The desperate airway-managing CICV in children
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Following a death in recovery at Royal Perth Hospital in 2001, we embarked on a program to improve airway management and training in our hospital. Attempted airway management in this case included failure to successfully oxygenate the patient via “the front of the neck”. One of the main aims of our program was to improve our understanding and training of the management of the “Can't Intubate Can't Oxygenate” (CICO) scenario. Subsequently, we started running weekly CICO training sessions on euthanased sheep (already being used by microbiology for blood agar collection). After an initial period of training in the euthanised sheep we received approval to run the CICO training session on the sheep prior to euthanasia. Since mid 2004 we have been running weekly sessions, having observed and trained over 1000 airway specialists in a time pressured live model.

Our findings from observation of the live simulation were very concerning. Much of what we had been traditionally teaching for the CICO scenario proved to be unsuccessful in the live model. Specifically, we observed an unacceptably high rate of severe hypoxic prior to obtaining a patent airway. The NAP4 study identified issues with poor outcomes from needle cricothyroidotomy (1). These issues, amongst others, are reflected in our own early experience and we highlighted a number of areas requiring change which we set out in a new algorithm for the CICO scenario(2). Below is the current version of our Can’t Intubate Can’t Oxygenate, modified from 2009.

A CICO event in the adult population is a relatively rare and terrifying incident for any anaesthetist. To consider this situation and its management in the paediatric population adds significantly to the difficulties and stressors encountered. Currently there is little consensus on what, if anything, is the correct management for this event in a small child. A algorithm addressing CICV management in the paediatric population was recently published by the APA(3). Other publications have looked at a comparison of cannulas and surgical techniques with varying messages emerging. (4) (5)(6) We have also published an article looking at a comparison of different cannulas and how they may affect success rates(7).

Any research into this scenario though is fraught with difficulties. Is the manikin or animal model a suitable substitute for the real thing? Who are the operators and what is their skill and experience level? Are we using the best equipment for the task? Are we teaching its use correctly? It is very clear to us from frequent observation in our live simulations that some
equipment that is designed “for purpose” repeatedly performed poorly, even in the hands of the very experienced anaesthetist.

Similarly to the APA, our current adult algorithm is not a “cannula algorithm” or a “scalpel algorithm” but one that tries to compliment the strengths of the anaesthetists in the first instance which means attempting the cannula technique first, then progressing to the scalpel if this proves unsuccessful.

One issue we have recurrently struggled with in the adult model is the pressure required to insert the cannula through the cricothyroid membrane or trachea. This is an issue that is equally or more pertinent and cannot be ignored in the paediatric population. Identifying the cricothyroid membrane in adults is not always possible due to patient factors and there is data showing similar concerns in children. Any algorithm that advocates the use of the cricothyroid membrane is making the assumption that you can locate it. If you can only locate the trachea then you may have to attempt your cannula insertion through tracheal rings. We conducted a study looking at insertion forces which showed that a 14g insyte cannula required around 7 Newtons of pressure to pierce a tracheal ring. A larger bore 6.0 french cannula required 12N to insert and the adult quicktrach required 24N. The smaller 18G insyte required only 4.5N. We identified two problems with the larger forces required to penetration tracheal rings. Firstly it is highly likely you may penetrate the posterior tracheal wall, secondly the force applied to the anterior trachea may result in occlusion of the tracheal lumen which markedly reduces the success rate of the procedure in some instances even 7N of force may be sufficient to cause severe collapse of the trachea making it virtually impossible to insert a cannula of this size using an aspirate as you go technique. The size of cannula, angle of insertion, and hand stabilisation required to insert a cannula successfully is paramount to any technique performed in the small child. We have found that trying to insert a large bore cannula without using both hands to aid in stabilisation of the trachea was an unreliable method in the smaller airway. This was true even in experienced hands, suggesting the need to use a smaller lumen cannula. Whilst the forces required to insert the cannula into the trachea would be considerably less with a smaller lumen cannula this however increases the likelihood of kinking and obstruction.

Assuming it is possible to address the practical issues and define a technique, using a piece of equipment, that allows a high chance of success with cannula insertion; can we safely deliver oxygen using current recommended techniques? In our training for management of the CICO in the animal laboratory in an adult model we had struggled to develop a strategy for oxygenting down a small bore cannula that is reproducible, effective and above all safe. It should be noted that a standard flow meter delivers oxygen at 4.0bar (4000cmH2O) even the Manujet at neonatal settings delivers 1.0 bar (1000 cmH2O) which are values that far exceed what a human lung can tolerate safely.

We currently use a y-piece insufflator connected to a standard oxygen flowmeter delivering approximately 250mls/second. We do not jet to a fixed time scale, but jet to a response in oxygen saturation. We have also identified some essential properties that an emergency jetting device must have. One of which we feel is essential is to gain feedback from the jetting device; have we actually delivered any oxygen? In the emergency CICO scenario there may often be marked expiratory obstruction so the risk of stacking breaths and subsequent barotrauma are very real. The patency of the expiratory lumen may also change dynamically during the event. Using visual clues to determine volume delivery has proven very unreliable as a feedback mechanism, especially in the stressed subject. In the adult model using a y-piece device gives you tactile feedback about gas flow which will assure you that the lumen of the cannula and the connections are patent. Unfortunately with flows reduced to paediatric levels, with our current device, this tactile feedback is lost. A second issue is with regards to rescue expiration back through the cannula. This appears in our training to be a significant safety aspect of a jetting device.

In the adult algorithm above if cannula attempts fail, we now teach a scalpel bougie technique in preference to the ATLS or EMST surgical techniques of cricothyrotomy. We have found
that asking anaesthetists to make a controlled incision under stress and time pressure proved very difficult. Most anaesthetists have minimal experience in using a scalpel blade. The scalpel bougie technique we teach involves a stab incision only and uses a bougie inserted through the incision to locate the trachea (2). When we first started running the simulations on live sheep the amount of bleeding that occurred with the scalpel bougie technique increased the difficulty of the procedure significantly. The participants had only ever been taught on mannequins or on ex vivo animal larynxes so had not had to deal with blood in the surgical field and airway. This has proven to be a barrier to success in our live simulation model along with poor scalpel handling and limited haemostasis technique. We hope that a similar scalpel bougie technique may be applicable to the paediatric model.

At present we are generating more questions than answers about the best approach for management of the CICO scenario in the paediatric population. But hopefully this will stimulate more directed research, with the aim of producing a safe, simple, evidence based method of providing oxygenation through the anterior neck structures in this difficult group.

1. RCoA Website: http://www.rcoa.ac.uk/document-store/nap4-full-report
3. APAGBI Website: http://www.apagbi.org.uk/sites/default/files/images/APA3-CICV-FINAL.pdf