Australian and New Zealand Committee on Resuscitation

Neonatal Resuscitation Guidelines 2016

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The Australian and New Zealand Committee on Resuscitation (ANZCOR) has recently published new Australian and New Zealand Neonatal Resuscitation guidelines. [1] In this article, we outline key changes from previous guidelines and provide some explanation of implications for practice. Readers are encouraged to read the full guidelines for a comprehensive update on recommended practice.

History and Background

The history of development of ANZCOR guidelines about neonatal resuscitation is summarised in Table 1. The first Australian-specific neonatal resuscitation guidelines were published by the Australian Resuscitation Council (ARC) in 2007 [archived by ARC and [2]]. These guidelines had a basis in the 2005 International Liaison Committee on Resuscitation (ILCOR) Consensus statement. [3] The 2007 ARC Guidelines were subsequently updated in 2010 to reflect the 2010 ILCOR consensus on the science of resuscitation with treatment recommendations (CoSTR). [4] This update was prepared with collaboration with the NZRC, which also published the 2010 update on its website.

The 2016 update is based on the ILCOR 2015 CoSTR. [5] A further recent revision reflects the Therapeutic Goods Administration update of medicine ingredient names. [6]

The 2015 ILCOR CoSTR was developed based on systematic review of the science of resuscitation published up to 2015. [5] The intention of ILCOR is not to produce guidelines, but to reach international consensus on the science of resuscitation and to issue treatment recommendations, which can then be adapted by national and multinational resuscitation councils (such as ANZCOR) to generate guidelines that take into account local circumstances, including resources.

There have been progressive improvements to the rigor of systematic review and evidence appraisal for development of the ILCOR consensus. For the 2015 ILCOR CoSTR, the GRADE process was used. [7, 8] Among measures to minimise risk of bias from reviewer conflict of interest, authors of key papers under review are excluded as evidence worksheet authors. The GRADE process facilitates rigorous assessment of level of bias in research papers, uses standardised terminology for consensus statements and recommendations, and allows for clear acknowledgement of

values and preferences that have influenced the recommendations.

For the 2015 CoSTR, 38 ILCOR Neonatal Working Group members (representing 13 countries) produced evidence worksheets on 26 topics, [5] resulting in several changes to the ANZCOR guidelines. Since the 2016 ANZCOR guidelines now reflect both topics considered in the ILCOR 2015 CoSTR reviewed using GRADE and topics covered only in previous ILCOR rounds, by necessity they contain a mixture of classification systems for levels of evidence and for strength of recommendations. (ANZCOR Guideline 1.4 [1]). This discrepancy will diminish over coming years as more topics are subjected to GRADE analysis. The ANZCOR Neonatal Resuscitation Guidelines have also been shortened by removing some procedural material that was considered more appropriate for training manuals. The changes to the guidelines are summarised in Table 2, and described below.

Flowchart

The 2016 flowchart has evolved from earlier versions. For thermoregulation, the instruction has changed from; “dry the baby…provide warmth” to “prevent heat loss” (2010 flowchart) to “maintain normal temperature” (2016 flowchart) because of an increasing recognition of the risks posed by hypothermia.

Ventilation corrective steps (including reducing mask leaks, increasing inflation pressures and inspired oxygen concentration) were suggested in 2010 for babies whose heart rates remained below 100. The 2010 flowchart also introduced the possibility of using continuous positive airway pressure (CPAP) for babies with laboured breathing or persistent cyanosis and commenced the provision of a target range for pre-ductal SpO2 in the first 10 minutes after birth. A banner reminding resuscitators to consider the need to summon help was also added. None of these recommendations has changed in 2016.

Previous flowcharts did not include any indicators of pace of resuscitation, or the timing of specific steps. Reasons included the lack of empirical evidence for any particular pace of progression through the algorithm, as well as concern that certain steps (particularly assisted ventilation) needed to be accomplished fully, using corrective steps if necessary, before progressing. Emphasising specific target times could impair performance and could lead to more interventions and greater risk of

harm, without actually improving outcomes. ANZCOR recognised that most babies who receive resuscitation measures are not in the completely pulseless, apnoeic state that is assumed in adult and paediatric resuscitation algorithms. In contrast, many are conscious or partly so, and have some respiratory effort and cardiac output. However, because of prematurity, anomalies or perinatal compromise, these babies are not able to accomplish the normal perinatal transition (where the lungs are aerated through spontaneous breathing, antenatal vascular shunts have ceased and the baby can maintain thermoregulation) unassisted.

