Abstract of thesis entitled

An evidence-based guideline for prevention of skin breakdown and nasal injury associated
with nasal continuous positive airway pressure in neonatal intensive care unit

Submitted by

SZETO WING HAN

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at The University of Hong Kong

in August 2015

Respiratory diseases are a leading cause of infant mortality and morbidity in preterm population. Unfortunately, those preterm newborns have higher chance to suffering from Respiratory distress syndrome (RDS), also called Hyaline membrane disease (HMD), due to their anatomic pulmonary system immaturity. In Hong Kong, same as oversea practice, nasal continuous positive pressure (NCPAP) is a standard ventilation mode to provide respiratory support to the neonates with respiratory diseases, thus the number of preterm babies with CPAP in NICU has increasing trend in this decade. Moreover, since the practical guidelines about NCPAP application in different hospitals are various, this may confuse the nurses that how to provide the standard and evidence-based nursing care to the neonates receiving NCPAP, especially how to prevent the NCPAP-related skin breakdown and nasal trauma. This dissertation aims to evaluate the current evidence on the NCPAP application for preterm babies and to develop an evidence-based guideline for prevention of skin breakdown and nasal injury associated with NCPAP.

Three electronic databases including PubMed, Medline and CINAHL were searched. Total six studies met the preset inclusion criteria for this dissertation, and the quality of those eligible
studies were evaluated by using a critical appraisal tool – Scottish Intercollegiate Guideline Network (SIGN). All studies were graded as high quality and showed that implementation of various nursing interventions (i.e. application of protective dressing) both are effective to reduce the incidence of NCPAP related skin breakdown and nasal injury among the newborns.

Afterwards an evidence-based guideline was developed which transferring the current evidence into a practical guideline to the local-setting neonatal intensive care unit (NICU). In addition, this proposed evidence-based guideline should be feasible after the consideration about available resources, approval methods, administrational support and staff competency. And the guideline is definitely benefit to the patients, nurses, healthcare professional, pediatrics department and the hospital. To facilitate the success of the guideline implementation, a three-month pilot program should be carried out. The estimated material cost was HKD $26100 and the non-material cost was HKD $7440 that total HKD $33540 was cost in this three-month pilot study. Furthermore, the estimated cost is HKD $111840 per year to implement the innovation annually.

A twelve-month implementation programme was designed and as scheduled including approvals seeking, stakeholders communication, project team set-up, guideline promotion, staff training, implementation and review of pilot study, six-month clinical implementation and evaluation. To evaluate the proposed innovation and the guideline, the outcomes will be evaluated into three categories – patients, NICU nurses and the pediatrics department. First, the patients outcomes will be measured by the incidence of NCPAP related nasal skin injury, duration of NCPAP application, location(s) of developed NCPAP related skin injury, total score of nasal trauma score (NTS) and the length of NICU stay. Second, nursing staff outcomes including their satisfaction and compliance towards the guideline. Third, to the department, the comparison between the material and non-material costs and project benefits will be done in evaluation part.
An evidence-based guideline for prevention of skin breakdown and nasal injury associated with nasal continuous positive airway pressure in neonatal intensive care unit

Submitted by

SZETO WING HAN

BNurs, RN

A thesis submitted in partial fulfillment of the requirement for the Degree of Master of Nursing at the University of Hong Kong

August 2015
DECLARATION

I declare that this dissertation represents my own work, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

(Sign) ___________________________

SZETO WING HAN

August 2015
ACKNOWLEDGEMENTS

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I would also like to thanks my family, classmates, hospital colleagues who showed their grateful support and encouragement for me to complete the dissertation and my Master of nursing study course.
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### Abbreviations

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<th>Abbreviation</th>
<th>Definition</th>
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<td>AARC</td>
<td>American Association for Respiratory Care</td>
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<td>APN</td>
<td>Advanced practice nurse</td>
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<td>BW</td>
<td>Body weight</td>
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<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
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<td>CO₂</td>
<td>Carbon dioxide</td>
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<td>COS</td>
<td>Chief of service</td>
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<td>CPAP</td>
<td>Continuous positive airway pressure</td>
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<td>DOM</td>
<td>Department Operations Manager</td>
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<td>EBP</td>
<td>Evidence-based practice</td>
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<td>ETT</td>
<td>Endotracheal tube</td>
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<td>HHHFNC</td>
<td>Heated humidified high-flow nasal cannulae</td>
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<td>HK</td>
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<td>HMD</td>
<td>Hyaline membrane disease</td>
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<td>IMV</td>
<td>Invasive Mechanical Ventilation</td>
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<td>MO</td>
<td>Medical officer</td>
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<td>NC</td>
<td>Nurse consultant</td>
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<tr>
<td>NCPAP</td>
<td>Nasal Continuous Positive Airway Pressure</td>
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<td>NICU</td>
<td>Neonatal Intensive Care Unit</td>
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<td>NPT</td>
<td>Naso-pharyngeal tube</td>
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<td>NSCS</td>
<td>Neonatal Skin Condition Scale</td>
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<td>NTS</td>
<td>Nasal Trauma Score</td>
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<td>PICO</td>
<td>Patient Intervention Comparison Outcome</td>
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<td>RCT</td>
<td>Randomized Controlled Trials</td>
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Chapter 1 – Introduction

1.1 Background

Respiratory diseases are a leading cause of infant mortality in United States of America (USA), the preliminary infant mortality rate was 0.9 per 1000 live births that the total number was 514 (U.S. Department of Health and Human Services, 2012). By compared, the infant mortality rate of Hong Kong is below the international statistics. However, respiratory diseases were one of top five contributing cause in infant’s death in 2012 (General Statistics Section, 2013a). Also, the proportion of infant’s mortality due to hypoxia has increased trend from 1.3% in 1951 to 10.8% in 2000 (General Statistics Section, 2013b). These data show the need to review the strategies for management of infants with respiratory diseases.

Respiratory distress syndrome (RDS), also called Hyaline membrane disease (HMD), which caused primarily by the inadequate pulmonary surfactant that the agent for lowering the pulmonary surface tension and remaining partially expanded alveolus during expiration (Khilnani, 2009). Due to the anatomic pulmonary system immaturity, RDS is one of the common acute respiratory diseases. It increases the work of breathing and causes the need of extra oxygen and assisted ventilation in preterm newborns (Karotkin, 2011) less than 37 completed gestation weeks (World Health Organization, 2014a). And the incidence of RDS is inversely proportional to the gestational age and birth weight, that affecting 40-50% of all infants under 32 weeks gestation (Mupanemunda &Watkinson, 2005) and occurring in 44% of all preterm infants with birth weight between 501 and 1500 grams (Gomella, Cunningham & Eyal, 2009).
Nowadays, to minimize the lungs injury and to preserve the functional properties of surfactant (Cloherty, Eichenwald, Hansen & Stark, 2012), insertion of endotracheal tube (ETT) for surfactant administration is one of the standard treatments to care the babies with RDS (Gomella, Cunningham & Eyal, 2009). Morley et al. (2008) showed that early Nasal Continuous Positive Airway Pressure (NCPAP) administration is closely related to less surfactant use and less mechanical ventilation exposure. And, early NCPAP application is encouraged to keep the alveoli open for promoting gas exchange and to reduce the work of breathing of preterm newborns with RDS (Bohlin, 2012). A study showed the use of neonatal CAP in preterm neonatal population has increasing trend since 2001, that from 18.1/1000 to 32.7/1000 livebirth in 2001-2008 (Roberts et al., 2011). This trend shows the management of neonates with CPAP should be one of the main focus fields in NICU nursing.

Furthermore, there are many complications associated with NCPAP administration, such as malposition interface, carbon dioxide (CO$_2$) retention, skin breakdown, nasal trauma, decreased gastrointestinal blood flow, pneumothorax and secretion obstruction (Karotkin, 2011). For the preterm infants receiving NCPAP, due to the immature and fragile skin, they may prone to develop pressure-related nasal trauma (Merenstein & Gardner, 2006) and facial skin injury that related to the fixation of the equipment by using adhesive materials (LeBlanc & Baranoski, 2011). Furthermore, about 50% of pediatric pressure ulcers are associated with medical devices and equipment (Willock et al., 2005). And the study of Fujii et al. (2010) showed the incidence of pressure ulcer in NICU was 16% and 50% of these cases were located on the nasal skin. All these findings showed the essential for healthcare professional to understand the complications of NCAP application and to recognize the proper way to use the NCPAP devices, for prevention of nasal trauma and skin breakdown associated with NCPAP application in NICU.
1.2 Affirming the need

Globally, about 15 million preterm babies were born annually and the number keeps increasing (World Health Organization, 2014), and about 7-12% of preterm deliveries occurred in developed countries (Lissauer & Fanaroff, 2011). Furthermore, the complications of prematurity cause almost 1 million newborns die every year. For enhancing the survival chance to these premature babies, close vital signs monitoring and intensive life support care are necessary. Thus, the demand of NICU services keep increasing throughout the world and the preterm newborns become the majority patient group in NICU. Since the structure and function of preterm babies’ respiratory system is not mature enough, most preterm newborns need assisted ventilation support after delivery. In addition, to maintain sufficient respiratory function, CPAP is the primary respiratory support mode for providing positive pressure to maintain the airway patency and to prevent lung collapse (Sinha, Miall & Jardine, 2012).

To prevent the prolonged ETT intubation and ventilator associated complications, NCPAP is the standard initial treatment to the neonates with RDS for reducing the need of endotracheal intubation and mechanical ventilation (MV). And the delivery systems of NCPAP could be nasal prongs and nasal masks for preterm neonates. In current clinical practice, NICU nurses need to decide which size of prongs or masks are fit for the neonates and also responsible to achieve the adequate seal between the interface and the nares to prevent air leak of the CPAP delivery system. There is no doubt the adequate seal between the interfaces and the neonates’ nares is important for ensuring the persistent positive airway pressure can be delivered from the CPAP system to the neonates (Karotkin, 2011). About the NCPAP application and the related nursing care to the neonates receiving NCPAP, most nurses are based on their own clinical judgments. And the nursing practice of NCPAP application and related nursing practices are not consistent and varies among the nurses, who have different experience and practice styles, in different local and oversea NICU. That
the various practices among different nurses may cause that the nursing care of the neonates receiving NCPAP cannot be implemented in a standard way in NICU. Since the practical guidelines about NCPAP in different hospitals are various, this may confuse the nurses that how to provide the standard and evidence-based nursing care to the neonates receiving NCPAP, especially how to prevent the NCPAP-related skin breakdown and nasal trauma. Furthermore, without any guidance criteria, the neonatal nurses may not be able to perform (1) specific and systematic assessment and (2) prevention strategies for device-related injury to the neonates with NCPAP in NICU. This may cause the neonates to develop NCPAP-associated nasal breakdown and skin injuries, those may cause the neonates to be exposed to the complications related to NCPAP application, such as altered physical appearance, pain and infection. Thus, developing an evidence-based guideline is an effective intervention for guiding the nurses to provide standardize and systematic nursing care to the neonates receiving NCPAP in NICU for preventing NCPAP-related skin breakdown and nasal injury. In addition, the benefit of implementing this guideline including reducing the risk of developing infection, shortening the length of NICU stay and reducing the financial cost that related to decreased incidence rate of NCPAP associated pressure ulcer (Baharestani & Ratliff, 2007).

