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Original Article

Comparison of training in neonatal resuscitation using self inflating bag and T-piece resuscitator

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ABSTRACT

Background: Both the self inflating bag and the T-piece resuscitator are recommended for neonatal resuscitation, but many health care workers are unfamiliar with using the latter. A prospective, comparative, observational study was done to determine the ease and effectiveness of training of health care personnel in the two devices using infant training manikins.

Methods: 100 health care workers, who had no prior formal training in neonatal resuscitation, were divided into small groups and trained in the use of the two devices by qualified trainers. Assessment of cognitive skills was done by pre and post MCQs. Psychomotor skill was assessed post training on manikins using a 10-point objective score. Acceptance by users was ascertained by questionnaire. Assessments were also done after 24 h and 3 months. Comparison was done by Chi square and paired *t*-tests.

Results: Pre-training cognitive tests increased from 3.77 (+1.58) to 6.99 (+1.28) on day of training which was significant. Post training assessment of psychomotor skills showed significantly higher initial scores for the T-piece group (7.07 + 2.57) on day of training. Reassessment after 24 h showed significant improvement in cognitive scores (9.89 + 1.24) and psychomotor scores in both groups (8.86 + 1.42 for self inflating bag and 9.70 + 0.57 for T-piece resuscitator). After 3–6 months the scores in both domains showed some decline which was not statistically significant. User acceptability was the same for both devices.

Conclusion: It is equally easy to train health care workers in both devices. Both groups showed good short term recall and both devices were equally acceptable to the users.

Introduction

Dr Hilda Roberts was the first person to strongly propose intermittent positive pressure ventilation (PPV) to newborns who did not cry on their own after birth.[1] The most common device used to deliver this is the self-inflating resuscitation bag with mask (BM). Devised in 1954, this has withstood the test of time.[2] Its appeal lies in its ability to use room air for self filling and the minimal skills required for assembly and use.

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Its drawbacks are the inability to provide Positive End Expiratory Pressure (PEEP) or to set a specific Peak Inspiratory Pressure (PIP), resulting in inconsistency in the amount of pressure given between breaths. Also, it is ergonomically difficult to keep the device in place during prolonged resuscitation, resulting in a large proportion of delivered breaths being unknowingly lost through leak around the face mask. The T-piece resuscitator (TP) is advantageous in all these aspects but needs a continuous flow of gas for operation and is slightly more complex to setup initially. Despite it being first described as early as 1913, its use, even today, is not widespread.[3] Several studies have shown that for the majority of babies who do not breathe at birth, initial ventilation with a self inflating bag and mask is adequate. However, the use of PEEP from birth in preterm babies requiring resuscitation is well established as it not only keeps the alveoli open but improves surfactant action. Recent guidelines have incorporated the TP resuscitator as an accepted method for delivering positive pressure ventilation to the neonate during resuscitation. It is recommended particularly in preterm neonates.[4] Training of health care personnel coming in contact with newly born babies in the use of this device is therefore crucial and it is essential that inhibitions and misconceptions in the use of the TP resuscitator be removed. This study was undertaken to determine the ease and efficacy of training in the two devices.

Material and methods

This was a prospective, observational, comparative study on 100 health care personnel. The sample size was calculated using the assumption that the overall baseline knowledge on the pretest would be 4/10. This was based on a previous study done in the unit. To achieve a 50% increase (to 6/10) with a power of 80% and an alpha error of 0.05, using a standard statistical package, we reached a figure of 92. For the purpose of convenience (since we were training in batches of 10) we decided on a study population of 100.

