A quality improvement initiative in reducing nasal trauma during the application of nasal bubble continuous positive airway pressure in a tertiary care neonatal unit

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ABSTRACT

Background: Trauma following nasal bubble continuous positive airway pressure (b*CPAP*) is more commonly observed in areas where there are inadequate nursing staffs. It may progress to be a source of sepsis, prolonged hospitalization, and permanent facial disfigurement. **Aim:** This study aims to conduct a quality improvement (QI) initiative to decrease the proportion of neonates developing nasal trauma following bCPAP from baseline of 79% to 30% over a period of 16 weeks in Level III neonatal intensive care unit of a tertiary hospital of South India. **Materials and Methods:** The study was conducted as a single-center QI initiative from October 2018 to February 2019. A QI team was formulated, problem/outcome indicator decided and problem analysis was done using fishbone analysis and Pareto principle. Change ideas were discussed and plan, do, study, and act (PDSA) cycles were formulated. It took four PDSA cycles to reach the aim. The first cycle aimed to train nurses, second to reinforce the same in treating doctors, third was to start using Duoderm (gel plaster) over nasal septum, and the fourth was to intermittently shift the baby to high-flow nasal cannula and introduction of written policy to maintain the changes introduced. **Results:** Incidence of nasal trauma reduced from baseline of 79% to 26% over a period of 16 weeks. Incidence of Grade III trauma reduced from 35% to 0%. **Conclusion:** A simple method of training the junior residents and nursing staff and use of barrier gel plaster and maintaining policy on the application of nasal CPAP (NCPAP) can go a long way in reducing NCPAP trauma substantially and hence helping reduce hospital stay, morbidity, and probably also sepsis-related mortality.

Key words: *Awareness and training of staff, Nasal trauma reduction, Nasal continuous positive airway pressure*

Continuous positive airway pressure (CPAP) has emerged as the first mode of respiratory support for preterm babies at the risk of developing respiratory distress (RD) syndrome in preterm infants and also for babies with term gestation with RD [1]. Although an early application of nasal bubble CPAP (bCPAP) is beneficial to infants with RD, there are only a few documented protocols available, especially in preterm infants [2,3].

Lack of proper monitoring during nasal CPAP (NCPAP) application can lead to the obstruction of nasal prongs from mucus plugging or tips pressed against the nasal mucosa can lead to low end-expiratory lung volume and consequential deterioration and increased work of breathing [4,5]. Inadequate humidification can lead to nasal mucosal damage. Local irritation and trauma [6,7] to the nasal septum may occur due to misalignment or improper fixation of nasal prongs [8]. Nasal masks can cause trauma to the base of nasal philtrum and columella [9,10]. The long-term use can cause nasal snubbing and circumferential distortion (widening) of the nares. CPAP head harnesses can cause irritation of the skin of head and neck.

The infants receiving CPAP have reported pneumothorax [5,7,11], pulmonary interstitial emphysema, pneumomediastinum, pneumatocele [12-16], and vascular air embolism [17]. Bowel distension is a mild complication noted with CPAP, may occur when an infant swallows air, and can be relieved using an orogastric tube [18]. The nasal injuries caused by the use of bCPAP prongs are classified into three stages, namely, mild, moderate, and severe. The mild (Stage I) is described as redness or nasal hyperemia, the moderate (Stage II) presents with bleeding injuries, and the severe (Stage III) refers to injuries with necrosis [19]. The aim of the study was to decrease the proportion of neonates developing nasal trauma following bCPAP from baseline 79% to 30% over a period of 16 weeks in Level III neonatal intensive care unit (NICU) of our hospital.

MATERIALS AND METHODS

This was a quality improvement (QI) study conducted at Level III NICU of a large tertiary hospital of South India from October 2018 to February 2019. All babies connected to nasal bCPAP in Level III NICU were included in the study and those babies who already received nasal bCPAP before admission were excluded from the study. Baseline data were collected in the month of

October 2018 and intervention phase was from November 2018 to February 2019. A QI team was formulated and the team leaders included the administrators, head of the department of neonatology, staff of pediatric and neonatology departments, and nursing and support staff. The Ethical Committee clearance was taken and a written consent of the parents or baby's relative was sought before starting the QI initiative.