In Hong Kong, same as oversea practice, NCPAP is a standard ventilation mode to provide respiratory support to the neonates with respiratory disorders. NCPAP application and related nursing care practices are various among different local hospitals, and no formal EBP protocol or guideline is well developed in all NICU among the public hospitals. Obviously, to develop and to implement an evidence-based guideline for prevention of skin breakdown and nasal injury associated with NCPAP in NICU is an essential clinical issue in Hong Kong.
1.3 Objectives and significance

To establish and facilitate an evidence-based guideline for prevention of skin breakdown and nasal injury associated with NCPAP in NICU, the following objectives of this dissertation should be achieved.

1. To evaluate current evidence about the prevention of skin breakdown and nasal injury associated with NCPAP in NICU
2. To critically appraise various clinical practices about the prevention of NCPAP-associated skin breakdown and nasal injury in local setting
3. To develop an EBP guideline for preventing NCPAP-associated skin breakdown and nasal injury in NICU
4. To assess the transferability and feasibility of implementing the guideline in NICU in a local public hospital
5. To contrive an implementation and evaluation plan for assessing the utilization of the proposed guideline in the local setting

The establishment and implementation of evidence-based guideline to prevent NCPAP-related skin breakdown and nasal injury would provide multiple benefits to in different aspects. For patients, an evidence-based guideline would facilitate the standard and effective strategies to reduce the incidence of NCPAP-related pressure ulcer that associated to the lower morbidity, mortality and the length of NICU length. Also, it can enhance the safety and efficiency when the neonates receiving NCPAP which able to reduce the chance of developing CPAP-associated complications. For NICU nurses, an EBP guideline can let the them perform the evidence-based and standard care to the newborns, this can enhance the quality of nursing care in NICU, and their work efficiency and confidence would be improved. For healthcare organization, an evidence-based guideline would reduce the neonatal mortality and morbidity and the length of NICU stay. All of them can relieve the financial and services burden of the public healthcare sector.
Chapter 2 – Critical Appraisal

2.1 Search and appraisal strategies

2.1.1 Identification of studies

Patient Intervention Comparison Outcome (PICO) framework was used to develop the searching strategies in databases and to generate the research question (Courtney & McCutcheon, 2010). In this study, Patient (P) was targeted as the newborns, infants or neonates that <28days of age in NICU (World Health Organization, 2014b); Interventions (I) includes applying different NCPAP interfaces- nasal mask/ nasal prongs and applying protective dressing for preventing NCPAP-related pressure ulcer; Comparison (C) were different NCPAP interfaces and no protective dressing; Outcome (O) was decreased incidence of NCPAP associated nasal injury and skin breakdown.

To identify the studies, a systematic literature search was carried out in three electronic databases including PubMed, Medline and CINAHL in August 2014. The searching keywords were ‘Preterm’, ‘Infants’, ‘Newborns’, ‘NICU’, ‘Nasal injury’, ‘Nasal trauma’, ‘Skin injury’, ‘Skin breakdown’, ‘Skin care’, ‘CPAP’ and ‘NCPAP’, and all keywords were used in three databases consistently. To screen the searching results, the title and abstracts were screened first to identify the articles that meet the selection criteria, then the full text of the selected articles were retrieved to ensure the eligibility. And only literatures in English and Chinese version were recruited. To show the details of the literature search, PRISMA flow diagram (Moher, Liberati, Tetzlaff, Altman & The PRISMA Group, 2009) has been used to present the process (Table 1). Also, for ensuring the guideline can meet the current clinical needs, only the articles that were published within 2004-2014 were selected.
Table 1. PRISMA flow diagram

Records identified through database searching (n = 36)

Additional records identified through other sources (n = 0)

Records after duplicates removed (n = 23)

Records screened (n = 21)  Records excluded (n = 2)

Full-text articles assessed for eligibility (n = 19)  Full-text articles excluded, with reasons (n = 2)

Studies included in qualitative synthesis (n = 0)

Studies included in quantitative synthesis (meta-analysis) (n = 6)

(Moher, Liberati, Tetzlaff, Altman & The PRISMA Group, 2009)
2.1.2 Selection criteria

Studies were included that meet all of the following criteria:

1. Target population of the study was the newborns and neonates that <28 days of age receiving NCPAP in NICU
2. Provide interventions to prevent NCPAP associated nasal injury and skin breakdown
3. The study design included randomization
4. Prevalence or the degree of the NCPAP associated skin breakdown or nasal injury as an outcome measure

Studies were excluded that meet any of the following criteria:

1. Target patients was adult or pediatrics population
2. Recruited infants in the studies were present of congenital facial malformation or congenital heart diseases
3. The articles were systematic review designed

2.1.3 Data extraction

The extracted data of the eligible studies were used to do the further analysis, including study design, sample size, patient characteristics, interventions, comparison, outcome measures and effect size. All these data were reviewed and analyzed, and being integrated into the Table of evidence (Appendix 1).
2.1.4 Appraisal strategy

For developing an evidence-based guideline, the recruited evidence should be reviewed and evaluated in a systematic way. The checklist from Scottish Intercollegiate Guidelines Network (SIGN) was used to be a tool to do the critical appraisal to assess the methodological quality and to perform the overall assessment to the study into different sections for ensuring the internal validity of individual study (Scottish Intercollegiate Guidelines Network, 2012a). After performing systematic critical appraisal to the study. According to the coding system that suggested by the handbooks from SIGN was used to grade the level of evidence and the code was 1++, 1+, 1-, 2++, 2+, 2-, 3 or 4 (Scottish Intercollegiate Guidelines Network, 2011). The details of the grading in this study can be found in Appendix 2, which is one of the practical steps to establish and implement the evidence-based guideline.

2.2 Results

2.2.1 Search results

The keyword search was conducted from 01 August 2014 to 23 August 2014 in three previous mentioned databases and total 141 papers were retrieved. Then, two papers in Spanish and the duplicate result were excluded in this appraisal. By using the title and abstract, 23 were screened out as potentially relevant to the topic and then the result was limited to the studies that with randomized experimental design, then total 5 RCTs and 2 prospective controlled studies were selected. Then, after limiting the publication years of the selected articles between 2004-2014, only 4 RCTs and 2 prospective controlled studies were retrieved. Afterwards, the full texts of all retrieved studies have been screened out and read in details. Then, based on the inclusion and exclusion criteria, total 6 articles have been screened out as eligible studies.
2.2.2 Study characteristics

Total 4 RCT studies and 2 prospective controlled studies were retrieved as eligible. Those studies were conducted in different countries between 2004-2014 in Switzerland (Buettiker, Hug, Baenziger, Meyer & Frey, 2004), in Malaysia (Yong, Chen & Boo, 2005), in Turkey (Gunlemez, Isken, Gokalp, Turker & Arisoy, 2010), in Australia (Collins, Barfield, Horne & Davis, 2014), in the United States of America (USA) (Newnam, McGrath, Salyer, Estes, Jallo & Bass, 2014) and in China (Xie, 2014). All 4 RCT studies can reach the level of evidence 1+, and other 2 prospective controlled studies can reach the level of evidence 2+.

The target population of all studies was neonates and infants receiving NCPAP in NICU, which included preterm and extreme low birth weight babies. All 4 RCT studies (Buettiker et al., 2004; Collins et al, 2014; Newnam et al., 2014; Yong et al., 2005) have compared the effectiveness of applying different kinds of NCPAP interfaces to prevent NCPAP-related skin breakdown and nasal injury. And, the brands and types of different NCPAP application devices have been clearly described in all studies. Buettiker et al. (2004) showed the severity of nasal injuries related to different NCPAP delivery systems. Yong et al. (2005) mentioned the relationship between the NCPAP duration and the incidence of the nasal trauma. In addition, all 6 retrieved studies used the incidence of nasal injury or trauma to measure the outcome. 4 studies also described the severity of skin breakdown and nasal injury related to NCPAP application (Newnam et al., 2014; Buettiker et al., 2004; Gunlemez et al., 2010; Xie, 2014). Collins et al. (2014) has mentioned the use of modified ‘Nasal trauma score’ to indicate the study outcome. In addition, only one RCT studies (Collins et al, 2014) and 2 prospective controlled studies (Gunlemez et al., 2010; Xie, 2014) mentioned the use of protective dressing for prevention of NCPAP-related nasal injury.
2.2.3 Methodological quality

To ensure the validity and reliability, the methodological designs of each study should be assessed individually (Burns & Grove, 2009), and the SIGN checklist for controlled trials in Appendix 3 was used as an assessment tool this time (Scottish Intercollegiate Guidelines Network, 2012b), and the assessment checklists of the studies listed in Appendix 4. Based on SIGN checklist, different criteria of the study should be checked for assessing the internal validity, and the checklist has been conducted to the retrieved studies. All studies have been clearly stated the focus question and described the target population. For the sampling recruitment and sample group assignment, all six studies have using randomization method to minimize the bias in affirming treatment effects. And Buettiker et al. (2004), Yong et al. (2005), Xie (2014) and Gunlemez et al. (2010) have not mentioned the details about the randomization method. Collins et al. (2014) used computerized method to do the randomization that using statistical software –STATA to produce the random number sequence and stratified by the gestational age. Newnam et al. (2014) used randomized sequential number to determine the group assignment. For concealment method, Yong et al. (2005), Collins et al. (2014) and Newnam et al. (2014) both used randomized sequential, opaque and sealed envelope to do the concealment. Buettiker et al. (2004), Xie (2014) and Gunlemez et al. (2010) have not mentioned the details about concealment method in the article. Although the study target of all studies was newborns with NCPAP, all 6 eligible studies have obtained the parental informed consent before recruiting the neonates to the studies. Furthermore, all studies have clearly stated that the corresponding review board or ethics committee has approved their studies. These definitely can benefit the studies through enhancing the validity of the findings (Polit & Beck, 2010). For blinding, all studies have not addressed the need of blinding, since the NCPAP devices, observation and the relative care were provide by NICU nurses, respiratory therapist or assigned team members.
The total number of recruited neonates and the number of assigned neonates of each experimental group have been well documented in all studies. Furthermore, for group allocation and to provide a fair experimental environment, the basic characteristics of the neonates (i.e. demographic data, diagnosis, birth weight, gestation age and CPAP setting) have been collected to do the basic measurement in all studies, and of them reported that no significant differences between the patients in the groups receiving different assigned interventions. For eliminating the significant difference factors, Buettiker et al. (2004) was the only study to do the group assignment that according neonates’ birth weight before randomized experimental group allocation of NCPAP-related interventions within the group, and showed the result separately in different weight groups. Gunlemez et al. (2010) and Newnam et al. (2014) have compared the neonates’ body weight among the experimental groups during analyzing the result. Yong et al. (2005) have limited the birth weight of the recruited infants should be $\leq 1501$g. Collins et al. (2014) and Xie (2014) both have mentioned the average birth weight that as baseline characteristics at randomization.