The participants included 1st year PG residents in Paediatrics, Obstetrics, Anaesthesia and probationer (trainee) nurses who had no previous, formal exposure to the use of T-piece Resuscitator and Self Inflating bag for neonatal resuscitation. Infant manikins with skill guides (Laerdal Resusci Baby) were used for teaching and evaluation of skills. If chest inflation was adequate a green light blinked on the Skills Guide. If the pressure was inadequate, or too much air got into the stomach, a red light blinked. A continuous blinking of the green light for >75% of the time during resuscitation was taken as delivery of effective PPV. Resuscitation devices used for training purposes were the Self inflating bag (Laerdal, 450 ml) with pop-off valve and correct sized mask and the T-piece Resuscitator (Neopuff by Fisher & Paykel) with appropriate mask. The participants who met the inclusion criteria were divided into groups of 10 each for training. The authors (SSM and KMA), who are qualified national trainers in Neonatal Resuscitation Protocol, carried out the training and assessment of physical skills. Groups of participants were called on a pre-decided date and time. To assess baseline cognitive knowledge they were subjected to a pretest which consisted of 10 multiple choice questions of 1 mark each which had to be answered in a time span of 03 min (Table 1). This was followed by a lecture with power point presentation on the two devices. This was followed by a post test which consisted of the same 10 multiple choice questions as in the pretest. Practical demonstration was then carried out in which the participants were demonstrated the use of both devices. Participants were then randomly allotted to be trained first on either of the two devices and crossed over to the other on completion. Demonstration of psychomotor skills included assembling the equipment, checking the effectiveness of the equipment before delivering PPV, correct position of the baby, correct mask application, application of

Table 1 – Questionnaire for cognitive skills.

1 Indication for giving (PPV) in LR is:
  a Apnoea at 1 min
  b Apnoea after 30 s of initial stabilization
  c Apnoea at birth
  d Apnoea after suctioning of mouth and nose
2 Positive pressure ventilation alone is given @
  a 40–60 breaths/min
  b >60 breaths/min
  c 30 breaths/min
  d <40 breaths/min
3 The size of the mask used depends on :
  a Size of face
  b Gestational age of baby
  c Weight of baby
  d Head circumference of baby
4 Immediate effectiveness of PPV is checked by:
  a Heart rate rise
  b Chest rise
  c Improvement in oxygenation
  d Onset of spontaneous respiration
5 PPV can be given by:
  a Mouth to mouth
  b Bag and mask
  c T-piece resuscitator
  d All of the above
6 Free flow oxygen CANNOT be given by
  a Self inflating bag and mask
  b Anaesthesia bag
  c T-piece resuscitator
  d Tube and mask
7 PEEP can be given by
  a T-piece resuscitator
  b Self inflating bag and mask
  c Laryngeal mask airway
  d Free flow oxygen
8 During cardiac compression (CC) PPV is given in the ratio of
  a 1 breath to 3 compressions
  b 3 breaths to 1 compression
  c 1 breath to 4 compressions
  d 4 breaths to 1 compression
9 The number of valves in a self inflating bag are:
  a 1
  b 2
  c 3
  d 4
10 FiO_2 can be controlled when using all EXCEPT:
  a Self inflating bag
  b Anaesthesia bag
  c T-piece resuscitator
  d LMA to mouth

Table 2 – Parameters for assessment of psychomotor skills.

Scale for assessment in Bag and Mask Resuscitation
1 Point given for each correct statement
1 Assembled bag and mask, attached oxygen and reservoir correctly <10 s
2 Checked affectivity
3 Positioned baby correctly to open airway
4 Placed mask correctly over airway
5 Provided good seal
6 Held bag at right angles to mask and baby
7 Gave pressure to produce adequate chest rise
8 Gave positive pressure at correct rate
9 No need for >2 corrective actions during 30 s of resuscitation
10 Did not need to be reassessed >1 time for passing score

Scale for assessment of resuscitation with T-piece resuscitator
1 Point given for each correct statement
1 Assembled equipment including oxygen tubing and setting pressures <10 s
2 Checked affectivity
3 Positioned baby correctly to open airway
4 Placed mask correctly over airway
5 Provided good seal
6 Positioned thumb correctly
7 Produced adequate chest rise with thumb movement
8 Gave positive pressure at correct rate
9 No need for >2 corrective actions during 30 s of resuscitation
10 Did not need to be reassessed >1 time for passing score

proper seal, delivery of correct pressure and rate, recognition of inadequate chest rise and administering corrective action (Table 2). Thereafter, each participant was individually assessed on their physical skills by observing them using the equipment over a period of 3 min. This was done in a similar manner for both devices. Scoring was as 'Yes' (1 point) or 'No' (0 point). Those who failed to get atleast 6/10 on first attempt were re-taught the skill and reassessed till they improved. Video recording of 10% of assessments was randomly done and these were scored by an independent, trained observer to determine if there was any significant observer variability (>1 point difference). All participants were called the next day for repeat tests. They were also given a non-validated, simple questionnaire on that day to determine their opinion on the two devices. Participants were then called back between 3 and 4 months after the training session for reassessment of cognitive and psychomotor skills in a similar manner.

