Emergency Medicine Research Review™

Making Education Easy

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In this issue:

Abbreviations used in this issue:

CO_2e = carbon dioxide equivalent; **ISS** = injury severity score; **N_2O** = nitrous oxide; **OR** = odds ratio; **RCT** = randomised controlled trial; **REBOA** = resuscitative endovascular balloon occlusion of the aorta; **RR** = risk ratio; **TBI** = traumatic brain injury.

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Welcome to this issue of Emergency Medicine Research Review.

We begin with a clinical study which demonstrates escalating rates of drug intoxication and declining rates of alcohol intoxication in Australian trauma patients. This is followed by an interesting paper which found that the overall environmental impact of the Penthrox device is better than N_2O - a notably harmful greenhouse gas. Next, I discuss an RCT which once again poured cold water on the use of REBOA, finding that its addition to standard care increased mortality in trauma patients with exsanguinating haemorrhage. We conclude with an interesting, albeit small RCT, which explores the use of cold intravenous saline infusions in exercise-induced hyperthermia; I imagine that intravenous fluids would comprise one of many strategies used for the critically-hyperthermic patient.

I hope you find these updates interesting and of value for your clinical practice, and I look forward to reading your comments and feedback.

Best regards,

Dr George Plunkett
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Drug and alcohol intoxication in major trauma

Authors: Woliansky J et al.

Summary: This paper presents the associations, trends and outcomes of drug and alcohol intoxication over a decade (2010-20), among patients captured in an Australian trauma registry. A total of 9700 patients were included in the analysis, of whom 9.4% were alcohol intoxicated and 9% drug-intoxicated. Between 2010 and 2020, drug use increased nearly three-fold (4.8% to 13.3%), whereas intoxication reduced (11.7% to 7.3%). ICU admission was significantly more likely with any form of intoxication (ORs 1.62-2.41). Intoxicated patients presented more frequently with non-accidental and violent injuries, however there were no differences in ISS between any group. Between each substance use group, there was no difference in mortality, although those who were polysubstance-intoxicated were significantly more likely to die versus non-intoxicated patients (OR 3.52).

Comment: I will note that I work in the centre in which this research was performed. Nevertheless, this study provides some useful insight into social trends of major trauma presentations to an inner-city hospital. Researchers demonstrated significant changes in substance use patterns, though this study demonstrates the challenges of adapting registry data retrospectively for publication. For instance, alcohol testing was only performed in 28.9% of patients, presumably missing a number of potentially intoxicated patients. Subsequent interview would also lead to under-reporting of intoxication. The same point can be made for testing of other drugs, which is further compounded by the challenges in interpreting a urine drug screen and diagnosing intoxication; a patient may test positive for cannabis use which occurred days prior to presentation, for instance. These issues of precision aside, this study demonstrates a number of social trends in this population – such as the high amount of methamphetamine use in penetrating trauma patients, and the changing nature of substance misuse over the 10-year study period.

Reference: Emerg Med Australas. 2023;35(5):792-8
Abstract

Environmental impact of low-dose methoxyflurane versus nitrous oxide for analgesia: how green is the 'green whistle'?

Authors: Martindale AEV et al.

Summary: The UK NHS is aiming to reduce its carbon emissions by 80% by 2032. It has been indicated that the short-acting analgesic methoxyflurane, delivered through the Penthrox 'green whistle' device, has lesser impacts on the environment than N_2O. These researchers investigated the environmental impact of the Penthrox device across its entire life cycle. Overall, Penthrox had an environmental impact of 0.84kg CO_2e, with 33.4% of this attributable to the raw materials involved. In contrast, 7mg of intravenous morphine measured at 0.01kg CO_2e. Entonox had a climate change impact of 117.7 times greater CO_2e than Penthrox.

