

Reduction of intubation rate during newborn resuscitation after transition from self-inflating bag to T-piece resuscitator: A quality improvement project

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ABSTRACT

Introduction: T-piece resuscitator (TPR) has many advantages compared to self-inflating bag (SIB). Early Continuous Positive Airway Pressure (CPAP) during newborn resuscitation (NR) with TPR at delivery can reduce intubation rate.

Methods: We speculated that the intubation rate at delivery room was high because SIB had always been used during NR and this can be improved with TPR. Intubation rate of newborn <24 hours of life was deemed high if >50%. An audit was carried out in June 2010 to verify this problem using a check sheet.

Results: 25 neonates without major congenital anomalies who required NR with SIB at delivery were included. Intubation rate of babies <24 hours of life when SIB was used was 68%. Post-intervention audit (August to November 2010) on 25 newborns showed that the intubation rate within 24 hours dropped to 8% when TPR was used. Proportion of intubated babies reduced from 48.3% (2008-2009) to 35.1% (2011-2012), odds ratio 0.58 (95% CI 0.49-0.68). Proportion of neonates on CPAP increased from 63.5% (2008-2009) to 81.0% (2011-2012), odds ratio 2.44 (95% CI 2.03-2.93). Mean ventilation days fell to below 4 days after 2010. Since then, all delivery standbys were accompanied by TPR and it was used for all NR regardless of settings. There was decline in intubation rate secondary to early provision of CPAP with TPR during NR. Mean ventilation days, mortality and length of NICU stay were reduced.

Conclusion: This practice should be adopted by all hospitals in the country to achieve Millennium Development Goal 4 (2/3 decline of under 5 mortality rate) by 2015.

KEY WORDS:

Quality improvement, self-inflating bag, T-piece resuscitator, intubation rate, newborn resuscitation

INTRODUCTION

T-piece resuscitator (TPR) provides more precise and consistent pressures in comparison with self-inflating bag (SIB) with manometer. It also supplies positive end expiratory pressure (PEEP)/continuous positive airway pressure (CPAP)

but SIB cannot, unless PEEP valve is attached.^{1,2} SIB without attached manometer and PEEP valve had always been used in our centre during newborn resuscitation (NR) at delivery rooms before 2010.

According to SMART (seriousness, measurable, appropriateness, remediable, timeliness) criteria, we had identified the reasons to carry out this clinical audit study. In terms of Seriousness, invasive intubation and mechanical ventilation on babies (especially premature neonates) cause barotrauma, volutrauma, ventilator associated pneumonia (VAP), upper airway injury, bronchopulmonary dysplasia (BPD), patent ductus arteriosus (PDA), retinopathy of prematurity, intraventricular hemorrhage (IVH), periventricular leucomalacia, necrotizing enterocolitis (NEC). This will result in increased risk of mortality and long term morbidity, parental dissatisfaction/anxiety, nursing care, procedures, costs, and length of stay. Intubation rate before 24 hours of life is Measured by obtaining the percentage of number of intubated babies less than 24 hours over the number of babies given positive pressure ventilation in delivery room. It was Appropriate to carry out this study because NR with TPR is practiced in many centres and its use is supported by latest neonatal resuscitation guidelines.³⁻⁵ There is good evidence that early CPAP during NR at delivery reduces intubation rate^{6,7} and thereby reduces surfactant administration, postnatal corticosteroid for bronchopulmonary dysplasia, mechanical ventilation days and total respiratory support.⁸⁻¹⁰ Early use of CPAP has been shown to enable faster achievement of stable oxygen saturation in preterm babies.¹¹ We believe that the problem of high intubation rate is Remediable with the use of TPR because it can be used to provide early CPAP and thereby prevent intubation. TPR was acquired in 2008 solely for transportation of neonates between centres but was never utilised for NR. It is Timely to introduce the use of TPR not only for the prevention of the above mentioned complications as supported by the accumulating evidence but also in anticipation of the opening of the new Women and Children Center (WCC) in Tuanku Jaafar Hospital, Seremban (HTJS).