In all studies, the outcome has been measured in a standardized, reliable and valid way, in addition, the result have been stated clearly in all articles. In Buettiker et al. (2004), the degree of nasal injuries was graded into three stages and the symptom of each stage has been well defined. In Yong et al. (2005), the type of nasal trauma has been defined into five groups (redness, bleeding, crusting, excoriation and narrowing of the passage) and the trained investigators observed the recruited infants daily, additionally the initial investigator could ask for the second opinions from another investigator to define the nasal trauma for reducing the observer bias. In Newnam et al. (2014), the Neonatal Skin Condition Scale (NSCS) has been used to grade the skin breakdown condition based on the clinical outcome (Lane & Drost, 1993). In Collins et al. (2014), the modified nasal trauma score chart (Table 2) has been used to record the measurable outcome about the condition of nasal trauma. Gunlemez et al. (2010) and Xie (2014) both use the incidence and the severity of nasal injury (mild, moderate and sever) to indicate the outcome.
Table 2. Nasal trauma score chart  (Collins et al., 2014)

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Score: 0=normal, 1=pink/red, 2=bleeding/ulcer/scab, 3=skin tear

Buettiker et al. (2004), Yong et al. (2005), Gunlemez et al. (2010), Xie (2014) and Newnam et al. (2014) mentioned no dropout patients in their studies. Collins et al. (2014) mentioned that total 33 patients were dropped out from the study, as 15 patients were dropped out due to the re-intubation and 18 patients were changed to other NCPAP devices rather than the previous assigned one, due to the development of apnea and nasal injuries. In addition, only Collins et al. (2014) and Newnam et al. (2014) have applied the intention-to-treat analysis to provide an unbiased estimation for assessing the effectiveness of the experimental intervention at the level of adherence and variations in compliance that observed in the clinical trial (Montori & Guyatt, 2001). And no studies have mentioned the drop out percentage. Furthermore, only Newnam et al. (2014) was conducted the study in different NICU that located at southeastern United States, and other studies only located in NICU for selected hospital.
2.3 Data summary and synthesis

Total 4 retrieved studies were RCT designed and the evidence level was high (Level 1: 1+). (Buettiker et al., 2004; Yong et al., 2005; Collins et al., 2014 and Newnam et al., 2014) And other 2 studies - Gunlemez et al. (2010) and Xie (2014) were prospective controlled studies and the evidence level was level 2: 2+.

For the patient’s characteristics, all studies eligible the infants based on their body weight and gestational age. The range of mean birth weight for all retrieved studies was 801-1945 grams. And Yong et al. (2005) and Newnam et al. (2014) focused on the neonates with low birth weight that less or equal to 1500 grams. The range of mean gestation weeks for the neonates in all retrieved studies was 26.77-33 weeks. But, only Collins et al. (2014) set the gestation week (smaller than or equal to 32 weeks) to be one of the inclusion criteria in the study. For the population size, only Newnam et al. (2014) conducted the study in different NICU in the southeastern United States. The population sizes of all study were relatively small, ranging from 40-179 in all retrieved studies. And only Collins et al. (2014) has mentioned the calculation of sample size, others studies have not mentioned the calculation of sample size in the journal articles.

The interventions were various and quite different among the retrieved studies, but this could be categorized into three major types – Nasal interfaces, NCPAP delivery system and nasal protective dressing. And all studies investigated about the association between the interventions and the development of nasal trauma and skin breakdown. Furthermore, Collins et al. (2014) was an only RCT study studying the effectiveness of the nasal dressing to prevent the NCPAP related pressure ulcer, this study also studied the association between the incidence of nasal trauma and CPAP delivery systems – Heated humidified high flow cannula (HHHFNC) and NCPAP. HHHFNC is a non-invasive positive pressure respiratory support system that having shorter and
narrowes prongs than NCPAP system, which presumes cause less nasal injury than NCPAP system. Gunlemez et al. (2010) and Xie (2014), both were prospective controlled design that studied about the effectiveness of silicon gel sheeting and hydrocolloid dressing to reduce the incidence of NCPAP associated nasal injury respectively. Buettiker et al. (2004) studied about different types of NCPAP system contributed to the nasal trauma, this study specifically recruited the brand of nasal interface – Hudson which is a soft and automatically curved NCPAP cannula that claimed to design for reducing the NCPAP associated nasal trauma (Teleflex, 2014). And only Newnam et al. (2014) studied the relationship between the presence of nasal trauma and the method of applying nasal interfaces (continuous applying or rotation applying). Since all studies compared that difference between various types of nasal devices or non-invasive respiratory assistance systems, thus no similar control could be identified from all retrieved studies.

For the outcome measures, incidence rates of NCPAP-related pressure ulcer were measured in all studies. Three studies, including Buettiker et al. (2004), Yong et al. (2005) and Newnam et al. (2014) have measured the CPAP duration to study the effectiveness of the interventions to delivery continuous and steady positive airway pressure. Buettiker et al. (2004) and Xie (2014) set up the categories of nasal injuries into mild, moderate and severe to describe the degree for further analysis. Collins et al. (2014) and Newnam et al. (2014) used the Nasal trauma score (NTS) and Neonatal Skin Condition Scale (NSCS) respectively for measuring the degree of nasal trauma in an objective and numeric way. Furthermore, various definitions of nasal trauma and skin breakdown were adapted in the studies.

For the effect size, all studies showed no significant difference between different nasal devices or NCPAP delivery systems that related to reduce the CPAP duration. Buettiker et al. (2004) showed that the association between the nasal interface – Hudson and the incidence of nasal injury was significant. In Yong et al. (2005), the difference between the nasal mask and prongs application related to the nasal trauma was not significant. But the duration of the NCPAP showed the
significant relationship with the development of nasal injuries. In Collins et al. (2014), HHHFNC application had significant less incidence of nasal injury when compared with NCPAP. And this study concluded that the nasal protective dressing not able to prevent NCPAP associated nasal trauma significantly. Gunlemez et al. (2010) demonstrated the application of silicon gel could decrease the incidence of NCPAP associated nasal trauma and the finding was statistically significant (p<0.05). And Xie (2014) showed that applying hydrocolloid dressing was able to decrease the incidence and the severity of NCPAP related nasal injury and the finding also was statistically significant (p<0.05). Newnam et al. (2014) showed the relationship between the less nasal trauma incidence and the rotated application of nasal mask and prongs was statistically significant.

All in all, this review of the current evidence supported that reduction of NCPAP duration, alter the NCPAP interfaces and the selection of NCPAP devices should according to the neonates’ weight. For the NCPAP duration, Yong et al. (2005) concluded that the CPAP duration was an only significant contributed factor for enhancing the risk for the infants to develop device-related pressure ulcer. This implied the factors, which can reduce the NCPAP duration, also useful to reduce the chance of the newborns to develop the nasal and skin injury. There were many studies tried to find out which type of NCPAP interfaces can effectively reduce the chance of the patients to develop the nasal trauma, thus the study design always comparing the difference among the manufactured material and shape of various type of interfaces. But, only few studies investigated the practical application method between different interfaces. In this review, Newnam et al. (2014) tried to not only studying the difference between continuous nasal prongs and nasal mask application to the patient, the rotational application method of these two interfaces also introduced and the result showed it is significantly effective to reduce the rate of developing nasal trauma. This kind of practice was new and the further implementation was addressed. From this evidence review, the current weight of the neonates also suggested to be one of the essential factors for nurses to
choose the type of NCPAP device applied to the newborns for preventing the device-related pressure ulcer. In addition, as suggested by Buettiker et al. (2004), NCPAP prong system may have advantages to the infants with very low birth weight. Furthermore, the studies also suggested that since the heavier neonate has relatively higher mobility power, thus the displacement of NCPAP interfaces more likely to happen among them that the chance of developing nasal injury and skin breakdown was relatively enhanced due to the fiction between the device and the tissue. Thus, the skills and methods of NCPAP equipment fixation also should be one of the contributed factor to the development of NCPAP associated nasal injury. In addition, as supported by Gunlemez et al. (2010) and Xie (2014) also concluded that application of protective nasal dressing – hydrocolloid and silicon gel may able to reduce the incidence and severity of NCPAP related nasal trauma in the neonatal population. Last but not least, all studies have clearly stated that the development of nasal injury is closely associated with the longer NCPAP duration in the discussion part.
Chapter 3 – Translation and application

3.1 Implementation potential

The systematic critical appraisal of current literatures showed sufficient evidence supporting the application of fit-size NCPAP devises and protective nasal dressing is effective in reducing the incidence and the severity of NCPAP related pressure ulcer, also the NCPAP duration. Those findings supported the development of evidence-based practice guideline for improving the clinical outcomes and enhancing the quality of care. To assess the appropriateness of the innovation to the clinical setting, the implementation potential should be evaluated in three area, including transferability, feasibility and cost-benefit ratio (Pilot & Beck, 2010).

3.1.1 Transferability of the findings

Even the studies showed the sound evidence to support the effectiveness of the proposed innovations, the interventions still not able to be directly transferred into the local setting besides considering the transferability. To commit the successful innovation in the local clinical environment, Pilot & Beck (2010) suggested that the transferability relies on the types of target client, philosophy of care, benefits to the target patients, as well as the duration of implementation and evaluation. And the comparison in these aspects between the local setting and the studies will be done as follows.

Types of target client

The local setting is a NICU of a local public hospital in Hong Kong and the total number of available bed is 12. In fact, there was no specific statistical data available about this local NICU, thus the clinical data collection was carried in this NICU from September 2013 to September 2014 in the selected local setting. From the result, there were approximately 300 NICU admissions in this
period and about 90% admitted patients were premature babies with 24 to 37 gestational age, and there were about 95% of these admitted premature neonates required NCPAP for respiratory support. Thus, the target clients for this proposed EBP guideline are premature babies smaller than 37 gestational weeks and receiving NCPAP support in NICU.

From the eligible studies, firstly all six studies recruited the babies under NCPAP support and located in NICU. Secondly, for the gestational ages, except the study of Buettiker et al. (2004) which also recruited the full term babies that the range of gestation weeks of recruited infants was 28.7 to 40.7. Others five studies (Yong et al., 2005; Gunlemez et al., 2010; Collins et al., 2014; Newnam et al., 2014; Xie, 2014) recruited the premature neonates with 24-37 weeks. That the patient’s characteristics and the environment setting is highly similar with the target one.

**Philosophy of care**

Definition of philosophy of care is various among different people and settings, however, providing professional nursing care to the patients must be the ultimate goal of all healthcare providers. The Nursing council of Hong Kong announced the ‘Code of ethics’ to guide the behaviors of registered nurses, that a professional nurse is responsible to provide the high-quality care to the patients and keep improving the nursing care standard (Nursing council of Hong Kong, 2002). To enhance the standard nursing care, Hospital Authority keeps promoting and encouraging the implementation of evidence-based practice in Hong Kong public healthcare system. Since the philosophy of care for the local setting and the suggested innovation are on the same track, the evidence-based practice can be established and implemented with support.
Benefits to the target patients

Approximately 300 preterm neonates admitted into target NICU annually, and about 90% of them could be benefited from this EBP implementation. And other 10% preterm babies may not be benefited, since they may require the invasive mechanical ventilation support or may not need the respiratory support after NICU admission. Furthermore, the number of premature babies keeps increasing and the trend of NCPAP utilization in NICU keeps growing, thus the implementation of this EBP guideline should bring the benefits to the patients in local setting.