Nevertheless, there is urgency about promptly commencing respiratory support for babies who have inadequate or absent breathing. Therefore, consistent with the ILCOR CoSTR 2015 suggested flowchart, the ANZCOR 2016 flowchart has a new reminder to commence assisted ventilation within one minute from birth for babies whose heart rate remains below 100 beats per minute, or who have gasping respirations or apnoea.

Suggested doses of intravenous adrenaline (epinephrine) for various gestations have been provided, to reduce the need for calculations using estimated weight in the heat of a resuscitation event.

Physiology of Newborn Infants - Guideline 13.1

Research over recent years has clarified that aeration of the lungs by spontaneous or assisted breathing is the predominant mediator that both clears lung liquid from the airways and promotes a fall in pulmonary vascular resistance, allowing the increased pulmonary blood flow that is also needed for effective gas exchange. [9] Establishing well-matched ventilation and perfusion can take up to several minutes. Therefore, newborns' oxygen saturation levels initially resemble intrauterine levels, and typically rise gradually over the first few minutes. These changes have been well described for normal term infants, and are to be the basis for appropriate targets for other infants, including those who require resuscitation.

Further recent research has indicated that the change from right-to-left to left-to-right blood flow across the ductus arteriosus that was thought to be a normal phase after birth may be an artefact of immediate clamping of the umbilical cord. If cord clamping is deferred until lung aeration has occurred, the expanding lung vascular bed may fill via the right ventricle from the placental circulation, rather than from the systemic

circulation. [9]

Anticipating the need for resuscitation, preparing equipment and organising and training teams – Guidelines 13.1 and 13.2

Resuscitating a newborn is a time-critical task that for all but the least compromised babies is beyond the capability of a single practitioner. It needs multidisciplinary teams to coordinate their activities to perform with high reliability and adaptability. Despite the much higher overall frequency of resuscitation events in newborns than adults, neonatal resuscitation teams are often formed *ad hoc* from team members who may not be familiar with each other's capabilities. ANZCOR Neonatal Resuscitation guidelines have increasingly recognized the critical role of human factors and teamwork. Key steps include anticipation (including good handover from obstetric/midwifery care providers, and to plan team composition and role allocation), preparation of equipment, communication and training.

Training All personnel who attend births need to be trained in skills that include neonatal airway support and ventilation via a face mask or laryngeal mask, as well as how and when to provide chest compressions. Personnel trained in advanced skills, including endotracheal intubation and vascular access, are needed for high risk births and occasional back-up, even when high risk has not been anticipated. Whereas the 2007 Guidelines provided no specific guidance about training, the 2010 Guidelines recommended at least annual training, and the 2016 Guidelines recommend that training requires regular reinforcement, more frequently than annually.

Instructor training Optimal methods to select, train and improve the performance of resuscitation trainers are not established. Based on low quality evidence, ANZCOR suggests that training of instructors should incorporate timely, objective, structured, individually targeted, verbal and/or written feedback. [5]

Equipment – Guidelines 13.1 and 13.4

Ventilation Devices While a T-piece device, self-inflating bag, or flow-inflating bag are all recognised as acceptable devices for ventilating newborn infants, since 2010 T-piece devices have been suggested as the preferred device [Guidelines 13.1 and 13.4]. The ILCOR CoSTR [5] found little evidence for advantages of T-piece devices over

self-inflating bags and made no recommendation. The CoSTR statement did make a suggestion that positive end-expiratory pressure (also known as positive end exhalation pressure or PEEP, which can be delivered reliably by a T-piece device but not a self-inflating bag) should be used during delivery room resuscitation of preterm newborns. [5]

In an example of a specific interpretation of values and preferences in different health care settings, we considered how this should be applied in Australian and NZ hospitals. We placed higher value on the demonstrated benefits of PEEP in recruiting lung volume, the routine use of manometry to adjust inflating pressures and the reliable titration of oxygen concentration (which can all be accomplished with a T-piece device) than on the lack of clinical trial evidence of improvement in outcome. Therefore, ANZCOR continues to recommend a T-piece device for delivery of positive pressure ventilation or CPAP during newborn resuscitation, as a matter of expert opinion. A flow-inflating bag with manometer is also suitable. A self-inflating bag should also always available, as it is the only device that will function if compressed gas sources (cylinder or reticulated medical gas) fail.

Blender and compressed gases ANZCOR continues to recommend that the T-piece device or flow-inflating bag should be used with a blender utilising both compressed air and oxygen, to allow accurate titration of oxygen concentration.