We aim to audit the number of intubations in the delivery room and Neonatal Intensive Care Unit, (NICU) among babies less than 24 hours of life resuscitated in the delivery

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Table I: Model of good care

	Process	Criteria	Standard
1	Assess for respiratory distress and HR at birth	Provide PPV with TPR if severe respiratory distress or HR<60	100%
2	Look for persistent respiratory insufficiency and bradycardia	Nasopharyngeal CPAP or intubation and ventilation with TPR	100%
3	Transfer to NICU	Use TPR during transfer	100%
4	Stabilization in NICU	Put on nasal CPAP or ventilator	100%

Table II: Demographic data of babies resuscitated at birth using SIB (June 2010) and TPR (August to November 2010)

	SIB	TPR
Number of subjects	25	25
<37 week	20 (80%)	16 (64%)
Median weight (<37 week)	1350g	1240g
Median gestation of premature babies in weeks (range)	31 (24-36)	30 (23-33)
>37 week	5 (20%)	9 (36%)
Median weight (>37 week)	2850g	2770g
Median weight (overall)	1560g	1460g
Caesarian section	13 (52%)	12 (48%)
Vaginal delivery	12 (48%)	13 (52%)

SIB: self-inflating bag; TPR: T-piece resuscitator.

suite and operation theatre using SIB. We also would like to find out whether there would be improvement of the afore mentioned outcome if TPR was used instead of SIB in the same setting. Our primary aim was to see drop of intubation rate when TPR was used.

MATERIALS AND METHODS

We propose that intubation rate of newborn <24 hours of life is deemed high if >50% of live-births were intubated (based on previous studies and because of inclusion of term babies in this audit). In order to assess the opportunity for improvement, we carried out a pre-intervention audit to verify the problem (intubation rate of babies <24 hours of life) and assess its size and effects (mortality and length of stay).

Audit before intervention required a standardised form was done in June 2010. We included 25 neonates who require assisted ventilation for the management of cardiorespiratory compromise at birth without major congenital anomalies.

Intubation rate of babies <24 hours of life when SIB was used for NR in delivery room is 68%, median length of stay in NICU was 10 days/patient and mortality rate was 28%. From these results, there is an urgent need to reduce intubation rate in order to prevent multiorgan complications associated with mechanical ventilation, decrease length of stay, improve patients' care and parental satisfaction as well as for economic reason. The diagrams (Figure I and II) below will help us to understand the cause and effects of high intubation rate during NR.

We then carried out our intervention with the intention to confirm that the use of TPR will have desirable effect in reducing intubation rate of newborn <24 hours of life, and therefore reduction of length of NICU stay and mortality rate. We employ the following measures in July 2010 to implement change in practice: all standbys in operation theatre (OT)/labour room to be accompanied by TPR, hands-on

teaching sessions to medical officers on setting up and the use of TPR, flow chart on the process of NR algorithm with steps requiring usage of TPR placed on the NICU noticeboard, provision of a bag for doctors to carry TPR when they go for delivery standbys, daily checking of TPR to make sure it was in good and functional condition, weekly visit to NICU and utilizing departmental meetings to remind the doctors to use TPR for all NR. In our enthusiasm to make this change of practice, we also ensured that the standard of good care (Table I) is not compromised.

We performed the post-intervention audit between August to November 2010 to assess the effects of change. We again included 25 subjects with similar inclusion and exclusion criteria and we used the same data collection form in the pre-intervention audit phase.

In the early 2013, we conducted an observational cross-sectional study to review the difference in the proportion of babies admitted into NICU needing mechanical ventilation and CPAP between 2008 and 2012 in order to determine the effect of sustaining change.

RESULTS

We managed to collect the targeted sample size of 50 infants; 25 were resuscitated with TPR and 25 with SIB. 36 babies were premature (less than 37 weeks) and 14 were term. Table II shows the demographic data of all the subjects.

Of the 25 babies resuscitated with TPR, only two (8%) were intubated and ventilated during the first 24 hours of life but there were higher percentage of intubation of among the neonates resuscitated with SIB, 17 (68%) out of 25. The mortality outcome was also higher among the babies resuscitated with SIB; seven (28%) compared to two (8%) in the TPR group. Median length of stay reduced to six days/patient (range 2 to 90 days/patient) in the TPR group from 10 days/patient (range 1-68 days/patient) in the SIB group.

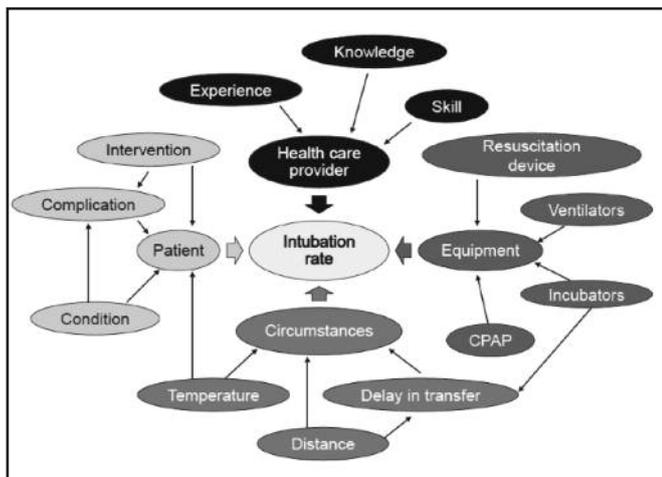


Fig. 1: Causes of high intubation rate.