Duration of implementation and evaluation

The EBP guideline will be implemented as a pilot program in one local NICU. In preparation stage, it will take two months for guideline introduction, program promotion, staff training and material preparation. Then, a three-month pilot program will be carried out in the clinical area for data collection. And it requires one month for gathering the finding and the feedbacks from the clinical staff afterwards. Furthermore, the evaluation stage will be one-month interval and then a modified EBP guideline will be established for enhancing the effectiveness of the guideline in clinical area. That, the duration of implementation and evaluation will totally need seven months. Essentially, the findings and the modified EBP guideline will be informed and suggested to the management team if the clinical outcome of this program is benefit to preterm babies with respiratory diseases for reducing related clinical complications and shortening the duration of NICU stay.
3.1.2 Feasibility

For identifying the feasibility to utilize the innovation, Pilot & Beck (2010) suggested assessing following three parts: (1) availability of staff, (2) method, (3) organizational climate and (4) availability of resource.

Availability of staff

Doubtlessly, the availability of staff and resource must be an essential element to implement the innovation. Thus, to gain the trust and willingness from the staff, removal of their doubts before innovation application is necessary. First, to respect the professional autonomy, all nurses have their freedom and right to express their willingness and opinions about this guideline. Second, based on the previous successful experience to promote new clinical practice in this local setting, such as protocol-led CPAP weaning program, the training courses will be provided to all nursing staff for enhancing their knowledge and skills to implement the EBP guideline. For reducing the interruption of routine staff functions, the training courses will be located in the ward. Basically, this course includes two parts – theoretical and practical sessions. In theoretical session, the duration is 30 minutes that includes guideline explanation and skills demonstration. And in practical session, the skills of NCPAP interface applications and the related observation skills will be shown based on the guideline, also each staff is only required to attend both sessions one time only. To enhance the convenience and involvement, the teaching materials in electronic form (i.e. presentation slides and demonstration video) will be saved in every computer in the ward that the staff are able to do the revision at anytime. Moreover, to help the staff overcome the difficulties when applying the promoted guideline, the nurse consultant will provide help and support in clinical area during the implementation stage. All above interventions will be able to build up the confidence of staff to implement the innovation.
From the previous experience, some nurses will show the unwillingness to carry out the new clinical guideline and to reckon the innovation will bring the extra workload to them. Even only small portion of the nurses will demonstrate the uncooperativeness, their reaction still need to be considered that they will be invited to join the small-group discussion for expressing their concerns and doubts about this innovation. Furthermore, since applying NCPAP interfaces and the related observation are parts of NICU routine nursing care, that the staff only required to follow the guideline strictly, and the aim of this innovation is modify and standardize the NCPAP nursing care practice, no extra workload required. And the benefits and foreseeable positive outcomes will be explained to all nurses to gain their trust for building a supportive atmosphere in clinical environment.

Method

To implement the proposed guideline into the clinical area, a project team will be established. The nurse consultant (NC) in this unit will be the project director who has the right to continue or to terminate the innovation. This director is liable to monitor the progress of the project, to promote the communication among the clinical staff and the management team, and also needs to complete the evaluation after the pilot program. Moreover, all twelve advanced practice nurses (APN) will be assigned to be the core members of this project team and they are responsible to staff training, guideline introduction and preparation of relevant equipment. Also, they need to help NC to collect the clinical data and staff’s feedback for project evaluation. Every two APN will form a group provide clinical audit and routine assessment to ensure the skills of guideline utilization can meet the required standard in NICU. This team structure will provide a clear picture of work allocation and promote the efficiency, and since the work allocation of each group member is based on individual job duties that no extra manpower or cost needed.
Organizational climate

Before implement the innovation, the get the approval and support must be collected from Ward manager (WM) and Department Operations Manager (DOM). Since the successful experience to develop a protocol-led CPAP weaning program previously in this unit, the administrators should support the research utilization and evidence-based practice for enhance the quality of nursing care and promote the positive clinical outcome. To the clinical staff, an EBP guideline can enhance their job satisfactory, facilitate their daily work with evidence support and bring the benefits to the patients. Thus, a supportive organizational climate can be built up. Additionally, to gain the support apart from the nursing department, the medical officers who worked in this unit will be informed about the guideline utilization through email and they all will be invited to join the guideline planning group and introduction talk for getting their support to our project, and their professional opinions also will be welcome about guideline refinement and project implementation.

Availability of resource

When comes to resources, since all members in the project team are recruited from the ward that no extra manpower requited. To implement the guideline, there are two kinds of materials needed. For the NCPAP interface, rotation applying of NCPAP interfaces (nasal mask/ nasal prong) was suggested by above eligible studies to provide CPAP support to the preterm. In addition, the studies suggested applying the nasal protective dressing to the neonates with NCPAP, and hydrocolloid one was suggested (Xie, 2014). In this NICU, translucent NCPAP interfaces and hydrocolloid dressings both are already provided previously, and no studies were noticed to mention the difference between various brands of this materials applied, thus this innovation will simply choose the materials which available in this NICU already that no extra medical equipment purchased for this innovation. For reminding the staff to follow the guideline strictly, the step of NCAP device application will be printed in hardcopy and hooked near the incubators that can
enhance the convenience of the staff to follow the guideline. Thus, the resources to making printing materials are needed, such as computer software, printer and A4 papers. Furthermore, the computer with PowerPoint and a room and three babies dolls are required to provide lectures and skills practical sessions.

After three-month pilot program, the effectiveness of this EBP guideline will be evaluated into two aspects. To the clinical outcome, the incidence of NCPAP related nasal and skin injury and the duration of NICU stay both will be evaluated after finishing the program. To the staff, the compliance of the guideline and the skill to apply NCPAP interface both will be assessed during the whole innovation by NC and assigned team members, and all measuring tools are available in this unit already. In addition, the feedback and comment from the clinical staff will be collected all the time for promotes the improvement in the future clinical implementation of the EBP guideline.

3.1.3 Cost-benefit ratio of the innovation

The potential benefit of implement this guideline are to reduce the incidence of NCPAP related skin and nasal injury and to shorten the duration of NICU stay. Since this intervention may be able to minimize the NCPAP related complications, the relevant healthcare expenditure also can be reduced. Furthermore, the confidence and job satisfactory of the clinical staff should be enhanced if the positive clinical outcomes resulted. Also, to implement evidence-based clinical practice will be motivated in clinical area if this innovation can be implemented successfully. In addition, the EBP guideline can benefit the patients and enhance the standard of NICU nursing care that the social status of the ward and the hospital can also be enhanced. Moreover, the experience of this innovation implementation can be shared with other clinical professional and boost them to promote the application of EBP guideline in clinical area.

Even the hydrocolloid, which used as the nasal protective dressing, may cause the allergy
reaction to the neonates by clinical observation. However, firstly no reported allergy case reported from the eligible studies and second no case was noticed from previous clinical observation. Additionally, all above eligible studies showed the designed innovations could reduce the incidence of NCPAP related nasal injuries (Buettiker et al., 2004; Yong et al., 2005; Gunlemez et al., 2010; Collins et al., 2014; Newnam et al., 2014 and Xie, 2014). All these showed the innovation is worthy for taking the risk to terminate the current practice and apply the new guideline.

The cost needs to implement this innovation should be estimated into two parts: material cost and non-material cost. To implement this innovation, the required materials include NCPAP interface with cap and hydrocolloid dressing. For the NCPAP interface and cap, suggested type from the eligible studies is translucent NCPAP interfaces with no specific brand. According the price lists which provided by the sales from various manufactures, the average price of a set of translucent NCPAP interfaces with cap is $200. Based on the previous clinical observation, total 270 preterm babies admitted in NICU annually, and total 95% of them required NCPAP supported. Since the NCPAP interface and cap should be single-patient use and one baby need two types of nasal interfaces – nasal mask and nasal prong that total 256 x 2 = 512 (sets) could be used annually and the estimated cost in this item should be $102400 per year. For the hydrocolloid dressing, the sale package is 5 slides (4x4 inches) in a box and the charge of each box is $100. Estimably, one slide could be cut into 8 sets nasal protective dressings and each neonates may need 2 to 3 sets during the whole NCPAP duration, that total 20 boxes are needed to implement the guideline and the estimated cost in this item should be $2000 per year. Thus, the total expenditure in material supply is $104400 per year and the cost for the three-month pilot program is about $26100. Details in Appendix 5.

The cost of manpower is the major expenditure in this innovation, including teaching sessions and practical workshop. Total 40 NICU nurses (RN) will be recruited to attend both teaching and
practical sessions; also the training time of each session is 30 minutes. Thus, after the calculation, the estimated cost to the manpower cost is $7440. Details in Appendix 6.

To the 3-month pilot program, total estimated cost including material and non-material is $33540. To implement the innovation annually, the estimated cost is $111840 per year.

3.2 Evidence-based protocol

To develop the EBP guideline, the result and suggestions of total six eligible studies (Buettiker et al., 2004; Yong et al., 2005; Gunlemez et al., 2010; Collins et al., 2014; Newnam et al., 2014; Xie, 2014) were summarized and analyzed for developing the recommendations in the guideline. Furthermore, the recommendations were graded based on the guideline that published by Scottish Intercollegiate Guidelines Network (2012) (Appendix 7). Since total four studies were RCT designed and the target population of these studies both were highly similar to this innovations. The grade of most recommendations was high (i.e A/B) and the details shown in Appendix 8.
Chapter 4 – Implementation plan

4.1 Communication plan

To implement the guideline in the clinical area successfully including various factors, practically the first step should be identifying the stakeholders whose are able to affect and be affected by the guideline implementation potentially in different levels (Pilot & Beck, 2010). Then, to prioritize them that based on their degree of influence afterwards and it is essential to develop a comprehensive communication plan to facilitate the success.

4.1.1 Stakeholders analysis

The stakeholders could be prioritized into three levels including (1) administrators, (2) managerial staff and (3) operational staff respectively.

The administrators of the Pediatrics department include Chief of service (COS), Department operative manager (DOM), Medical Consultant, Nurse consultant and Ward manager (WM). To communicate with those administrators is essential for getting their approval and support to this project, because all of them have the authority to continue or determine the project, to manage and allocate the various kinds of resources.

The managerial staff includes advanced practice nurses (APN) who assigned by DOM and NC, the communication among the team is important because they are all responsible to prepare and coordinate the resources, introduce the guideline, promote the staff training, implement the pilot study, provide clinical supervision, monitor the progress, collect the clinical data and do project evaluation.

The operational staff include all frontline nurses and medical officers working in NICU. To
nurses, they are all responsible to apply the guideline into clinical area and to monitor the physical condition of the neonates. To doctors, they may worry about the guideline implementation will affect their routine medical assessment and the respiratory status of the neonates with NCPAP. Thus, the success of guideline utilization is highly depends on their understanding and cooperativeness to the guideline.