Comment: The environmental impacts of the care we provide are being increasingly scrutinised. In the near future, more and more of our management will incorporate questions regarding sustainability. N_2O is a notably harmful greenhouse gas, provoking many of our EDs to explore alternatives. In this impact assessment, researchers compared the assertion that methoxyflurane has a smaller environmental impact by looking at all products and processes in its administration. In this life cycle impact assessment, the N_2O product was demonstrated to emit 98.89kg CO_2e, as opposed to 0.84kg CO_2e for methoxyflurane – for perspective, the authors note that an economy flight from Newcastle to Heathrow emits 120.2kg CO_2e. And while the small impact of methoxyflurane is impressive, this pales in contrast to 7mg intravenous morphine, which produced an estimated 0.01kg CO_2e. There are some caveats to note: the analysis of methoxyflurane assumes perfect user technique – that is, patients remembering to exhale all of the drug back into the device's charcoal filter to prevent environmental release, which seems unlikely. Further, the dose of N_2O selected for comparison was, reasonably, based on drug equivalence – though this represented 30 minutes of 50% N_2O being used at a rate of 14L/min, which is not reflective of how many of us use N_2O in our practice.

Reference: Emerg Med J. Published online 28 September, 2023
Abstract

Emergency department resuscitative endovascular balloon occlusion of the aorta in trauma patients with exsanguinating hemorrhage

Authors: Jansen JO et al., and the UK-REBOA Study Group

Summary: In the UK-REBOA RCT, 90 patients (median age 41 years; 69% male; median ISS 41) in major trauma centres with exsanguinating haemorrhage were randomly allocated to receive either standard care with resuscitative endovascular balloon occlusion of the aorta (REBOA; n=46) or standard care alone (n=44). At 90 days, patients in the REBOA arm showed significantly higher mortality than those in the standard care arm (primary outcome; 54% vs. 42%; OR 1.58; 95% CI 0.72—3.52), furthermore, more deaths occurred due to bleeding in the REBOA arm (32% vs. 17%), primarily within the first 24 hours. It was concluded that the addition of REBOA to standard care in the treatment exsanguinating haemorrhage may increase mortality versus standard care alone.

Comment: REBOA – the technique of occluding the aorta with a balloon in the exsanguinating trauma patient via Seldinger insertion into the femoral artery – continues to be studied as a potential resuscitation procedure in haemorrhagic shock and each time, so far, results have been underwhelming. REBOA advocates seem an optimistic lot, hoping further trials in alternate settings with differing inclusions may demonstrate efficacy and so on to this trial of REBOA use in the UK. Eligible patients were older than 16 years, non-pregnant and with suspected or confirmed life-threatening torso haemorrhage deemed amenable to REBOA. Illustrating the difficulties in identifying appropriate candidates, over 5 years, 16 major trauma centres were able to identify 90 patients for randomisation to standard care or standard care plus REBOA. The trial was terminated early (short of the planned 120 patients) as the prespecified threshold demonstrating harm was met.

Similar to an Australasian context, most participants were male (69%) and victims of blunt trauma (97%), with high ISS (average 41). Groups were well-matched in general, though the REBOA group did have lower median systolic blood pressure on arrival (84 vs. 99mmHg) and had slightly higher rates of head injury. At 90 days, 54% of the REBOA patients died versus 42% of the standard care group (OR 1.58; 95% CI 0.72—3.52). Multivariable regression was performed to adjust for differences at baseline, but again demonstrated unacceptable mortality for the REBOA group. Survival curves are published and demonstrate harmful early effects of REBOA – possibly due to delaying attempts at early haemorrhage control. While the overall trial size was small, and some baseline differences did exist between the groups, this trial would seem to, for the near future at least, pour cold water on REBOA use outside of a research setting.

Reference: JAMA. Published online 12 October, 2023
Abstract

Pathology testing in non-trauma patients presenting to the emergency department with recurrent seizures

Authors: Burgess M et al.

Summary: The frequency, yield and influence of pathology tests among patients presenting to an Australian ED with atraumatic recurrent seizures were assessed in this retrospective cohort study. Between 2017-20, 398 patients were included, 86.9% of whom underwent ≥1 pathology test. An abnormal result was detected in 517 (18.3%) pathology tests, which resulted in ED management changes for 12 presentations. A change in epileptic drug management was more likely among patients who had an abnormal pathology test result (OR 2.08; p=0.008). It was concluded that in this population, pathology tests may be performed excessively.

