UPDATE ON PAEDIATRIC EMERGENCY MEDICINE

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Introduction

This session will present clinical cases of paediatric emergencies in the hospital setting, in order to illustrate recent changes in our approach to the management of these situations. Resuscitation events for children in hospital are considerably less common than for adults, but can be challenging. An unfamiliar paediatric ward environment, different equipment, technical difficulty with procedures, presence of parents and other family members, and occasionally rare underlying conditions all contribute to a highly stressful experience for the resuscitation members.

Cardiac Arrest

Outcomes of cardiopulmonary arrest in children are understood by most health practitioners to be much worse than for adults. This is because children more commonly suffer from decompensating mechanisms of arrest where deterioration in cardiovascular, respiratory or central nervous systems builds up over a period of minutes to hours prior to the collapse. Consequently, there is often significant irreversible damage to brain, heart, kidneys, and other organs leading to poor rates of survival and low quality of survival. This compares poorly with the outcomes achieved by the successful rapid resuscitation from cardiac arrest due sudden onset arrhythmias in adults.

However when paediatric and adult cardiac arrest survival is compared using like for like types of arrest (out of hospital vs in hospital, decompensation vs arrhythmia), children do better in all categories. Approximately 10-15% of paediatric arrests are due to sudden onset of a shockable rhythm, with higher rates in tertiary children's centres due to the types of condition managed in these hospitals. Recent survival to hospital discharge for children is 27% for in hospital arrest (IHCA) with 65% having good neurological outcome. In comparison survival rates for adults with IHCA are around 18%.

Even for out of hospital cardiac arrest, children tend to do better (6.4% survival vs 4.5% for adults). Worst outcomes are seen in children < 1 year old with OHCA (1.7% survival) due to the dominant contribution of Sudden Unexpected Death in Infancy (SUDI) in this age group. These infants have frequently been dead for several hours at the time of discovery, with little to be gained by attempted resuscitation.

The signs which we should use to determine whether or not to commence cardiopulmonary resuscitation (CPR) in an unmonitored child are surprisingly controversial and difficult for such a basic question. Tibballs from the Royal Children's Hospital in Melbourne has shown that doctors and nurses with a range of levels of experience all have high rates of errors in incorrectly detecting an absent pulse, or failing to detect a pulse which is present. His study was based on children on ECMO in the PICU with observers blinded as to whether a pulsatile circulation was present or not. Although standard advice is to commence CPR when a practitioner is uncertain if an unresponsive child has a pulse, this doesn't help if the rescuer is both certain and incorrect. The alternative advice to look for "signs of life" has been found to be vague and difficult to teach while still leading to errors since victims in early VF are often making abnormal agonal breathing efforts. Current wording in ALS / APLS teaching is to commence CPR in the unresponsive patient who is "not breathing normally."

Since the best survival is seen in those children who arrest due to shockable rhythms, it is important that we maintain knowledge and skills around defibrillating children safely and effectively. The correct energy setting for defibrillation is traditionally worked out on the basis of J/kg. As with drugs and other dose / sizing estimations in paediatrics, this is a convenient over-simplification. The aim is to deliver an adequate current flow to the myocardium to revert the rhythm without causing harm. The actual current delivered is determined by multiple

factors in addition to the energy setting on the defibrillator. Other factors being equal, small infants are likely to require a higher J/kg setting than older children / adults. Most research in this area has been conducted on piglets and other animals, with limited confidence as to how this might apply to humans. Large numbers of cases are now being accumulated in resuscitation registry databases. Studies based on defibrillation success rates in children from registry cases suggest that an effective energy setting for most children is somewhere between 3-4 J/kg. Other aspects of paediatric defibrillation have been extrapolated from adult medicine, with a single shock approach (unless witnessed and monitored) and two minute intervals between shocks using a biphasic waveform. Automated external defibrillators (AEDs) are increasingly deployed in hospital wards rather than manual defibrillators. The rationale is that these are more likely to be used correctly and safely by less experienced staff than a manual defibrillator. Disadvantages include relatively long interruptions to CPR during rhythm analysis and the lack of energy output adjustment. “Read through” rhythm analysis is an area of intensive development effort by defibrillator manufacturers and could reduce the pause in compressions to little more than that required to deliver the shock. New resuscitation guidelines around the world, including Australia and New Zealand, now make stronger recommendations for the use of AEDs in paediatric arrests, regardless of whether energy output modulation is available (a reduction in output to 50J for children aged 1-8 years is preferred if possible, but the absence of this should not stop a shock being delivered if indicated).

Managing Hypovolaemic Shock

Many cases of paediatric collapse result from hypovolaemic shock, as a final common pathway for a range of common illnesses producing inadequate intake or excessive losses. Since blood pressure is maintained throughout a relatively long period of circulatory compromise before the child decompensates, heart rate and signs of peripheral perfusion remain important for early detection of problems. Unfortunately heart rate, capillary refill and warmth / colour of peripheries are all affected by many other internal and external factors. This presents a challenge when designing trigger thresholds for paediatric early warning scores (PEWS) and medical emergency team (MET) systems which need to be sensitive enough to prevent ward arrest events while not overwhelming the MET with unnecessary call outs. There is encouraging evidence that MET systems can reduce in-hospital paediatric mortality, but more work is needed to determine the best PEWS to base these on.

Intravenous fluid therapy in children is a cause of occasional serious iatrogenic harm. The choice of initial resuscitation fluid is simple since no alternative type of fluid has been shown to be superior to normal saline for the initial boluses in resuscitation from shock. For other seriously ill children, historically there has been common use of very hypotonic solutions, such as 4% dextrose / 0.18% saline. This has also frequently been given at inappropriately high “normal maintenance” rates. Hospitals should not stock 4% dextrose / 0.18% saline anywhere near the paediatric wards, since there is no indication for using this. Paediatric intravenous fluid guidelines covering a range of situations should made accessible to all medical and nursing staff responsible for hospitalised children.

Vascular Access

Emergency vascular access in children has become much easier with better intraosseous access systems. There can be no justification in a critically ill or arrested for prolonged attempts at peripheral venous cannulation or the administration of drugs via the endotracheal tube when IO systems are available. Manual insertion of an intraosseous needle has a high success rate in the hands of a person with a little experience, but frequently fails when attempted for the first or second time in a real emergency. Most people find the use of a drill to be faster and to have a lower failure rate. The drill also allows the technique to extend to older children and adults. Insertion of the IO needle in a responsive child is usually tolerated with little expression of discomfort. However administration a fluid bolus through the needle produces pain and withdrawal of the limb, which is both distressing and risks security of the vascular access. This can be greatly reduced by administering local anaesthetic (appropriate volume of 1% lignocaine) through the needle before commencing a fluid bolus.

An alternative to emergency vascular access for children in status epilepticus is to administer midazolam by a mucosal route. Parents are frequently instructed in the use of buccal midazolam. An improvement on this technique is to use a mucosal atomiser device (MAD), which is a simple nozzle which fits a standard 1-2ml syringe and produces a very fine spray when liquid is pushed from the syringe under pressure. This can be administered nasally and is very rapidly absorbed. The MAD is also used widely in Australian and NZ Paediatric emergency departments to administer rapid strong pain relief. Intranasal fentanyl delivered nasally using a MAD

produces equally rapid and powerful analgesia to intravenous morphine, and avoids the delay involved in placing an IV when a child first arrives with a painful injury.

References

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