4.1.2 Communication process and strategies

To obtain the support and ensure the effectiveness of the guideline implementation, an inclusive communication plan should be carried out with above-mentioned stakeholders. A timetable to show the details is demonstrated in Appendix 9.

The first phase (in week 1) should be informing the administrators and getting their approval to the guideline implementation. Since COS and DOM have the highest authority in the department, their approvals must be collected in the initial step. Additionally, the approval from NC, medical consultants and ward managers all will be collected. The informed contents to the administrative stakeholders including the problems of existing practice, current literature evidence, the significance of this evidence-based guideline utilization, the project proposal, the transferability and feasibility of the intervention, and expected clinical outcomes. Once getting their approval, the project will go into second phase (in week 2) directly. In this phase, NC will be invited to be the project director and scheduled meetings will be conducted to further discuss the practical details. Afterwards NC, WM and the project coordinator will assign total twelve APNs to be the team members that based on their interest and relevant experience.

As a managerial staff, those recruited APNs will be informed to attend a compulsory informative talk that including to emphasis the significance of the project, introduce the guideline and explain the clinical details. Once the project team (NC, project proposer and twelve APNs)
formation confirmed, the weekly-based team meetings will be organized in phase 3 (week 3 to week 5) for conferring the details about the staff training, guideline promotion, equipment preparation, resources allocation and pilot study. In phase 4 (week 6-8), guideline promotion and staff training will be conducted by those APNs in project team to inform and prepare those operational staff for the guideline implementation. Additionally, the feedbacks and doubts about the guideline implementation from clinical staff are all welcome in entire program to enhance their cooperativeness. After those mentioned stakeholders and the environment should be well prepared for the guideline implementation, a three-months pilot study (Phase 5) will be started.

Once implement the pilot study, the project team is responsible to monitor the progress and to conduct biweekly-based meetings for reporting and trouble-shooting. After complete the pilot study, an evaluation session (Phase 6) will be held by the project team, and then a refined guideline and the evaluation report of pilot project will be released to the administrators by email and verbal presentation before applying the refined guideline into six-months implementation phase (Phase 7). Then, the final project report and evaluation report both will be hand-in to the administrators within one month after completing the actual implementation.
4.2 Pilot testing plan

4.2.1 Objectives

Before actual implementation, a pilot test will be performed in the clinical setting with small-group patients. And the outcomes evaluation of this trial run will be utilized to determine the project’s feasibility and to detect any possibly unexpected difficulties when undergoing the full implementation. Additionally help the researchers to refine the plan of future implementation (Pilot & Beck, 2010).

4.2.2 Target population and enrollment

This project targets the neonates with NCPAP in NICU. Based on the mentioned eligible studies and the admission rate in the local setting, total thirty clients should be the maximum affordable sample size in this pilot study. In addition, convenience-sampling method will be applied in this pilot study that all newborns that admitted in NICU and received NCPAP will be recruited until total thirty sample cases being obtained.

4.2.3 Time frame

The guideline promotion and staff training will be carried out in week 6-8. Afterwards the pilot study will be started from week 9 (see Appendix 9). The admission rate and NCPAP application rate of the local setting will be used as a reference, it may take about two months to achieve the pre-set sample size (total 30) and one more month to finish the clinical observation and collect all relevant data. Then, the project team will review the result and the project director will prepare the evaluation report within one month after the pilot study, which aims to refine the guideline and prepare the following actual clinical implementation.
4.2.4 Outcomes measurement

The outcomes measures include (1) the incidence of NCPAP related nasal and skin injury and (2) the duration of NICU stay. Furthermore, the (3) satisfaction and acceptance of NICU nursing staff to the proposed guideline also will be measured.

4.2.5 Data collection

Those recruited APNs in project team are responsible to data collection in this project, and they will be informed from the frontline NICU nurse(s) if presence of neonate(s) who fulfill the inclusion and exclusion criteria. Once neonate(s) is recruited into the study, APN(s) will obtain verbal parental consent within 4 hours and then collect the relevant data, including demographic data (sex, gestational age, height and birth weight), medical diagnosis, and the time of NCPAP initiation, and those information will be documented in Part 1 on ‘Data collection sheet’ (see Appendix 10). And they will assess the neonates’ skin condition as baseline. Moreover, on-duty APN(s) in project team are responsible to perform on-site observation during NCPAP application and to assess the technique of NICU nurses for ensuring the compliance and competency of frontline staff to the proposed guideline, and then fill-in item 1 and 2 in Part 2 on ‘Data collection sheet’, also make sure regular assessment and nasal interface alteration has been performed afterwards (see Appendix 10).

The case nurse(s) of the recruited neonate(s) is responsible to assess the neonates’ skin condition at intervals of every 4 hours in their shift, and to document the results by using the modified ‘Nasal trauma score (NTS) chart’ (Collins et al., 2014) (see Appendix 11). Therefore, once the NCPAP application is terminated, the clinical data for outcomes measurement will be collected and be documented by on-duty APN(s) in Part III on Data collection sheet (see Appendix 10), including time of NCPAP termination, reason for NCPAP termination, NCPAP duration,
clinical details of developed NCPAP related skin injury – date and injury part(s), highest score of NTS and the length of NICU stay. And the collected data will be utilized for result analysis and pilot study evaluation to modify the plan of following actual implementation.

4.2.6. Result analysis and evaluation

After the pilot study, evaluation of this pilot test will be accomplished in the following one month. APN(s) in project team are responsible to gather and computerize the clinical data, staff feedback and encountered problems. The project coordinator will arrange meeting for team discussion. Except the clinical result, the discussed content also includes the encounter difficulties about guideline implementation. Then all team members can express their opinions and suggestions. The project director will be responsible to do data analysis and then gather those suggested recommendations to refine the clinical guideline and to develop a comprehensive plan for actual implementation. Eventually, those clinical data, staff feedback, encountered problems, suggested strategies, refined guideline and the details of actual clinical implementation plan all will be documented into the evaluation report, which will be reported and submitted to the department administrators for getting final approval of the following clinical implementation.

4.3 Evaluation plan

4.3.1 Outcomes identification

After actual implementation of the proposed guideline, the outcomes in different aspects will be measured to evaluate the innovation and the guideline. And the outcomes will be divided into three categorizes including (1) patients, (2) NICU nurses and (3) the pediatrics department.

Prevention of NCPAP related nasal skin injury is the main objective of this innovation, the patient outcomes will be identified to be the primary outcomes for project evaluation that including
incidence of NCPAP related nasal skin injury, duration of NCPAP application, location(s) of developed NCPAP related skin injury, total score of NTS and the length of NICU stay.

To NICU nurses, scheduled training session(s) will be provided to all NICU nurses for guideline introduction, clinical plan explanation and NCPAP application technique assessment before the pilot study for enhancing their knowledge and competency to the innovation. Moreover, their satisfaction and compliance towards the guideline both will be evaluated to reflect the feasibility of this innovation.

For the pediatrics department, the cost-benefit analysis should be applied to determine the clinical promotion of this guideline is worthwhile or not. On the one hand, the costs includes extra expense and manpower to plan and implement the guideline into clinical area, such as buying appropriate NCPAP interfaces and others relevant materials. On another hand, the benefits include to reduce the incidence of NCPAP related skin injury, the duration of NCPAP application and the length of NICU stay. Also, to improve the quality of NICU nursing care. Thus, the comparison between above costs and benefits will be done in the evaluation plan.

4.3.2 Nature and number of target subjects

(Patient’s nature)

To maintain the uniformity of the study and to evaluate the effectiveness of the proposed guideline, the recruited patients should be the neonates that smaller than 28 days of age whose also need to receiving NCPAP in NICU, this inclusion criteria is same as the target population in the previous mentioned six eligible studies, and the convenience sampling method will be applied. Furthermore, there is no specific characteristic of the neonates’ demographic information will be set to exclude them from the project. Moreover, even NCPAP application to the recruited neonates was terminated, the responsible project team members still follow the cases until they are discharged or
transferred out from NICU for further collecting the relevant clinical details.

(Sample size)

From the non-published official record in this local setting, the incidence of NCPAP related skin injury in this NICU was 30% in 2014. And, from the reviewed eligible studies, a high-quality RCT - Newnam et al. (2014) has reported the incidence of NCPAP related skin injury was 24.2% after applying proposed nursing intervention(s), that about 5.8% decreased incidence rate can be expected after implementing the proposed guideline in this local setting. Afterwards the sample size is calculated by using the free online statistics program which available on the website - http://homepage.cs.uiowa.edu/~rlenth/Power/. And based on the above estimation, a sample size of 38 will be needed to achieve 80% power and 5% significance level. Taking a 10% possible attrition rate into account, the various discontinuous factors including patient death, need of intra-hospital transfer, parental decline and need of invasive mechanical ventilation, the actual sample size should be rounded up to 50. As the previous department record showed the annual admission rate should be 200-300, it is reasonable to set the duration of the actual implementation period is six-month.

4.3.3 Timing and frequency of evaluation

During the actual implementation, APNs in project team will keep monitoring the compliance about the patient outcomes documentation by utilizing the designed record form (See Appendix 10 and 11) every shift. After the neonates discharge from NICU, the documentation will be collected and the data will be computerized. When the actual clinical implementation accomplished, the project director will be responsible to do data analyze and complete the evaluation report. Furthermore, in this one-month evaluation period, the project coordinator will arrange biweekly-based team meetings to discuss and review the innovation, including suggested problem-solving strategies and recommendations to the future clinical implementation plan.
To evaluate the effectiveness of training sessions to enhance the knowledge level of NICU nurses about the guideline and the technique of NCPAP application, the nurses who attended the training session need to undergo the post-lecture assessment and the result will be evaluated after the taught sessions. Moreover, to evaluate the satisfaction and compliance of frontline staff about the guideline implementation, all NICU nurses will be invited to participate the satisfaction survey (see Appendix 12) within one week after the project accomplished, and the result of this survey will be collected in 5-point Likert scale (Likert, 1932) and analyzed by the project team.

As mentioned in previous paragraphs, to the pediatrics department, the comparison between the costs and benefits of proposed guideline implementation that will be finished by the project director and the assigned APNs in the project team after the official numbers about the relevant clinical numbers (i.e. NICU admission rate) at a six-month basis being accounted.

4.3.4 Data analysis

All collected clinical data will be certified and analyzed by the project director within one month after accomplishment of actual clinical implementation. Also, the paired t-test will be applied to compare the measured outcomes of the control group and the experimental group. Patient’s demographic data and the clinical outcomes will be presented by the format of descriptive statistics (i.e. mean±standard deviation and range). For the measured outcomes in NICU nurses category, the result of the satisfaction survey will be collected and documented by using the descriptive statistics, and all descriptive statistics will be analyzed by using 5% significance level and being reported with 95% confidence interval. In addition, the expense of materials preparation and the difference between the actual and estimated total cost to implement this innovation both will be present in the evaluation report. For the qualitative data, including the opinions provided from the administrators, the feedback and comments from frontline staff, the reflection and
suggestions from project team members both will be gathered, collected, organized and presented in a written format in the evaluation report by the project director.