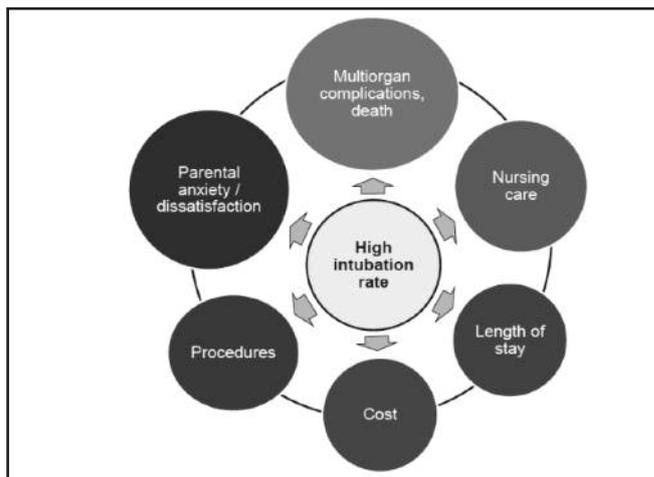


Fig. 2: Effects of high intubation rate.

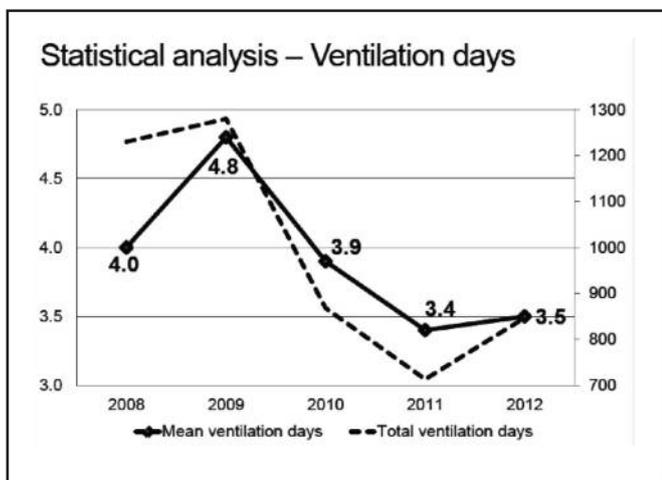


Fig. 3: Mean neonatal ventilation days between 2008-2012.

Since then, all delivery standbys were accompanied by TPR and it was used for all NR regardless of settings. In the early 2013, the observational cross-sectional study to review the difference in the proportion of babies admitted into NICU needing mechanical ventilation and CPAP between 2008 and 2012 was carried out to determine the effect of sustaining change. Since the implementation of TPR usage for every NR, the proportion of babies being invasively ventilated dropped from 48.3% (571/1182) in year 2008-2009 to 35.1% (452/1287) in year 2011-2012 with the odds ratio of 0.58 (95% CI 0.49-0.68). The proportion of neonates on CPAP increased from 63.5% (751/1181) in year 2008-2009 to 81.0% (1042/1287) in year 2011-2012 with the odds ratio of 2.44 (95% CI 2.03-2.93). Mean ventilation days has also fallen to below 4 days since we implemented the use of TPR in 2010 (Figure III).

DISCUSSION

One of the key causes of high intubation rate among newborn babies is because of the use of SIB in NR which cannot provide early CPAP without the use of PEEP valve. To date, this is the first report from Malaysia comparing the

effectiveness of NR using TPR and SIB. This audit showed that high intubation rate can be overcome by implementation of early CPAP with the use of TPR (Intubation rate of babies <24 hours of life when SIB was used was 68% and it dropped to 8% when TPR was used). Proportion of intubated babies reduced from 48.3% (2008-2009) to 35.1% (2011-2012), odds ratio 0.58 (95% CI 0.49-0.68). Proportion of neonates on CPAP increased from 63.5% (2008-2009) to 81.0% (2011-2012), odds ratio 2.44 (95% CI 2.03-2.93). Mean ventilation days fell to below 4 days after 2010. The proportion of neonates on invasive ventilation was already declining since 2008 before the introduction of TPR. This can be explained by the availability of non-invasive ventilation devices such as CPAP driver, synchronised intermittent positive airway pressure (SIPAP), heated humidified high flow nasal cannula (HHFNC) etc. However, we believe that the sustained reduction in proportion of mechanically ventilated babies is also partly contributed and further accentuated by transition from SIB to TPR in 2010.