Comment: Sometimes efficient and patient-centred care can become derailed by unnecessary testing and while ordering less tests can be easier for the experienced consultant, there can be a tendency towards over-ordering by more junior staff as well as front-of-house staff facing large patient volumes. In the context of seizures in the known epileptic patient, what is the value of routine blood testing? This retrospective chart audit seems to pretty clearly articulate the answer – virtually nil. Across the 4-year period, 398 presentations were identified where blood testing was performed and while abnormalities were not uncommon, these were frequently minor electrolyte abnormalities. The discussion section is particularly illuminating, noting that electrolyte abnormalities were treated but of almost certainly limited significance, and as for other abnormalities identified (such as on full blood examinations, urea electrolytes and creatinine levels or liver function tests), these tests were all clearly indicated by other features on history and examination. While a simple and brief retrospective audit of documentation, this study provides support to the practice of reviewing and discharging the epileptic patient without testing, post uncomplicated seizure, provided their history and examination are benign.

Reference: Emerg Med Australas. 2023;35(5):834-41
Abstract

Generative artificial intelligence for chest radiograph interpretation in the emergency department

Authors: Huang J et al.

Summary: These researchers analysed the accuracy and quality of AI-generated chest radiograph interpretations in the ED setting, as rated by six ED physicians using a 5-point Likert scale. AI interpretations were retrospectively generated for a random sample of 500 ED encounters from 500 patients. Similar accuracy and quality scores were recorded for reports generated by AI and radiologists; however, both of these modalities produced higher textual quality scores than teleradiology (both p<0.001). It was concluded that this generative AI tool may help ED physicians to interpret chest radiography in a timely manner.

Comment: AI technologies are being trialled in just about every facet of medicine. Typically, AI excels when large volumes of data can be interpreted to arrive at a conclusion. More advanced imaging modalities have typically and paradoxically, been easier for AI to interpret. In this study, researchers assessed the ability of AI to interpret the more vague and murky world of chest X-rays. Five hundred studies were each reported by all three of a teleradiologist, on-site attending radiologist and AI. Interestingly, the assessment was not against a gold standard modality, but by six ED physicians rating their agreement with the report.

While the study would seem to imply that the AI tool performed as well as the radiologist at diagnosing acute findings (in this study cardiomegaly, pulmonary oedema, pleural effusions, infiltrates, pneumothorax and support devices) these are rarely the cause of my angst when tasked with following up radiology reports. The more subtle findings occupying my time (e.g., potential pulmonary nodule, mediastinal pathology or bony lesion) are not identified at all in this study – either in the main body or example sample reports in the supplementary material – by any of the reporting techniques. While this study is novel in using ED physician agreement as the assessing tool, I would be more comfortable with comparison against a more typical standard, e.g., CT scanning. Nevertheless, a tool such as this may be of use, particularly for more junior staff without timely radiology reporting such as might occur in more rural or regional departments.

Reference: JAMA Netw Open. Published online 5 October, 2023
Abstract

A novel simulation model significantly improves confidence in canthotomy and cantholysis among ophthalmology and emergency medicine trainees

Authors: Wilde C et al.

Summary: Lateral canthotomy and cantholysis is the definitive management for orbital compartment syndrome, however delayed treatment and poor outcomes can result from lack of physician confidence. These researchers used equipment from the ED to create an anatomically correct, low-cost simulation model to help emergency medicine (n=47) and ophthalmology registrars (n=18) to feel confident in performing lateral canthotomy and cantholysis. The proportion of trainees who felt 'quite confident' in performing the procedure unsupervised out of hours was significantly higher after the teaching session than beforehand (42% vs. 9.23%; p<0.01). After using the model, trainees also felt significantly more confident in diagnosing orbital compartment syndrome and locating necessary equipment. Most trainees (66%) expressed that they would value even further teaching via simulation.