4.3.5 Basis for determining guideline effectiveness

The proposed guideline will be considered as an effective one if the following criteria can be meet. To patients, the incidence of the NCPAP related skin injury could be decreased after the guideline implementation and the duration of NCPAP application also could be reduced. To the NICU nurses, the expected compliance rate of guideline application can be over 90% and over 75% NICU nurses show satisfactory about the guideline implementation. To the department, the length of NICU stay can be decreased after guideline implementation and the actual cost of guideline implementation will not over the estimated budget.
## Appendix 1: Table of Evidence

<table>
<thead>
<tr>
<th>Citation</th>
<th>Study Type</th>
<th>Evidence Level</th>
<th>No. of Patients</th>
<th>Patient Characteristics</th>
<th>Interventions</th>
<th>Comparison</th>
<th>Outcome Measure</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buettiker et al. (2004)</td>
<td>RCT</td>
<td>1+</td>
<td>Total 40 neonates (n=40)</td>
<td>Neonates aged ≤ 28 days with 2 out of 4 symptoms of RDS (cyanosis/tachypnea/intercostal retractions/nasal flaring) whose admitted to NICU and required NCPAP treatment</td>
<td>3 different CPAP systems (Nasopharyngeal/Hudson/Infant flow system) were randomized assigned to the recruited neonates receiving NCPAP</td>
<td>Applied 3 different CPAP systems: Nasopharyngeal or Hudson or Infant flow system to the neonates receiving NCPAP</td>
<td>Median duration of CPAP; Degree of nasal injuries</td>
<td>- Weight groups divided into (Nasopharyngeal/Hudson/Infant flow system) 1. Median duration of CPAP Group 1: 1.1 days (1/1.6/0.7) (p&gt;0.05) Group 2: 1.1 days (0.9/1.1/1.3) (p&gt;0.05) 2. Degree of nasal injuries Group 1: Mild (2/3/1), Moderate (0/2/1) Group 2: Mild (0/0/1), Moderate (2/2/2), Severe (0/0/1)</td>
</tr>
<tr>
<td>Yong et al. (2005)</td>
<td>RCT</td>
<td>1+</td>
<td>Total 89 neonates (n=89)</td>
<td>Infants with very low birth weight (&lt;1501g) with respiratory distress and received NCPAP</td>
<td>2 different NCPAP interfaces (Mask/Prong) were randomized assigned to the recruited infants receiving NCPAP</td>
<td>Applied nasal mask or prong to the neonates with very low birth weight and receiving NCPAP</td>
<td>1. Incidence of nasal injury 2. Duration of NCPAP</td>
<td>Group 1: 12 versus Group 2: 17 (p=0.5) Group 1: 22.3 versus Group 2: 27.7 (p=0.07)</td>
</tr>
<tr>
<td>Citation</td>
<td>Study type</td>
<td>Evidence level</td>
<td>No. of patient</td>
<td>Patient characteristics</td>
<td>Interventions</td>
<td>Comparison</td>
<td>Outcome measure</td>
<td>Effect size</td>
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</tr>
<tr>
<td>Collins et al. (2014)</td>
<td>RCT</td>
<td>1 +</td>
<td>Total 89 neonates (n=89) and divided into 3 groups</td>
<td>Infants whose born at &lt;32 gestation weeks, required ETT intubation and now consider to be extubated to receive positive airway pressure</td>
<td>1. Two different non-invasive respiratory support systems (HHHFNC/NCPAP) were randomized assigned to the recruited infants 2. Two different NCPAP dressings were randomized assigned to the infants receiving NCPAP</td>
<td>1. The nasal trauma score under different systems (HHHFNC/NCPAP) 2. The nasal trauma score of the applying different nasal dressings under NCPAP</td>
<td>1. Mean nasal trauma score under different systems HHHFNC: 2.8 (SD 5.7) NCPAP: 11.7 (SD 10.4) 2. Mean nasal trauma score with different nasal dressings under NCPAP Sticky Whiskers: 14.4 (SD 12.5) Cannulaide: 9.5 (SD 7.3)</td>
<td>* (statistically significant)</td>
</tr>
<tr>
<td>Newnam et al. (2014)</td>
<td>RCT</td>
<td>1 +</td>
<td>Total 78 neonates (n=78) and divided into 3 groups</td>
<td>Neonates weight between 500-1500 g and required NCPAP treatment</td>
<td>Two different nasal interfaces (mask/prongs) was randomized assigned to the recruited neonates under different application design (Continuous mask/Continuous prongs/Rotation mask and prongs)</td>
<td>The type of nasal interfaces and application method contributed to the incidence of nasal trauma to the neonates receiving NCPAP</td>
<td>1. Number of CPAP days 2. NSCS score (erythema) 3. NSCS score (excoriation)</td>
<td>1. Number of CPAP days 2. NSCS score (erythema) 3. NSCS score (excoriation)</td>
</tr>
<tr>
<td>No. of patient</td>
<td>Patient characteristics</td>
<td>Interventions</td>
<td>Comparison</td>
<td>Outcome measure</td>
<td>Effect size</td>
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<tr>
<td>179</td>
<td>Total 179 neonates (n=179) and divided into 2 groups</td>
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<tr>
<td>(1)</td>
<td>No silicon gel: 87</td>
<td></td>
<td></td>
<td>Birthweight (g), mean ± SD</td>
<td>1752±689</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>Silicon gel: 92</td>
<td></td>
<td></td>
<td></td>
<td>1776±715</td>
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<td></td>
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<tr>
<td></td>
<td>Preterm infants receiving NCPAP with single NCPAP setup after completing 24hrs NCPAP</td>
<td></td>
<td></td>
<td>Gestational age (wk), mean ± SD</td>
<td>32.1±3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group 1: 14.9% (n=13)</td>
<td></td>
<td></td>
<td></td>
<td>32.2±3.3</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Group 2: 4.3% (n=4)</td>
<td></td>
<td></td>
<td>Incidence of nasal injury</td>
<td>1. Incidence of nasal injury Group 1: 14.9% (n=13) Group 2: 4.3% (n=4) (OR: 3.43; 95%CI: 1.1-10.1; p&lt;0.05)*</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td>2. Incidence of columella necrosis</td>
<td>Group 1: 6.8% Group 2: 1.08% (OR: 6.34; 95%CI: 0.78-51.6; p&lt;0.05)*</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Onset of nasal injury (NCPAP days)</td>
<td>Group 1: 10.8±3.1 Group 2: 16.2±3.2 (p&lt;0.05)*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant
Xie (2014) conducted a prospective controlled study with randomization involving 65 neonates (n=65) divided into two groups:

1. **Hydrocolloid**: 87 infants
2. **Paraffin oil**: 92 infants

Neonates requiring NCPAP treatment were randomized into two groups. Hydrocolloid dressing was applied to the infants in Group 1, and Paraffin oil (as a control measure) was applied to the neonates in Group 2.

**Occurrence of Nasal Injury**: The incidence was compared between the two groups.

- **Group 1**: 6% (n=2) incidence of nasal injury
- **Group 2**: 21.8% (n=7) incidence of nasal injury

The Mann-Whitney U test revealed a statistically significant difference between the two groups (p = 0.01).
Appendix 2. SIGN Level of evidence
(Scottish Intercollegiate Guidelines Network, 2011)

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Key to evidence statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1++</td>
<td>High quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias</td>
</tr>
<tr>
<td>1+</td>
<td>Well conducted meta-analyses, systematic reviews, or RCTs with a low risk of bias 1 - Meta-analyses, systematic reviews, or RCTs with a high risk of bias 2++ High quality systematic reviews of case control or cohort studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal</td>
</tr>
<tr>
<td>1-</td>
<td>Meta-analyses, systematic reviews, or RCTs with a high risk of bias</td>
</tr>
<tr>
<td>2++</td>
<td>High quality systematic reviews of case control or cohort studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal</td>
</tr>
<tr>
<td>2+</td>
<td>Well conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal</td>
</tr>
<tr>
<td>2-</td>
<td>Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytic studies, i.e. case reports, case series</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>
### Methodology Checklist 2: Controlled Trials

Study identification  *(Include author, title, year of publication, journal title, pages)*

<table>
<thead>
<tr>
<th>Guideline topic:</th>
<th>Key Question No:</th>
<th>Reviewer:</th>
</tr>
</thead>
</table>

**Before** completing this checklist, consider:

1. Is the paper a [randomised controlled trial](#) or a [controlled clinical trial](#)? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist. If it is a [controlled clinical trial](#) questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+

2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.

Reason for rejection: 1. Paper not relevant to key question 2. Other reason (please specify):

### Section 1: Internal validity

**In a well conducted RCT study...**

<table>
<thead>
<tr>
<th>Does this study do it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes ☐  No ☐  Can’t say ☐</td>
</tr>
</tbody>
</table>

| 1.1 | The study addresses an appropriate and clearly focused question. | Yes ☐  No ☐  Can’t say ☐ |
| 1.2 | The assignment of subjects to treatment groups is randomised. | Yes ☐  No ☐  Can’t say ☐ |
| 1.3 | An adequate concealment method is used. | Yes ☐  No ☐  Can’t say ☐ |
| 1.4 | Subjects and investigators are kept ‘blind’ about treatment allocation. | Yes ☐  No ☐  Can’t say ☐ |
| 1.5 | The treatment and control groups are similar at the start of the trial. | Yes ☐  No ☐  Can’t say ☐ |
| 1.6 | The only difference between groups is the treatment under investigation. | Yes ☐  No ☐  Can’t say ☐ |
| 1.7 | All relevant outcomes are measured in a standard, valid and reliable way. | Yes ☐  No ☐  Can’t say ☐ |
| 1.8 | What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed? | Yes ☐  No ☐  Can’t say ☐ |
1.9 All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).

<table>
<thead>
<tr>
<th>Yes □</th>
<th>No □</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can't say □</td>
<td>Does not apply □</td>
</tr>
</tbody>
</table>

1.10 Where the study is carried out at more than one site, results are comparable for all sites.

<table>
<thead>
<tr>
<th>Yes □</th>
<th>No □</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can't say □</td>
<td>Does not apply □</td>
</tr>
</tbody>
</table>

### SECTION 2: OVERALL ASSESSMENT OF THE STUDY

2.1 **How well was the study done to minimise bias?**

*Code as follows:*

- High quality (++)
- Acceptable (+)
- Unacceptable – reject 0

2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?

2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?