Paired *t*-tests and Chi square tests were done for parametric continuous data and categorical data respectively on SPSS ver 17.0.

Results

Trainee nurses (probationers) constituted 70% of the study population. The rest were newly joined Paediatric, Obstetric & Gynaecology and Anaesthesiology residents. On comparison of theory scores on the day of training it was found that there was a significant improvement in the scores after the lecture. On assessment of practical skills, the overall initial scores on the day of training were significantly better in the TP group compared with the BM group. Mean score in BM group was 5.86 (SD 2.4, 95% CI 5.37–6.34) and in the TP was 7.07 (SD 2.57, 95% CI 6.56–7.57) ($p = 0.0002$ on paired *t* test) (Table 3). When each of the objective parameters were compared among the participants it was seen that assembling of bag and mask was done correctly by 70% of participants in the stipulated time, whereas only 52% of the participants assembled the T-piece correctly in the time given which was statistically significant ($p - 0.0137$ on Chi test). The parameters where TP was found to better than BM were: "checking of equipment" ($p - 0.0007$), "providing good seal" ($p - 0.0021$), "adequate chest rise" ($p - 0.0398$) and "no need for corrective action" ($p < 0.0001$) (Table 4).

The number of participants requiring more than one-teaching and re-assessing session was more in the TP group as compared with the BM group (57% vs 24%) and this was statistically significant.

73% of the participants felt that acceptability of both the devices was the same (Table 5). On assessment after 24 h the mean scores had increased in both groups and were comparable. 79% of the participants could be followed up with a reassessment of cognitive and psychomotor skills between 3 and 6 months of training. Though there was some decline in all scores these were not statistically significant (Table 6).

Video recording of 10% of the assessments of psychomotor skills by a trained observer not connected with the study gave similar scores as the researchers.

Discussion

The simplest method of testing cognitive effectiveness of training is to administer the same set of objectively structured questions to the participants before and after the training session and to analyse the difference. We used this method in our study and repeated the tests the next day and after 3–6 months to determine recall.

A qualitative review of the literature done by Hawkes et al on various aspects of the T-piece resuscitator with particular emphasis on the evidence comparing its effectiveness with Bag and Mask ventilation showed that there was no difference

Table 3 – Cognitive and psychomotor scores on day of training.

Cognitive scores mean (SD) 95% CI		Psychomotor scores mean (SD) 95% CI	
Pre test	Post test	B&M	TP
3.77 (1.58)	6.99 (1.28)	5.86 (2.4)	7.07 (2.57)
3.45–4.08	6.73–7.24	5.37–6.34	6.56–7.57
p value (One tailed paired *t* test) < 0.05		*p* value (unpaired *t* test) < 0.05	

Table 4 – Comparison of psychomotor skills on the two devices.

Parameter	Percentage of participants who performed correctly		*p* value Chi square test
	Bag & Mask	T-piece resuscitator	
Assembled in <10 s	72	52	0.0137
Checked affectivity	35	60	0.0007
Positioned baby correctly	76	80	0.6086
Placed mask correctly	73	80	0.0625
Provided good seal	52	74	0.0021
Held equipment correctly	73	78	0.51
Gave adequate pressure	56	71	0.0398
Gave at correct rate	71	74	0.7515
No need for repeated corrective action	21	52	<0.0001
No need for >1 reassessment	24	57	<0.0001

between the two when used on neonates. However, from manikin studies, advantages of the T-piece resuscitator include the delivery of inflating pressures closer to predetermined target pressures with lesser variation in pressures delivered. Disadvantages include a technically more difficult setup, more time required to adjust pressures during resuscitation and less ability to detect changes in compliance.[5]

A study done by Agarwal et al at All India Institute of Medical Sciences on 27 undergraduate medical students showed significant improvement in retention of knowledge and skills after a workshop on neonatal resuscitation.[6] They found that the pretest score on 20 multiple choice questions averaged at 25% and improved to 87% post workshop. In our study mean pretest cognitive score before the theory lecture was 37.7% which improved to 69.9% post test. We used a single lecture as method of training. The pre and post tests showed a significant improvement in cognition following even one single lecture taken by a trained person.