Comment: This is a different sort of article to include in Research Review, and probably is influenced by my role in education. There is increasing awareness of the need to diagnose orbital compartment syndrome, and indeed increasing willingness (at least in hospitals I have worked in) for ED physicians to perform the necessary canthotomy and cantholysis. Training for this procedure though has been difficult to come by – in my experience limited to either observation of filmed footage, or cadaveric courses – which are limited in size and expensive to attend. In this study, an English team have described a model constructed from commonly available supplies found in absolutely any ED. They have subsequently tested trainee confidence in three domains – the diagnosis of orbital compartment syndrome, ability to find necessary equipment to perform the procedure and finally, the canthotomy and cantholysis. Interestingly, ophthalmology registrars as well as emergency registrars were included in the evaluation group, and use of this model raised the number of trainees happy to perform the procedure unsupervised, out of hours from 9% to 42%. While it can be argued that studies such as this don't demonstrate any direct patient-related outcome, I would encourage all of our readers to have a look at this and consider building this model for your trainees. As for many critical procedures, the confidence to perform the needed procedure is the main roadblock to improving patient outcome. Any study demonstrating an ability to improve junior clinician confidence in these procedures should be welcomed.

Reference: J Emerg Med. 2023;65(5):e460-6
Abstract

Success rates of lateral canthotomy and cantholysis for treatment of orbital compartment syndrome

Authors: Scoville NM et al.

Summary: The success rates of lateral canthotomy and cantholysis for the treatment of orbital compartment syndrome were evaluated in this retrospective cohort study. Success was defined as a reduction in intraocular pressure after the first attempt to <30mmHg. The study included a total of 74 eyes from 64 patients. Ophthalmologists performed the initial procedure in 32% of cases; the remaining 68% were carried out by emergency medicine providers. Success rates were comparable between ophthalmologists and emergency medicine providers (79.2% vs. 68%; p=0.413). Initial failure of lateral canthotomy and cantholysis was associated with poorer visual outcomes, as was head trauma without an orbital fracture. All cases which involved a vertical lid split procedure were categorised as a success. It was concluded that education on the lateral canthotomy and cantholysis procedure and the vertical lid split could improve patient outcomes.

Comment: The prior study on educating emergency providers on lateral canthotomy and cantholysis prompted me to look for some associated literature. While there will always be questions regarding the external validity of a single centre study such as this, orbital compartment syndrome is typically from blunt trauma and therefore ubiquitous, though regional rates may vary somewhat depending on local work and recreational activities. The rate of orbital compartment syndrome (in this study confirmed with associated high orbital compartment pressure) is higher than most would anticipate, with 74 cases from 64 patients in a window of under 3 years reflecting its role as a referral centre. The next key observation is that while there was no statistically demonstrable difference in initial success rate between emergency physicians and ophthalmologists, just 68% of initial emergency physician canthotomies were successful, indicating room for improvement. Looking at outcomes, patients having their initial canthotomy performed by an ED physician experienced significantly worse visual acuity at follow-up. While the reasons for this are unclear, given the fall in intraocular pressure is similar for successful procedures in both groups, it is likely this is due to the higher incidence of failure and the prolonged amount of time prior to definitive management. Finally, the study concludes with a description of the vertical lid split procedure as a potential rescue technique.

Reference: Am J Emerg Med. 2023:70:140-3
Abstract

Pre-hospital endotracheal intubation in severe traumatic brain injury

Authors: Knapp J et al.

Summary: The objective of this retrospective cohort study was to determine the quality of prehospital care in severe traumatic brain injury (TBI) patients with regard to ventilation targets and mortality. A total of 208 eligible patients with TBI requiring tracheal intubation and transported by Swiss Air Rescue were included in the analysis. Systolic blood pressure, end-tidal partial pressure of CO_2 ($PetCO_2$), and arterial partial pressure of CO_2 ($PaCO_2$) were assessed. The rate of adherence to blood pressure recommendations was 89%. A total of 45% of patients were normo-ventilated and 29% were normo-ventilated with a systolic blood pressure ≥90mmHG, according to $PetCO_2$. At hospital admission, only 33% of patients were normocapnic due to the poor correlation between $PaCO_2$ and $PetCO_2$. A decreased risk of mortality was strongly associated with normocapnia at hospital admission; however, mortality was not influenced by prehospital or on-scene times.