CO_2 detection/verification of endotracheal tube position It has been asked whether the disposable, colorimetric CO_2 detector suggested since 2007 should be replaced or supplemented with continuous capnography. ANZCOR has not recommended this because the limited available evidence has established feasibility [5] but has not shown improvements in clinical outcomes. Furthermore, we lack normative data (such as for oximetry) to define the normal trajectory of exhaled CO_2 levels or the target levels for infants receiving resuscitation. Meanwhile, additional equipment and processes could distract from more important tasks and observations during resuscitation.

Laryngeal masks In 2016, ANZCOR continues the suggestion from 2010 to have a size 1 laryngeal mask available for any ‘can’t intubate, can’t ventilate’ situation in a baby of greater than about 34 weeks.

Timing of Cord Clamping – Guideline 13.1

The 2010 guidelines noted that although it was beyond the scope of *resuscitation* guidelines (because these infants do not need resuscitation), evidence supported deferred over immediate cord clamping in healthy term infants. This reduced the likelihood of iron deficiency anaemia later in infancy, albeit with a greater likelihood of needing phototherapy for neonatal jaundice. The 2015 ILCOR CoSTR found that deferred cord clamping for very low birth weight infants was also supported, albeit by very low quality evidence, to improve cardiovascular stability, haematological indices and to reduce grade I and II intraventricular haemorrhage and necrotising enterocolitis. [5]

However, in the studies in both term and VLBW infants, many of the infants at highest risk of adverse outcomes and of requiring resuscitation were excluded or were withdrawn, leaving major uncertainty about the balance of priorities in infants who are depressed after birth. Delaying lung aeration could pose greater risks than not receiving a placental transfusion. Furthermore, it appears that a physiological purpose of placental transfusion is to fill the pulmonary vascular bed. It is yet to be established whether the presence or absence of lung aeration before the cord is clamped influences the size of placental transfusion. ANZCOR guidelines therefore now *suggest* (equating to a weak recommendation) delaying cord clamping in preterm infants not requiring immediate resuscitation after birth. We continue to caution that the more severely compromised the infant, the more likely it is that resuscitation measures need to take priority.

Research is underway to examine whether assisted ventilation can be effectively provided before cord clamping. However, there is insufficient published evidence regarding feasibility and merits of this approach. The cord must be clamped (to remove low-resistance placental run-off) if chest compressions are needed.

Cord milking has also been studied as an alternative method to accomplish placental transfusion, but in accord with the ILCOR CoSTR, we suggest against its routine use because of insufficient evidence to define benefit or potential harms.

Body Temperature – Guideline 13.1

The guidelines now strongly recommend maintaining normal body temperature (between 36.5 and 37.5^{0}C) during and after resuscitation. This is based on substantial

evidence of increased mortality and morbidity in infants in whom normothermia is not maintained. [5] Temperature on admission to newborn units is a predictor of outcome and recording it is recommended as a quality of care measure. Some uncertainty about how to best measure temperature does not detract from the importance of measuring it and undertaking corrective measures. A range of interventions to maintain normothermia may be needed individually or in combination, depending on local circumstances and characteristics of the infant.

Assessing Heart Rate during Resuscitation – Guideline 13.3

ANZCOR guidelines continue to emphasise the importance of tone, breathing and heart rate in the initial assessment of need for resuscitation, and subsequently, the additional importance of oxygenation, which is preferably assessed using pulse oximetry. Previous guidelines note that visual judgement of oxygenation is highly inaccurate [10], whereas pulse oximetry can provide accurate readings within about a minute of application. [11] Pulse oximetry also provides a continuous indication of heart rate, although because of risk of artefacts, the rate should be checked periodically by auscultation. The 2015 CoSTR found evidence that ECG is superior to oximetry for the rapid and accurate estimation of heart rate. [5] Heart rates in the first 1-2 minutes after birth appear higher when measured by ECG than by oximetry or auscultation. [12, 13] Therefore, ECG monitoring has the potential to prevent the implementation of measures that are based on falsely low estimates of heart rate. However, as yet there is no evidence that ECG monitoring improves outcomes, and there are implications for resources: both equipment and the team capability needed for an additional form of monitoring. Because oximetry is so important in estimating oxygenation, ECG monitoring should be considered as an adjunct rather than a replacement for oximetry. Therefore, ECG monitoring is omitted from the ANZCOR algorithm, pending further evidence, but the guidelines contain a *suggestion* to consider ECG monitoring.

Airway Management in the Presence of Meconium Stained Liquor – Guideline 13.4

Various measures have been proposed to reduce the risk of meconium aspiration syndrome (MAS). Both suctioning the infant's oropharynx before the shoulders have emerged, and routine endotracheal suctioning of vigorous infants have been shown to

be ineffective in large randomised trials. Optimal management for non-vigorous infants (no breathing or crying, low or absent muscle tone) has been uncertain.