In a study done by Taksande et al, neonatal resuscitation was taught to final year undergraduate students (55.14%), BSc nursing students (12.14%), staff nurses (11.21%), Paediatric residents (4.67%), Anaesthesia residents (3.73%) and Obstetric residents (4.67%). Participants were given a pretest of 35 multiple choice questions covering the entire neonatal resuscitation protocol. After the pretest, multimedia lecture sessions on resuscitation steps were delivered by specially trained faculty. The skills on manikins were demonstrated and hands-on practice was done by the participants after the session. The written post test administered at the end of the training session showed statistically significant improvement in scores. However, no post test on psychomotor skills was done.[7] In a previous study done by us we found a significant improvement in cognitive skills following a workshop on neonatal resuscitation conducted for resident doctors.[8]

The uniqueness of our study was that after training the participants in two approved methods of delivering PPV, they underwent an assessment test on manikins with skill guides. They were marked based upon the ability to execute specific, objective skills in delivering PPV. The results revealed that on the day of training the mean score on psychomotor skills was significantly higher in the TP group as compared to the BM group implying that it was initially easier for the participants to imbibe skills in the use of T-piece resuscitator as compared to the Bag and Mask on training manikins. However on recall at 24 h and thereafter this difference did not persist.

Table 5 – User acceptability of the two devices (%).

	A B&M better	B T-piece better	C Both same
Ease of assembly	32	27	41
Ease of use	33	24	43
Effectiveness of use	45	35	20
Overall acceptability	12	15	73

On analysis of the various skills it was observed that assembling the Bag and Mask was found to be easier than assembling the T-piece by most of the participants (72 vs 52, $p < 0.05$, Table 4). This might be due to the fact that is technically more challenging. In all other parameters the T-piece was found to be better than the Bag and Mask.

Our study was also unique in that the practical demonstrations and assessments were repeated till the participants got scores of >6/10. However, for the purpose of assessment only the initial scores were taken. The number of times this had to be done for the Bag and Mask was significantly higher than for the T-piece resuscitator. Similar results were also observed in studies done by Christabel et al.[9] In a study done by Cusack and Fawke 69% of junior trainees who failed the first assessment had a second assessment recorded. There was an 85% pass rate at second assessment.[10]

One of the observations during T-piece use was that the operators could use both hands to affix the mask to the face and achieved better seal between the mask and airway as compared to Self inflating bag. Klingenberg et al also noticed similar results in their study.[11]

We randomly video-recorded 10% of the assessments of psychomotor skills and found that a trained observer not connected with the study gave similar scores as the researchers. This showed that the assessment was reliable and reproducible. Other workers have also used video recordings to assess resuscitation particularly in a real-life situation on patients.[12]

The aim of our study was to determine the ease and efficacy of training health care personnel in the two main devices used to give PPV to asphyxiated neonates. We found that this was the same for both the devices. Our study showed that though the T-piece resuscitator was harder to assemble it was initially easier to use on the training manikins. On follow-up the skills achieved on both devices was similar and well retained. In fact, the cognitive scores improved significantly at

Table 6 – Follow-up cognitive and psychomotor scores.

	Cognitive scores mean (SD) 95% CI	Scores on B&M mean (SD) 95% CI	Scores on T-piece mean (SD) 95% CI
At 24 h	9.89 (1.24)	8.86 (1.42)	9.70 (0.51)
	9.64–10.1	8.57–9.14	9.59–9.80
At 3 months	8.85 (1.63)	7.76 (2.45)	8.18 (1.20)
	8.52–9.17	7.27–8.24	7.94–8.41
p-value (paired *t*-test)	NS	NS	NS

24 h (Table 6) probably because there was reinforcement of cognition during psychomotor training. It is well known that if not practised, psychomotor skills decrease over the next three to six months.[10] In our study we could recall 79 of the participants at 3–4 months and found no significant decline in their skills.

The strength of our study lies in the methodical training and objective methods of assessment of both cognitive and psychomotor skills. User acceptability was also assessed. Though more of the participants (73%) felt that acceptability of both the devices was the same, the questionnaire used for this was not a validated one.

The limitation of our study is that we restricted it to training manikins and short follow-up. The effectiveness of the self inflating bag and T-piece resuscitator in delivering PPV to asphyxiated newborns can only be determined after more studies on neonates.

Conflicts of interest

All authors have none to declare.

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