Comment: This retrospective study of all suspected TBI patients transported by one air ambulance service in Switzerland yields some interesting results, and contentious conclusions. The first issue encountered is that of exclusions – while 110 patients were removed initially due to presence of expected criteria (typically no TBI demonstrated), a further 139 (31%) were unable to be included due to an inability to identify a matching medical record at the hospital due to inappropriate data entry. The authors explain this away as a chance event equally likely to occur to all patients and therefore unlikely to bias any result – however I am not so sure. It would seem plausible that data entry errors are more likely in the more time-critical patient. In any event, the loss of nearly one-third of the patient population is typically catastrophic for study veracity.

The researchers demonstrated that compliance with $PetCO_2$ targets was poor, with just 45% meeting target on arrival to hospital. Further muddying the waters was the demonstration that $PetCO_2$ at admission was only weakly correlated with $PaCO_2$, with an R of 0.14. This is encapsulated in the bizarre Fig 2D, demonstrating that mortality is inversely proportional to $PetCO_2$ – even as the value rose beyond 50mmHg. The authors concluded that poor correlation between $PaCO_2$ and $PetCO_2$ was the reason for only a minority of patients having a normal $PaCO_2$ on admission. I don't believe this can be confidently stated when less than half of patients met their target $PetCO_2$. Nor can I be happy this study demonstrates the need for arterial CO_2 monitoring in this cohort of patients – if they were not ventilated to meet target $PetCO_2$, why would they be ventilated to meet target $PaCO_2$? In any case, I don't know how much faith to place in a data set missing one-third of patients, beyond noting that $PetCO_2$ is only weakly correlated with $PaCO_2$ in this population.

Reference: Scand J Trauma Resusc Emerg Med. 2023;31(1):46
Abstract

Oxygenation during the apnoeic phase preceding intubation in adults in prehospital, emergency department, intensive care and operating theatre environments

Authors: White LD et al.

Summary: This Cochrane systematic review of 23 RCTs (n=2264) compared the benefits and harms of apnoeic oxygenation prior to intubation versus no apnoeic oxygenation during intubation in eligible adults. A total of eight studies (n=729) evaluated the use of low-flow nasal cannulae (<15L/min O_2), while 15 (n=1535) evaluated the use of high-flow (>15L/min). Settings included the ED (2 studies), ICU (7 studies) and the operating theatre (14 studies). Two studies were considered to be at low risk of bias. When using apnoeic oxygenation at any flow rate, there was little to no difference in the incidence of severe hypoxaemia from the start of apnoea until successful intubation (RR 0.86; p=0.25; low-certainty evidence). Due to insufficient evidence, data could not be gathered on the effect on the incidence of hypoxaemia, and no studies recorded hospital length of stay. Investigators noted that the lowest recorded oxygen saturation may be improved (mean increase 1.9%; p<0.001; low-certainty evidence), and duration of ICU stay may be decreased (mean difference -1.13 days; p<0.0001; low-certainty evidence). Little to no difference was observed in first pass success rate (p=0.79), or in the incidence of adverse events. The impacts on mortality were also unable to be assessed due to a lack of evidence.

Comment: Apnoeic oxygenation seemed to gain favour in many ED intubation algorithms in the last 10-15 years, driven at least to some degree by FOAM podcasts asserting its benefit. This Cochrane systematic review examines all relevant studies from the critical care literature base to determine if any benefit can be demonstrated. The methods employed in this Cochrane review are typically robust, with an exhaustive search strategy identifying relevant studies. Of particular interest for emergency practitioners, results were subdivided into those receiving low-flow (i.e. <15L/min O2) and high-flow (rates >15L/min). Overall, the pool of 23 identified studies seemed of reasonably high quality, with the main criticism being lack of blinding of participants, with only two studies investing in high-quality blinding of apnoeic oxygenation use. Of note, I would expect that open-label studies of this sort would typically bias in favour of apnoeic oxygenation.