During preparation of the 2015 CoSTR, a single small randomised trial found no benefit to routine tracheal suctioning of such infants in reducing death or meconium aspiration syndrome [14] and has since been supported by another small study. [15] Both studies had much higher rates of mortality and meconium aspiration syndrome than those seen in Australia or New Zealand. [16] These studies have power only to detect large differences; small but nevertheless clinically significant beneficial or adverse outcomes are not excluded. Previous recommendations for routine endotracheal suctioning of depressed infants were based on limited evidence from 1974-6 comparing only small numbers of infants (who received of endotracheal suctioning as part of a multifactorial intervention) with historical controls. [17-19]

Since 2010, ANZCOR had gone beyond other resuscitation councils [20, 21] in suggesting that if endotracheal intubation to suction meconium is performed, it should be undertaken before spontaneous or assisted respirations have commenced and very promptly to minimise the delay in establishing breathing. The 2016 ANZCOR guidelines conclude that the combined evidence is now insufficient to suggest intubating non-vigorous infants immediately after birth to suction meconium from the trachea. Clear communication among the clinicians present remains necessary to establish and follow a treatment plan.

The European Resuscitation Council has continued to recommend using a laryngoscope to visualise the vocal cords and perform pharyngeal suction, [22] an approach has not been examined in any research study or considered by ILCOR. Therefore, it is not endorsed by ANZCOR.

We are often asked if endotracheal suctioning for meconium can be performed using a suction catheter, for speed and simplicity. Again, there is no research on this practice. A suction catheter may not dislodge thick, particulate meconium. Success of neonatal intubation using even a purpose-designed endotracheal tube is relatively low, [23-25] and may be lower with more flexible tubing. We cannot endorse routine use of a procedure that involves the potential harms of laryngoscopy, without any evidence on which to estimate benefit.

Positive Pressure Ventilation during resuscitation – Guideline 13.4

The recommendations for indications, techniques and pressures have not changed, because of lack of new evidence. The evidence in relation to sustained initial inflation breaths relates to very preterm infants, and they are therefore addressed in Guideline 13.8 (see below).

Chest Compressions - Guideline 13.6

Chest compressions are rarely required during the resuscitation of newly born infants. The recommended ratio of three compressions to each inflation has not changed.

Adrenaline (epinephrine) - Guideline 13.7

The 2016 guidelines place greater emphasis on commencing attempts to establish vascular access as soon as chest compressions are required, to minimise delays in the administration of IV adrenaline (epinephrine), given there is continuing doubt about the efficacy of endotracheal adrenaline (epinephrine).

Resuscitation in Special Circumstances - Guideline 13.8

Material relating to very preterm infants has now been collected together in Guideline 13.8. This includes discussion of the FiO2 to use when commencing resuscitation in preterm infants. The suggested starting FiO2 (up to 0.50) has not changed from the 2010 guidelines. The ILCOR CoSTR 2015 concluded that there is evidence to suggest against commencing resuscitation with an FiO2 of 0.65-1.00, but the optimum FiO2 remains uncertain. [5] It is possible that there isn't a "one size fits all" optimum level for all preterm infants, who can vary widely in birth weight, gestation, prior circumstances and morbidities. Nevertheless, a high proportion of very preterm infants (<32 weeks) will require some supplemental oxygen during their resuscitation, so in the absence of new evidence, starting in 30-50% is reasonable. The option of commencing resuscitation with room air remains in the guidelines because it may be appropriate for larger, more mature preterm infants, especially those who have had antenatal glucocorticoids, and because we suggest it is the best choice if blended air and oxygen is not available.

ANZCOR suggests against the routine use of an initial sustained inflation of > 5

seconds in preterm infants but consistent with CoSTR 2015, suggests that sustained inflation may be considered in individual clinical circumstances or in research settings. This is a weak recommendation, based on low quality of evidence. [5] Studies indicate a reduced need for intubation at 72 hours after a sustained inflation but the study protocols have varied sufficiently widely that there is a lack of clarity as to how to administer this. Furthermore, no longer-term benefits have yet been demonstrated. Recent evidence has indicated that in some circumstances, sustained inflation may cause unintended glottic closure. [26]

A new section has also been added to Guideline 13.8 on infants with abdominal wall defects.

Conclusion

The ANZCOR guidelines for resuscitation of newborn infants at birth have undergone further revision to reflect changes in available evidence. While removing the suggestion to undertake endotracheal suctioning of depressed, meconium-exposed infants, and the suggestions to consider ECG monitoring as an adjunct, and to commence obtaining vascular access more promptly in infants who receive chest compressions will attract the attention of many doctors, the higher emphasis on maintaining normal temperature during resuscitation of infants of all gestations, and to undertake more frequent reinforcement of training are likely to have much larger clinical impact. The revision also includes greater transparency about the rationale for recommendations and suggestions as well as the obvious gaps in evidence.