Problem indicator or outcome indicator was decided using the formula: Number of babies who developed nasal trauma following nasal bCPAP divided by total number of babies who were connected to nasal bCPAP in any given time multiplied by 100.

Baseline data were recorded over a period of 1 month from October 1, 2018, to October 31, 2018. A short questionnaire was prepared to find out awareness regarding the method of the application of nasal bCPAP and monitoring during the period of its use from the residents and nursing staff. Change ideas were formulated after discussion with team members and plan, do, study, and act (PDSA) cycles were formulated. Trauma grading was done as Stages I, II, and III.

There were four PDSA cycles that were conducted. The first PDSA cycle of training, the nurses were undertaken for a period of 1 month. All the nursing staffs of Level III NICU were asked to complete a questionnaire to assess their basic knowledge of indications, mechanism, application, settings, and complications of nasal CPAP. After the first evaluation, lectures and small group discussion with each shift nurse was introduced to improve knowledge and communication. After the classes, the staff answered the questionnaire again. The training included the use of proper sized nasal prongs and caps, demonstrating steps of the application of nasal bCPAP, and securing its tubing. The importance of maintaining the required position of head and nasal prongs was stressed on and the position was checked once per shift and twice in the night shift. Appropriate temperature and humidification were checked, and crusting in and around the nose was prevented by the use of nasal drops and suctioning if required.

The second PDSA cycle involved training doctors was undertaken for the next 1 month and this included a similar questionnaire-based evaluation and training of doctors who were posted in Level III for that month. The third PDSA cycle involved the use of gel plaster over nasal septum for 1 month. This cycle included demonstration and initiation of the use of gel plaster dressing (Duoderm) as the first plaster before the application of Velcro plaster for CPAP. This gel plaster was applied at the upper lip along with a small strip over the nasal septum at the right angle to the first one.

The fourth PDSA cycle involved formulating a written policy and the use of high-flow nasal cannula (HFNC) intermittently if feasible. This was also undertaken for 1 month. A written policy was made available to the nursing staff and treating doctors which included all the steps followed in the initial PDSA cycles. The cycle included shifting the baby from CPAP to HFNC intermittently in case of erythema (Grade I trauma) at the septum if the baby was clinically stable.

Root cause analysis was done using Pareto principle and fishbone analysis. Pareto principle revealed that 80% of nasal injuries were due to lack of awareness and education regarding proper technique among staff and lack of policy and supervision of the method of application. Fishbone analysis was done to find the issues related to persons, policy, material, and method responsible for the high incidence of nasal trauma following nasal CPAP (Fig. 1).

Data were collected weekly and reviewed during the meeting of the team members monthly. Data analysis was done at the end of each PDSA cycle using run charts.