In one randomised controlled trial published in 2007 comparing usage of TPR and SIB on preterm babies <33 weeks, there were fewer infants in the early functional residual capacity intervention (TPR) group intubated within 72 hours of age (38 [37%] of 104 vs 52 [51%] of 103; P <0.04; OR: 0.57 (95% CI: 0.32–0.98)).⁶ In another retrospective study, the intubation rate of babies <34 week was reduced significantly from 63.6% in the first period (before application of early CPAP) to 23.8% in the second (after application of early CPAP).⁷ Looking at our data, the intubation rate (68%) when self-inflating bag was used was comparable to other mentioned studies. After intervention with TPR, the intubation rate dropped dramatically to just 8%. This marked decline of intubation rate can be explained by the inclusion of term babies and its small sample size in this audit study.

The disadvantages and complications of mechanical ventilation includes higher incidence of barotrauma, volutrauma, VAP, upper airway injury and BPD. These are even more important in premature infants who can be directly or indirectly affected by different mode of ventilation which predispose them to multiorgan complications such as

PDA, retinopathy of prematurity, IVH, periventricular leucomalacia and NEC.^{12,13} If intubation can be avoided from delivery onwards with the use of CPAP via the TPR followed by non-invasive nasal CPAP in NICU, we hope that these complications can be avoided. The results were very encouraging as there were 60% drop of numbers of baby being intubated when resuscitation was carried out using the TPR in comparison with SIB. Therefore, we hope the above mentioned complications can be prevented as much as possible, especially when the majority of admission into NICU are for premature babies (72% in this study), if TPR can continue to be utilised as frequent as possible not only for resuscitation in the delivery suite or operation theatre but also in the NICU and Special Care Nursery setting.

It is undoubtedly very much easier to manage a neonate on nasal CPAP compared to a neonate on a ventilator. This fact is true for both nurses and doctors. Nursing work (tracheal suctioning) and procedures (e.g. regular blood gases, arterial catheterization, intubation) can be reduced considerably if a patient is on nasal CPAP. This in turn can decrease incidence of anemia (due to repeated venepuncture and/or arterial blood sampling) and pain/discomfort among these neonates.

If we are able to cut down on the numbers of babies being invasively intubated and ventilated, over time this will result in positive economical impact. Nasal CPAP device for use in NICU is definitely very much cheaper than using ventilators. By adopting NR in delivery room with TPR, the use of these ventilators can be limited for more seriously ill babies while non-intubated neonates can be placed on nasal CPAP. In the long term, we purchase of less ventilators and save cost so that money can be shunted to other more crucial areas.

After the end of this audit, most of the paediatric medical officers were comfortable in setting up the TPR as well as using it for standby during delivery of high risk patients. We hope that NR with TPR will translate into lower mortality and morbidity particularly long term neurodevelopmental disabilities in these neonates. Although this study was not designed to determine statistical significance and the multiple confounding factors of mortality among the infants in this audit, there is remarkable fall of mortality from 28% to 8% after intervention, possibly by preventing complications of intubation and due to small sample size in the audit cycle. The data presented shows reduction in neonatal mechanical ventilation, ventilation days, inborn mortality rate, and increased numbers of patients on NCPAP and VLBW survival rate. This finding speaks volume of the benefits and advantages of TPR when used for resuscitation of neonates.

We believe that these results were due to reduction of intubation rate secondary to early provision of CPAP with TPR during NR. However we cannot deny that this could have been due to other confounding factors. The other limitation of this study is that other remediable causes of high intubation rate were not addressed and pathological effects, parental perception, economic impact, feedback from doctors and nurses were not studied. Although our audit sample size is small but the number of patients in the cross-sectional study was large. This report highlights the benefits of conducting a full cycle clinical audit. There was sustaining

change in practice according to evidence-based medicine which translates into improved quality of care.

Our centre is acquiring more TPR and TPR-incorporated radiant warmer for NR in delivery rooms, NICU, Special Nursery Care, and for transfer of ventilated babies between wards and hospitals. This is done in anticipation of the new WCC. We strongly recommend that this practice be adopted in the whole country in hope that we will be able to achieve 2/3 decline of under 5 mortality rate in accordance to World Health Organization Millennium Development Goal (MDG) 4.¹⁴

In conclusion, NR with TPR at delivery clearly reduces intubation rate, length of stay and mortality rate, thereby potentially preventing direct and indirect ventilator associated multiorgan complications, long term morbidity especially among preterm babies, reducing workload of health care providers, improving patients' care and well-being and generating positive economic impact. Future audit studies should address other root causes as well as short and long-term effects of high intubation rate at NR.

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