2.4 **Notes.** Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.
**Methodology Checklist 2: Controlled Trials**

**Study identification** *(Include author, title, year of publication, journal title, pages)*


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<td>1. Is the paper a <strong>randomised controlled trial</strong> or a <strong>controlled clinical trial</strong>? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist. If it is a <strong>controlled clinical trial</strong> questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+</td>
<td></td>
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</tr>
<tr>
<td>2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.</td>
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<td><strong>Reason for rejection:</strong> 1. Paper not relevant to key question □ 2. Other reason □ (please specify):</td>
<td></td>
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</tr>
</tbody>
</table>

**Section 1: Internal validity**

*In a well conducted RCT study…*

| 1.1 The study addresses an appropriate and clearly focused question. | **Does this study do it?** | Yes |
| 1.2 The assignment of subjects to treatment groups is randomised. | | Yes  
But the method of randomization of this study was not mentioned clearly in the article |
| 1.3 An adequate concealment method is used. | **Can't say**  
Concealed method has not been mentioned in this study. | |
| 1.4 Subjects and investigators are kept ‘blind’ about treatment allocation. | **Can't say**  
Blinding method has not mentioned in this study. | |
| 1.5 The treatment and control groups are similar at the start of the trial. | **Does this study do it?** | Yes  
No statistical difference of the neonates within each group. Diagnosis, gestational age, weight, CPAP duration and setting, blood gas and oxygen requirement were matched for three groups. |
The only difference between groups is the treatment under investigation.

1.7 All relevant outcomes are measured in a standard, valid and reliable way.

The only difference between each weight groups was the NCPAP delivery system.

Three NCPAP systems have been introduced to the NICU nurses by the manufacturer and all nurses have at least 3 years clinical experience to apply the systems.

What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?

0 %

All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).

Does not apply

Where the study is carried out at more than one site, results are comparable for all sites.

No

SECTION 2: OVERALL ASSESSMENT OF THE STUDY

2.1 How well was the study done to minimise bias? Code as follows: Acceptable (+)

2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention? Yes

Except the blinding and concealment methods have not been mentioned, this study was conducted in a systematic way.

2.3 Are the results of this study directly applicable to the patient group targeted by this guideline? Yes

2.4 Notes. Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.

- Prong system was suggested to the low birth weight neonates, as NPT was easily blocked and had higher resistance during CPAP delivery
- Bi-nasal prong system was suggested to reduce the chance of the neonates with low body weight to develop the NCPAP nasal injury but expensive cost also mentioned
- The nurses expressed that all NCPAP systems were difficult to fix the NCPAP interfaces and then the chance of developing pressure ulcer due to the fiction

### Section 1: Internal validity

**In a well conducted RCT study...**

<table>
<thead>
<tr>
<th>Key Question</th>
<th>Reviewer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1</strong> The study addresses an appropriate and clearly focused question.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
| **1.2** The assignment of subjects to treatment groups is randomised. | Yes
But the method of randomization of this study was not mentioned clearly in the article |
| **1.3** An adequate concealment method is used. | Yes
The serial number that used for randomized group assignment was contained in seal opaque envelopes |
| **1.4** Subjects and investigators are kept ‘blind’ about treatment allocation. | Can't say
Blinding method has not mentioned in this study. |
| **1.5** The treatment and control groups are similar at the start of the trial. | Yes
No statistical difference of the neonates within each studied group. And the birth weight and gestational age were matched among the groups |

**Does this study do it?**
The only difference between groups is the treatment under investigation. **Yes**

The only difference between the groups was the NCPAP device applied.

All relevant outcomes are measured in a standard, valid and reliable way. **Yes**

What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed? **0 %**

All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis). **Does not apply**

Where the study is carried out at more than one site, results are comparable for all sites. **No**

**SECTION 2: OVERALL ASSESSMENT OF THE STUDY**

How well was the study done to minimise bias? **Code as follows:** **Acceptable (+)**

Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention? **Yes**

Except the blinding method, this study was well designed and being conducted in a systematic way.

Are the results of this study directly applicable to the patient group targeted by this guideline? **Yes**

Notes. Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.

- Development of nasal trauma was common in neonates receiving NCPAP
- Long duration of NCPAP was associated with the development of nasal trauma
- Soft silicon nasal mask was softer and more fit for the nasal airway
- Treatment of nasal trauma should be initiated immediately when the trauma discovered
- No statistically difference of the incidence rate to the nasal trauma by using nasal prong or mask
- Barrier protection and protective dressing (Duoderm) were suggested to the neonates receiving NCPAP
Methodology Checklist 2: Controlled Trials

**Study identification** *(Include author, title, year of publication, journal title, pages)*


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<tr>
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<tr>
<td>3. Is the paper a <strong>randomised controlled trial</strong> or a <strong>controlled clinical trial</strong>? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist. If it is a <strong>controlled clinical trial</strong> questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+</td>
<td></td>
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</tr>
<tr>
<td>4. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.</td>
<td></td>
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</table>

**Reason for rejection:** 1. Paper not relevant to key question □ 2. Other reason □ (please specify):

### Section 1: Internal validity

**In a well conducted RCT study…**

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The study addresses an appropriate and clearly focused question.</td>
<td>Yes</td>
</tr>
<tr>
<td>1.2</td>
<td>The assignment of subjects to treatment groups is randomised.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Randomization was conducted by computer that using the statistical software</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>An adequate concealment method is used.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>The randomized sequence number was contained in the sealed opaque envelope</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Subjects and investigators are kept ‘blind’ about treatment allocation.</td>
<td>No</td>
</tr>
<tr>
<td>1.5</td>
<td>The treatment and control groups are similar at the start of the trial.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Except gender, no statistical difference of the neonates within each group. All demographic characteristics of enrolled neonates in each group are similar</td>
<td></td>
</tr>
</tbody>
</table>
1.6 | The only difference between groups is the treatment under investigation. | Yes | The difference between the studied groups were NCPAP systems and the protective nasal dressings |

1.7 | All relevant outcomes are measured in a standard, valid and reliable way. | Yes |

1.8 | What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed? | Assigned HHHFNC + Sticky Whiskers: 12 Assigned NCPAP + Sticky Whiskers: 13 Assigned NCPAP + Cannulaide: 8 |

1.9 | All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis). | Yes |

1.10 | Where the study is carried out at more than one site, results are comparable for all sites. | No |

**SECTION 2: OVERALL ASSESSMENT OF THE STUDY**

2.1 | How well was the study done to minimise bias? *Code as follows:* | Acceptable (+) |

2.2 | Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention? | Yes | Except no blinding method, this study was conducted in a systematic way. |

2.3 | Are the results of this study directly applicable to the patient group targeted by this guideline? | Yes |

2.4 | **Notes.** Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above. | - HHHFNC application after extubation has less contribution to the nasal trauma when compared with NCPAP  
- Use of protective dressing was not related to reduce the incidence rate of NCPAP-related nasal trauma |
Methodology Checklist 2: Controlled Trials

Study identification  (*Include author, title, year of publication, journal title, pages*)


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</tr>
<tr>
<td>1. Is the paper a randomised controlled trial or a controlled clinical trial? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist. If it is a controlled clinical trial questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason for rejection: 1. Paper not relevant to key question</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Other reason (please specify):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Section 1: Internal validity**

*In a well conducted RCT study...*

| 1.1 The study addresses an appropriate and clearly focused question. | Yes |
| 1.2 The assignment of subjects to treatment groups is randomised. | Yes |
| Randomization was conducted by the respiratory therapist without blinding to draw the serially numbered envelopes when group assignment and before NCPAP application |
| 1.3 An adequate concealment method is used. | Yes |
| The randomized sequence number was contained in the numbered opaque sealed opaque envelope |
| 1.4 Subjects and investigators are kept 'blind' about treatment allocation. | No |
| 1.5 The treatment and control groups are similar at the start of the trial. | Yes |
| No statistical difference of the neonates within each group. All demographic data of enrolled neonates in each weight group are similar |
1.6 The only difference between groups is the treatment under investigation. Yes
The difference between the among the experimental groups was the nasal interfaces applied.

1.7 All relevant outcomes are measured in a standard, valid and reliable way. Yes
Neonatal Skin condition scale (NSCS) was used to score the skin condition. And a skin expert team was responsible to enrolled the subjects and to evaluate the outcome.

1.8 What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed? 0 %

1.9 All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis). Yes

1.10 Where the study is carried out at more than one site, results are comparable for all sites. Yes
This study was conducted in 70 NICU beds in the southeastern United States.

SECTION 2: OVERALL ASSESSMENT OF THE STUDY

2.1 How well was the study done to minimise bias? Code as follows: Acceptable (+)

2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention? Yes
Except the blinding method has not been mentioned, this study was conducted in a systematic way.

2.3 Are the results of this study directly applicable to the patient group targeted by this guideline? Yes

2.4 Notes. Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.

- Practice of rotation of prong or mask nasal interfaces was able to reduce the incidence of nasal injury in neonates weighting <1500g
- Healthcare providers should select the nasal interface that fit for patient’s face or nose, rather than only prefer one kind of devices
- NCPAP design, focused skin assessment and nursing care were related to forehead skin necrosis and injury
- Re-intubate the neonates who having respiratory status for skin breakdown should be avoided
**Methodology Checklist 2: Controlled Trials**

### Study identification

*Include author, title, year of publication, journal title, pages*


---

<table>
<thead>
<tr>
<th>Guideline topic</th>
<th>Key Question No:</th>
<th>Reviewer:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong> completing this checklist, consider:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Is the paper a randomised controlled trial or a controlled clinical trial? If in doubt, check the study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>design algorithm available from SIGN and make sure you have the correct checklist. If it is a controlled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>clinical trial questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reason for rejection:** 1. Paper not relevant to key question 2. Other reason (please specify):

---

**Section 1: Internal validity**

*In a well conducted RCT study...*

<table>
<thead>
<tr>
<th>Question</th>
<th>Does this study do it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The study addresses an appropriate and clearly focused question. Yes</td>
</tr>
<tr>
<td>1.2</td>
<td>The assignment of subjects to treatment groups is randomised. Yes</td>
</tr>
<tr>
<td></td>
<td>Patients were randomized alternate day into 2 groups based on application of silicon gel sheeting or not</td>
</tr>
<tr>
<td>1.3</td>
<td>An adequate concealment method is used. No</td>
</tr>
<tr>
<td>1.4</td>
<td>Subjects and investigators are kept ‘blind’ about treatment allocation. Can’t say</td>
</tr>
<tr>
<td></td>
<td>Blinding method has not mentioned in this study.</td>
</tr>
<tr>
<td>1.5</td>
<td>The treatment and control groups are similar at the start of the trial. Yes</td>
</tr>
<tr>
<td></td>
<td>No statistical difference of the infants among the experimental and control group. All demographic data of enrolled neonates in each weight group are similar.</td>
</tr>
</tbody>
</table>
The only difference between groups is the treatment under investigation.  
Yes  
The difference between the among the experimental groups was applying silicon gel sheeting or not

All relevant outcomes are measured in a standard, valid and reliable way.  
Yes  
The condition of the nose and masked manner were observed and documented by the same surgeon from plastic and reconstructive department

What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?  
0 %

All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).  
No

Where the study is carried out at more than one site, results are comparable for all sites.  
No  
This study was conducted in NICU of Kocacli University, Medical Faculty Hospital

### SECTION 2: OVERALL ASSESSMENT OF THE STUDY

2.1 How well was the study done to minimise bias? **Code as follows:** Acceptable (+)

2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?  
Yes  
Except the blinding and concealment method has not been mentioned, this study was conducted in a systematic way.