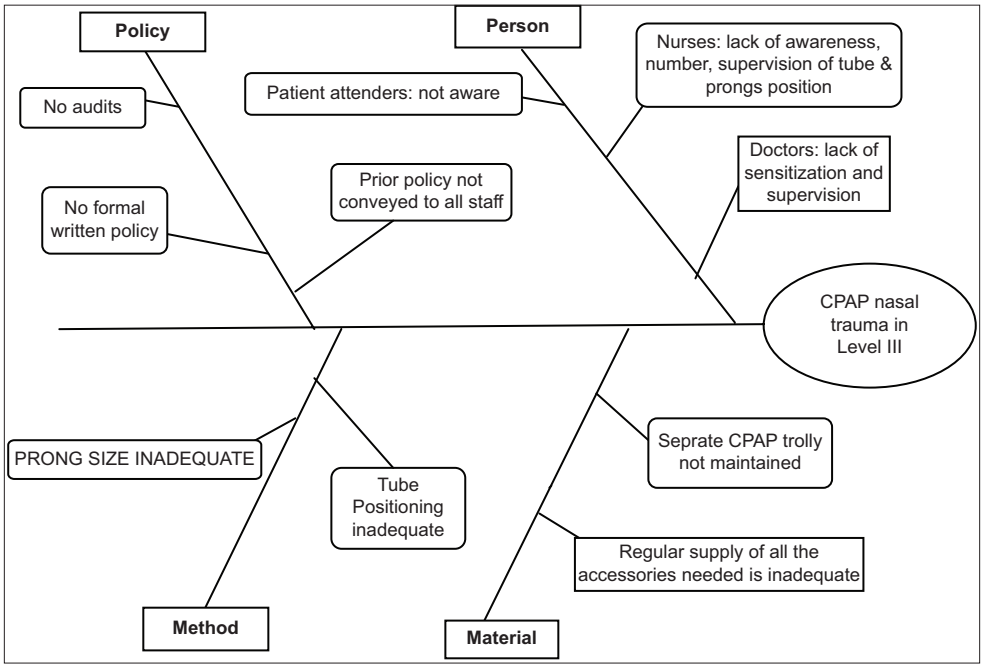

Figure 1: Fishbone analysis

RESULTS

The total number of babies connected to CPAP at baseline was 31. Nasal septal injury was noted in 79% (25) of the babies connected, of which Grade I trauma was noted in 19% (6), Grade II was noted in 25% (8), and Grade III trauma was noted in 35% (11) of the total babies connected. A total of 91% (10) out of these 11 babies were very low birth weight.

The PDSA cycle 1 decreased the incidence of nasal trauma from 79% to 60%, Grade I trauma to 14% (from 19%), Grade II to 21% (from 25%), and Grade III to 25% (from 35%), as shown in Fig. 2.

The second PDSA cycle decreased the incidence of nasal trauma from 60% to 52%. Grade I trauma reduced to 12% (from 14%), Grade II to 20% (from 21%), and Grade III to 20% (from 25%). The third PDSA cycle decreased the incidence of nasal trauma from 52% to 32%. Grade I trauma reduced to 16% (from 12%), Grade II reduced to 12% (from 20%), and Grade III trauma to 4% (from 20%), as shown in Fig. 3. The fourth cycle decreased the incidence of nasal trauma from 32% to 26%. Grade I trauma reduced to 16% (from 17%), Grade II trauma to 9% (from 12%), and Grade III trauma reduced to 0% (from 4%). Data derived from the baseline recording and intervention phase PDSA cycles were plotted on run charts (Figs. 4 and 5).

DISCUSSION

Nasal trauma is one of the most common complications of NCPAP therapy. The incidence was noted as 79% in the present study which was higher than that observed in the studies by do Nascimento *et al*., Fischer *et al*., Robertson *et al*., and Yong *et al*. [20-22]. In the present study, for minimizing nasal trauma, hydrocolloid patch cut was used which was economical in comparison to the commercially available NCPAP dressings. This was in accordance with the studies by Yong *et al*., Jatana *et al*., and Günlemez *et al.* [23-25]. However, Collins *et al*. demonstrated that the use of protective dressings was not associated with decreased nasal trauma for infants on NCPAP [26].

The most important step in our QI project was a stable fixation method which prevented exertion of any pressure on the septum as the prongs and the attached unit moved en masse with the head movement. This finding was in accordance with the previous study done by Collins *et al*. [26]. A written standardized protocol and supervision of its implementation were of utmost importance of this QI initiative. This was in accordance with the study done by Chen *et al*. [27].

The strengths of the study included the ease with which the steps can be applied at any facility where NCPAP is being used Duoderm or any equivalent gel plasters can be made available at these facilities. The study had a few limitations. The result of QI initiative would tend to wane if a proper monitoring or auditing system would not be in place. The Hawthorne effect (change in

