA, after multivariate adjustment and propensity matching, early PCI was associated with improved survival compared with early CAG without PCI and no early CAG, but early CAG without PCI was not associated with improved outcome compared with no early CAG.[77] In contrast, a propensity analysis of 1881 OHCA patients from Arizona without ST-elevation (STE) on the initial ECG showed that CAG was associated with survival regardless of whether PCI was performed.[78] The ability to undertake urgent CAG after OHCA implies the need for direct transfer to a PCI-capable hospital and several investigators have already documented that is associated with better outcomes compared with transfer to the nearest hospital. Two further studies published in *Resuscitation* in 2018 support this hypothesis. In a study of 509 OHCA patients from Western Australia, those transferred direct to a PCI-capable hospital were twice as likely to survive to hospital discharge (adjusted odds ratio (aOR) 1.97; 95% confidence interval [CI] 1.13–3.43).[79] A similar study of 4922 OHCA patients from Montreal, Canada also documented an association between being transported to a PCI-capable centre and survival to discharge

(aOR = 1.60; 95% CI 1.25–2.05; p < .001); although this benefit was potentially negated if it took more than 14.0 min longer to be transported to the PCI-capable center.[80]

Prognostication

The value of neuron-specific enolase (NSE) as a predictor of poor neurological outcome has been confirmed in more studies published during 2018. In a substudy of the TTM for 24 h versus 48 h trial,[81] TTM at 33 °C for 48 did not attenuate levels of NSE or S-100b compared with the standard 24 h of TTM.[82] This implies that these two biomarkers can be used safely as prognosticators even if TTM is continued beyond the standard 24 h.

Post anoxic myoclonus is associated with poor outcome among comatose cardiac arrest survivors; however, several reports have documented good outcomes despite the occurrence of myoclonus. The charts of 59 patients who developed myoclonus within 72 h of cardiac arrest and underwent continuous electroencephalogram (EEG) monitoring were reviewed.[83] Seven of the 59 patients (12%) regained consciousness and these patients were were more likely to have preserved brainstem reflexes and normal voltage background at all times. No patient with burst suppression or low voltage background (N = 52) at any point regained consciousness.

Approximately 30% of comatose cardiac arrest survivors develop seizures and many of these are non-convulsive, making them difficult to diagnose without EEG monitoring. Most ICUs are not equipped to undertake formal continuous EEG monitoring and standard intermittent EEG is frequently unavailable outside of normal working hours. The bispectral index (BIS) monitor is widely available and easy to use; it comprises a 4-channel quantitative EEG system and can display simplified raw EEG readings. Two neurophysiologists reviewed 32 simplified BIS EEG samples from post-cardiac arrest patients in whom full standard EEG recording were made at the same time and indicated the presence of five simple EEG patterns (i.e. diffuse slowing rhythm, burst suppression pattern, cerebral inactivity, epileptic activity/periodic epileptiform discharges (PEDs) or status epilepticus (SE)).[84] Compared to the standard EEG, the neurophysiologists interpreted all simplified EEG samples with a sensitivity of 86% and a specificity of 100%. Even more importantly, two inexperienced physicians were able to identify SE with a sensitivity of 80% and a specificity of 94%. This implies that ICU clinicians with minimal training in EEG interpretation may be able to identify epileptic activity in post-cardiac arrest patients at times when more sophisticated neurophysiological monitoring is unavailable.

Automated infrared pupillometry provides a quantitative measurement of pupillary response to a calibrated light stimulus and is more reliable than the standard manual methods for subjective assessment of the pupillary light response (PLR). Pupillometry was used to evaluate the PLR in 50 OHCA patients, of whom 23 survived for 90 days after cardiac arrest.[85] Quantitatively measured PLR was consistently greater in survivors and patients with favourable neurological outcomes during the 72 h after ROSC.

Imaging, particularly computed tomography (CT), is an important part of the multimodal approach to prognostication. The appearances of cerebral hypoxic-ischaemic injury seen on CT and magnetic resonance imaging (MRI) and the pathophysiological mechanisms that they represent have been reviewed comprehensively.[86] The value of the grey to white matter ratio (GWR) on brain CT for the prognostication of outcome in post-cardiac arrest patients has been studied extensively. In a systematic review and meta-analysis of this topic, it was concluded that the basal ganglia GWR had the highest prognostic value in predicting poor neurological outcomes in post-cardiac arrest patients.[87]

Education and quality improvement

Randomised controlled simulation studies have confirmed that more frequent re-training improves CPR skill performance. In a study comparing 3, 6 and 12 month retraining intervals amongst 96 non-medical university students, the best knowledge and skill performance was achieved by those re-trained every 3 months.[88] Reducing the training interval to monthly enabled even better skill performance compared with 3, 6 and 12 month retraining intervals.[89] Novel technologies such as virtual reality and digital training open up new opportunities.[90] However, a systematic review and meta-analysis of randomised controlled trials suggests that the evidence base for digital resuscitation training is insufficient to be confident it is equivalent to face to face training.[91]

Conflicts of interest

JPN is Editor-in-Chief of Resuscitation and Chair of the European Resuscitation Council. He is a co-investigator for two National Institute of Health Research (NIHR) funded studies: AIRWAYS-2 and PARAMEDIC-2.

JPO, MJAP, GDP and JS are Editors of Resuscitation.

JPO serves as Cardiac Co-Chair for the National Institutes of Health-sponsored Resuscitation Outcomes Consortium (ROC). He serves as the Virginia Commonwealth University Principal Investigator for the National Institutes of Health-sponsored Neurological Emergency Treatment Trials Network (NETT).

GDP is Co-Chair of the International Liaison Committee on Resuscitation. He is Chief Investigator for the NIHR funded PARAMEDIC-2 trial.

JS is Chair of the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation.

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J.P. Nolan[a,b,*]
[a]*University of Warwick, Warwick Medical School, Coventry, CV4 7AL UK*

[b]*Royal United Hospital, Bath, BA1 3NG UK*

J.P. Ornato
Department of Emergency Medicine, Virginia Commonwealth University Health System, Richmond, VA, USA

M.J.A. Parr
Liverpool and Macquarie University Hospitals, University of New South Wales and Macquarie University, Sydney, Australia

G.D. Perkins
University of Warwick, Warwick Medical School and University Hospitals Birmingham NHS Foundation Trust, Coventry, CV4 7AL UK

J. Soar
Southmead Hospital, North Bristol NHS Trust, Bristol, BS10 5NB UK

* Corresponding author at: University of Warwick, Warwick Medical School, Coventry, CV4 7AL UK.
E-mail addresses: jerry.nolan@nhs.net (J. Nolan) ornato@aol.com (J. Ornato) m.parr@unsw.edu.au (M. Parr) g.d.perkins@warwick.ac.uk (G. Perkins) jasmeet.soar@nbt.nhs.uk (J. Soar).

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