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Table 1. History of development of ANZCOR Neonatal Resuscitation Guidelines

Year	Landmark	Process of development
1992	ILCOR formed including the ARC	
1995	ILCOR first considered neonatal resuscitation	
1998	ILCOR included combined Australian and New Zealand membership (as ANZCOR)	
1999	ILCOR Advisory Statement on "Resuscitation of the Newly Born" [27] – first advice on neonatal resuscitation.	"…careful review of current constituent organization guidelines and current international literature" [27]

2005	ILCOR 2005 CoSTR [3]	Specific steps including; • topic identification • expert topic review • discussion and debate at international meetings • opportunities for peer review • careful documentation of conflicts of interest of committee members and other co-opted evidence reviewers. • levels of evidence and strengths of recommendation assigned. [28]
2007	ARC neonatal resuscitation guidelines [archived by ARC and [2]].	• Based on ILCOR 2005 CoSTR • Informed by discussion and consensus among "many people involved in teaching neonatal resuscitation in Australia" [2]
2010	ILCOR 2010 CoSTR [4]	

2010	ARC and NZRC updated Neonatal Resuscitation Guidelines	• Based on 2010 ILCOR CoSTR • Consultation via the Australian and New Zealand Neonatal Network and Special Interest Group in Neonatal Resuscitation of PSANZ.
2015	ILCOR 2015 CoSTR [5]	Utilised GRADE process for evidence appraisal and guideline development
2016	ANZCOR updated Neonatal Resuscitation Guidelines[1]	• Based on ILCOR 2015 CoSTR • Consultation with PSANZ membership • Opportunity for public and professional organisations to provide feedback via the ARC and NZRC websites.
Abbreviations: ILCOR - International Liaison Committee on Resuscitation; ARC – Australian Resuscitation Council; ANZCOR – Australian and New Zealand Committee on Resucitation (members are the Australian and New Zealand Resuscitation Councils); NZRC – New Zealand Resuscitation Council; CoSTR – Consensus on the Science of Resuscitation with Treatment Recommendations; PSANZ – Perinatal Society of Australia and New Zealand (member of ARC since 2015)		

Table 2. Key changes in suggestions or recommendations in the 2016 ANZCOR Neonatal Resuscitation Guidelines. [1]

2016 Guidelines	2010 Guidelines	Location in Guidelines	Strength of recommendation*
Changed: Prompt to maintain a normal body temperature during resuscitation of all newborns	Prevent heat loss	Flowchart 13.1, 13.8	Recommended
Added: Prompt to ensure the onset of spontaneous or assisted breathing within 1 minute of birth	No mention in flowchart	Flowchart	Recommended
Added: Consider deferred cord clamping in preterm infants who do not require resuscitation	No recommendation	13.1	Suggested
Added: Not to perform cord milking, until more comprehensive evidence of safety and efficacy is available	No recommendation	13.1	Suggested
Added: Assess temperature on admission for neonatal intensive or special care as a measure of quality of care	No recommendation	13.1	Recommended
Changed: Training requires regular reinforcement - some form of retraining should take place more often than once a year	Training should place at least annually.	13.2	Suggested

Added: Resuscitation instructors should be provided with structured feedback	No recommendation	13.2	Suggested
Added: ECG can be used as an adjunct to auscultation and saturation monitoring, to provide a more rapid and accurate measure of heart rate during resuscitation	No recommendation	13.3	Suggested
Changed: No routine endotracheal intubation to suction meconium from the trachea in meconium-exposed, non-vigorous infants	"…there is insufficient evidence on which to recommend a change in current practice of performing endotracheal suctioning of non-vigorous infants who have been exposed to meconium stained fluid"	13.4	Suggested
Added: In preterm infants: Avoid 65-100% oxygen at the commencement of resuscitation of preterm infants Commence in 21-50% with subsequent adjustments as needed, guided by oximetry and clinical response	No recommendation	13.8	Suggested
Added: Commence vascular access (e.g. an umbilical venous catheter) as soon as chest compressions are required. Early intravenous administration of adrenaline	No recommendation	13.7	Suggested

is suggested over endotracheal administration.			
Added: Use gestation-based chart for adrenaline doses, rather than attempting weight-based calculation during resuscitation		Flowchart	Suggested
* The word “recommended” is used when a strong recommendation is made, and the word “suggested” is used when a weak recommendation is made. See ANZCOR Guideline 1.4 [1]			

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