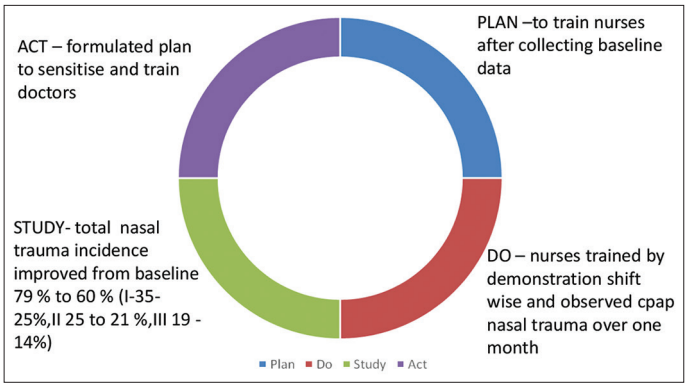

Figure 2: Plan, do, study, and act cycle 1

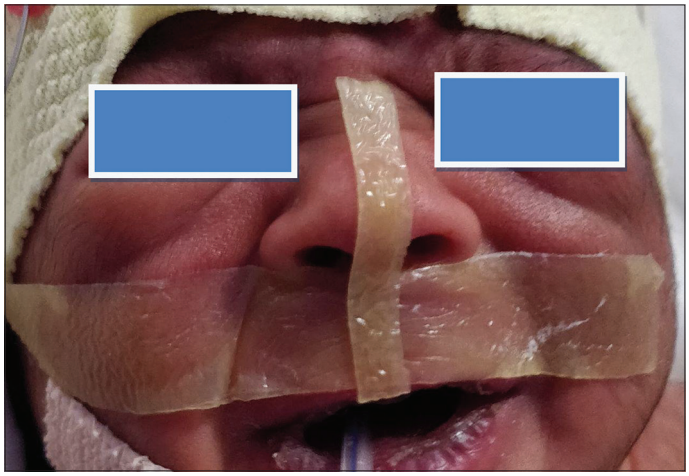

Figure 3: Gel plaster application

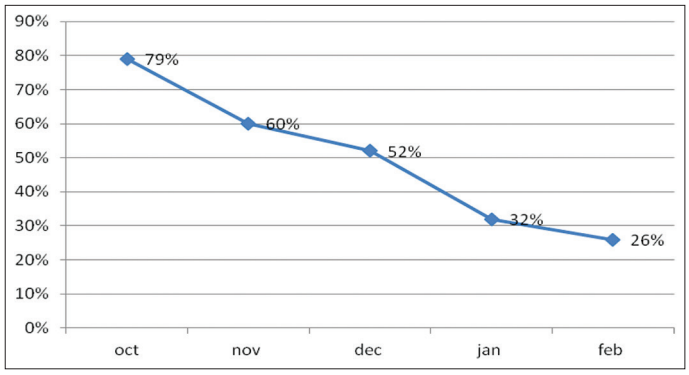

Figure 4: Percentage decrease in total cases of nasal trauma from baseline of 79% in October 2018 to 26% in February 2019 plotted on a run chart

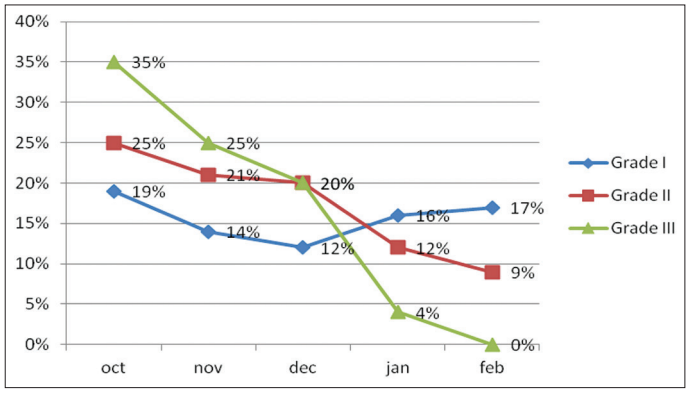

Figure 5: Change in percentage of individual grade of nasal injuries from baseline in October 2018 to February 2019

behavior when people get aware of being watched) could not be totally mitigated.

CONCLUSION

A simple method of training the staff and use of barrier gel plaster and maintaining policy can go a long way in reducing NCPAP trauma substantially and hence help in reducing hospital stay, morbidity, and probably also sepsis-related mortality. The steps used toward attainment of the objective were simple and reproducible at any health facility even in resource-poor settings with inadequate nursing staff for monitoring.

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