Regarding the appropriate primary outcome, the incidence of severe hypoxaemia (defined as SpO_2 <80%), not one of the included studies demonstrated a reduction. The pooled result also remained non-significant; nor could apnoeic oxygenation be demonstrated to decrease the incidence of hypoxaemia (defined as intubations where SpO_2 decreased below 93%); nor could it be shown to decrease mortality, adverse events or first pass success. Some benefit was noted in duration of ICU stay, though the reasons for this would seem unclear. The authors note there are currently a further 15 studies in this field at various stages of completion. This Cochrane review casts significant doubt on the use of apnoeic oxygenation. That said, it remains a therapy with minimal demonstrable harm. Results such as these don't necessarily refute its use (for now, at least, I will continue to use it), but also provide support to colleagues who argue that its use complicates an already difficult situation.

Reference: Cochrane Database Syst Rev. 2023;8(8):CD013558
Abstract

Whole-body cooling effectiveness of cold intravenous saline following exercise hyperthermia

Authors: McDermott BP & Atkins WC

Summary: There is anecdotal evidence for the efficacy of cold intravenous fluids in facilitating whole-body cooling for heat illness. In this RCT, eight healthy volunteers (three females; mean age 25 years; mean weight 72.9kg) from the University of Arkansas exercised outside until volitional exhaustion or rectal temperature reached ≈38.9°C. Following this, participants were cooled via either cold (≈5°C) saline intravenous fluids, or passive cooling (sitting in shade). Hydration status was comparable between treatment arms prior to exercise (p=0.847). Throughout each trial, wet bulb globe temperature was similar between arms (p=0.426), and there was no difference in maximum rectal temperature reached (p=0.184). Patients in the intravenous arm demonstrated a significantly faster cooling rate than passive cooling (p=0.002). Rectal temperature, heart rate and thermal sensation decreased in all patients, but there were no significant differences recorded between cooling methods.

Comment: Perhaps it's just my fascination with 'healthy volunteer' use in trials, but I find this trial an interesting read. The volunteers were randomised to either passive or active cooling using cold intravenous fluids, and then made to exercise either to a rectal temperature of ≈38.9°C or exhaustion. The cooling methods, sitting in shade versus cold intravenous fluids, were compared. Researchers concluded that while cold intravenous fluids did produce faster cooling (0.039°C/min vs. 0.028°C/min) this was still too slow, and they produced no difference in heart rate reduction, heart rate recovery or thermal sensation, leading them to question the use of cooled fluids.

While the use of a RCT is to be commended, there are a number of key issues to consider. The a priori sample size calculation demonstrated the need for nine participants. Unfortunately, due to one subject being unable to reach the designated rectal temperature and two being unable to tolerate intravenous cannulation, only eight participants were studied. While the rate of cooling was greater in the cool intravenous fluid group, the authors conclude that this is not fast enough to be of benefit in those with critical heat stress. This conclusion though would seem exaggerated, as cooled intravenous fluids would typically be just one of many in a package of interventions in the critically-hyperthermic patient. Nor does it consider disordered homeostatic mechanisms that occur at the extreme of illness. This is an interesting, though small study in healthy volunteers that may not adequately represent real-world conditions. Further studies will be necessary comparing multiple components of a cooling approach before making firm conclusions on this subject.

Reference: Am J Emerg Med. 2023:72:188-92
Abstract

Emergency Medicine Research Review™

Independent commentary by Dr George Plunkett, MBBS (Hons), B Mus (Hons), Grad Cert Aeromed Ret, M Clin Res Meth, FACEM

George is co-Director of Emergency Medicine Training at Royal Melbourne Hospital – a busy quaternary trauma centre in the Parkville precinct encompassing RMH, RWH and the VCCC. After completing initial studies in Brisbane, George made the move to Melbourne where he lives with his wife and two children. After obtaining specialist qualifications in Emergency Medicine, he has established interests in education, trauma, and cardiology. George has conducted research on the management of atrial fibrillation, lectured for the University of Melbourne on the topics of acute cardiology and trauma, and has delivered presentations to international and local meetings on the subjects of trauma, vehicular ramming attacks, acute cardiology and clinical change implementation. Outside of medicine, George enjoys the idea of sleep.