2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?  
Yes

2.4 **Notes.** Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.

- Application of silicon gel sheeting to the nares of the infants receiving NCPAP may able to reduce the incidence and the severity of NCPAP related nasal trauma  
- Longer NCPAP duration is one of the significant risk factor for contributing the development of NCPAP associated nasal injury
**Methodology Checklist 2: Controlled Trials**

**Study identification** *(Include author, title, year of publication, journal title, pages)*


<table>
<thead>
<tr>
<th>Guideline topic:</th>
<th>Key Question</th>
<th>Reviewer:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before completing this checklist, consider:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Is the paper a <strong>randomised controlled trial</strong> or a <strong>controlled clinical trial</strong>? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist. If it is a <strong>controlled clinical trial</strong> questions 1.2, 1.3, and 1.4 are not relevant, and the study cannot be rated higher than 1+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reason for rejection:** 1. Paper not relevant to key question □  2. Other reason □ (please specify):

**Section 1: Internal validity**

*In a well conducted RCT study...*  
*Does this study do it?*

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>The study addresses an appropriate and clearly focused question.</td>
<td><strong>Yes</strong></td>
</tr>
</tbody>
</table>
| 1.2 | The assignment of subjects to treatment groups is randomised. | **Yes**  
The eligible neonates were randomly divided into 2 groups – clinical trial group (applying hydrocolloid dressing) and control group (applying paraffin oil) |
| 1.3 | An adequate concealment method is used. | **No** |
| 1.4 | Subjects and investigators are kept 'blind' about treatment allocation. | **Can't say**  
Blinding method has not mentioned in this study. |
| 1.5 | The treatment and control groups are similar at the start of the trial. | **Yes**  
No statistical difference of the infants among the clinical trial group and control group. All demographic data of enrolled neonates in each weight group are similar. |
<table>
<thead>
<tr>
<th>1.6</th>
<th>The only difference between groups is the treatment under investigation.</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The difference between the among the experimental groups was applying hydrocolloid dressing or paraffin oil smear.</td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>All relevant outcomes are measured in a standard, valid and reliable way.</td>
<td>Yes</td>
</tr>
<tr>
<td>1.8</td>
<td>What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?</td>
<td>0 %</td>
</tr>
<tr>
<td>1.9</td>
<td>All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).</td>
<td>No</td>
</tr>
<tr>
<td>1.10</td>
<td>Where the study is carried out at more than one site, results are comparable for all sites.</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>This study was conducted in NICU of the Children’s Hospital of Hunan Province.</td>
<td></td>
</tr>
</tbody>
</table>

**SECTION 2: OVERALL ASSESSMENT OF THE STUDY**

<table>
<thead>
<tr>
<th>2.1</th>
<th>How well was the study done to minimise bias? <em>Code as follows:</em></th>
<th>Acceptable (+)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><em>Code as follows:</em></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td><em>Except the blinding and concealment method has not been mentioned, this study was conducted in a systematic way.</em></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Are the results of this study directly applicable to the patient group targeted by this guideline?</td>
<td>Yes</td>
</tr>
<tr>
<td>2.4</td>
<td><strong>Notes.</strong> Summarise the authors’ conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Application of hydrocolloid dressing to the nostrils surface of the infants receiving NCPAP can significantly decrease the incidence and the severity of NCPAP associated nasal injury.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hydrocolloid dressing is safe and easy to use.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- It is essential to perform the careful and frequent nasal inspection on the first day of NCPAP application in preterm neonates.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5. Table of estimated material cost

Total number of neonates admitted in NICU = 300 babies per year
Total number of preterm babies admitted in NICU = 300 x 90% = 270 babies per year
Total number of preterm neonates required NCPAP = 270 x 95% = 256 babies per year

<table>
<thead>
<tr>
<th>Items</th>
<th>Calculation</th>
<th>Cost (HK dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCPAP interfaces with cap (Set)</td>
<td>$200 (per set) x 2 x 256</td>
<td>$102400 (1)</td>
</tr>
<tr>
<td>Hydrocolloid dressing (box)</td>
<td>$100 (per box) x 20</td>
<td>$2000 (2)</td>
</tr>
<tr>
<td>Printing material</td>
<td>Hospital provision</td>
<td>$0</td>
</tr>
<tr>
<td>Estimated annual expenditure in material supply</td>
<td>(1) + (2) = $102400 + $2000</td>
<td>$104400</td>
</tr>
<tr>
<td>Estimated material cost in 3-month pilot program</td>
<td>$104400 x 1/4</td>
<td>$26100</td>
</tr>
</tbody>
</table>

(* Estimably, the guideline can be applied to total 256 preterm neonates in NICU)

Appendix 6. Table of estimated non-material cost

Total number of recruited NICU nurses = 40 RN
Total minutes for each nurse spend to attend the sessions (theoretical + practical) = 60 minutes
Average salary for a 5-day work RN = $30000 (per month) = $ 187.5 (per hour) = $3.1 (per minute)

<table>
<thead>
<tr>
<th>Items</th>
<th>Calculation</th>
<th>Cost (HK dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost of a RN to attend 30-minute theoretical session</td>
<td>$30 x 3.1</td>
<td>$93 (1)</td>
</tr>
<tr>
<td>Labor cost of a RN to attend 30-minute practical session</td>
<td>$30 x 3.1</td>
<td>$93 (2)</td>
</tr>
<tr>
<td>Total cost for a RN to attend both sessions</td>
<td>(1) + (2)</td>
<td>$186 (3)</td>
</tr>
<tr>
<td>Total labor cost to train all NICU RN</td>
<td>(3) x 40 = $186 x 40</td>
<td>$7440</td>
</tr>
</tbody>
</table>
**Appendix 7. SIGN grades of recommendation**

(Scottish Intercollegiate Guidelines Network, 2012c)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At least one meta-analysis, systematic review or clinical trial classified as 1++ and directly applicable to the guide’s target population, or a body of evidence composed of studies classified as 1+ with high consistency amongst them.</td>
</tr>
<tr>
<td>B</td>
<td>Body of evidence composed of studies classified 2++, directly applicable to the guide’s target population and that have been shown to have high consistency amongst them, or evidence extrapolated from studies classified as 1++ or 1+.</td>
</tr>
<tr>
<td>C</td>
<td>Body of evidence composed of studies classified as 2+ directly applicable to the guide’s target population and that have shown to have high consistency amongst them; or evidence extrapolated from studies classified as 2++.</td>
</tr>
<tr>
<td>D</td>
<td>Level 3 or 4 evidence or evidence extrapolated from studies classified as 2+.</td>
</tr>
</tbody>
</table>
Appendix 8. Evidence-based guideline

XXX Hospital

Department of Pediatrics and Adolescent Medicine

Evidence-based guideline:

**USE OF HYDROCOLLOID NASAL PROTECTIVE DRESSING AND ROTATION APPLICATION OF TRANSLUCENT NCPAP INTERFACES (NASAL MASK/NASAL PRONG) TO THE PRETERM NEONATES IN NICU**

1st edition on 30 December 2014 by SZETO WING HAN (RN)

Approved by:

<table>
<thead>
<tr>
<th>Role</th>
<th>Date:</th>
<th>Sign:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chief of Service (COS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultant (NICU)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurse Consultant (NC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department operations manager (DOM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ward Manager (WM)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Evidence-based guideline:

Use of hydrocolloid nasal protective dressing and rotation application of translucent NCPAP interfaces (nasal mask/nasal prong) to the preterm neonates in NICU

Background:

Respiratory diseases were top five contributing causes in infant’s death in HK (General Statistics Section, 2013a). Respiratory distress syndrome (RDS) is one of the common acute respiratory diseases that increases the work of breathing and causes the need of extra oxygen and assisted ventilation in preterm newborns (Karotkin, 2011) less than 37 completed gestation weeks (World Health Organization, 2014a). And the incidence of RDS is inversely proportional to the gestational age and birth weight, that affecting 40-50% of all infants under 32 weeks gestation (Mupanemunda & Watkinson, 2005) and occurring in 44% of all preterm infants with birth weight between 501 and 1500 grams (Gomella, Cunningham & Eyal, 2009). Early NCPAP application is encouraged to keep the alveoli open for promoting gas exchange and to reduce the work of breathing of preterm newborns with RDS (Bohlin, 2012).

Due to the immature and fragile skin, the preterm prone to develop pressure-related nasal trauma (Merenstein & Gardner, 2006) and facial skin injury that related to the fixation of the equipment by using adhesive materials (LeBlanc & Baranoski, 2011). About 50% of pediatric pressure ulcers are associated with medical devices and equipment (Willock et al., 2005). Fujii et al. (2010) showed the incidence of pressure ulcer in NICU was 16% and 50% of theses cases were located on the nasal skin. Thus, it is a need for healthcare professional to understand the complications of NCAP application and to recognize the proper way to apply the NCPAP devices, for reducing the incidence of NCPAP-related nasal injury in NICU.
**Goal:**
To reduce the incidence of pressure-related skin breakdown and nasal injury associated with the NCPAP application in preterm neonates (24-37 gestational ages) in NICU

**Intended users:** All nurses worked in NICU

**Target population:** Preterm infants with 24-37 gestational ages with NCPAP support in NICU

**Exclusion population:**
1. Preterm infants with congenital facial deformities
2. Preterm infants with traumatic facial deformities

**Equipment (to each neonate):**
1. Nasal mask x 1
2. Nasal prong x 1
3. Hydrocolloid (nasal protective dressing) x 2-3 sets

**Methodology:**
To identify the studies, a systematic literature search was carried out in three electronic databases including PubMed, Medline and CINAHL in August 2014. The searching keywords were ‘Preterm’, ‘Infants’, ‘Newborns’, ‘NICU’, ‘Nasal injury’, ‘Nasal trauma’, ‘Skin injury’, ‘Skin breakdown’, ‘Skin care’, ‘CPAP’ and ‘NCPAP’, and all keywords were used in three databases consistently. Finally, total 6 studies were selected, including 4 RCTs and 2 Prospective controlled studies. All 6 eligible studies were critically appraised according the checklist, which established by Scottish Intercollegiate Guidelines Network (SIGNS, 2012a; SIGNS, 2012b). Among them, four studies showed high methodological quality (Buettiker et al., 2004; Yong et al., 2005; Collins et al., 2014; Newnam et al., 2014) and other two studies showed moderate methodological quality (Gunlemez et al., 2010; Xie, 2014). The following recommendations are extracted from the above six eligible studies, and each recommendation is assessed by the GRADE system that established by Scottish Intercollegiate Guidelines Network (SIGNS, 2012c) for showing the strength of the supporting evidence, nor clinical importance.
Guideline:

Recommendation 1

*Obtain a fit-size nasal interfaces and hat is the first action to prevent NCPAP-related pressure ulcer*

Grade of recommendation: A

Evidence: All eligible studies showed that a fit-size nasal interfaces can effectively reduce the pressure point from the NCPAP devices to the neonates, and to lower the chance to damage the facial structure of the neonates, especially the preterm with fragile facial structure (Buettiker et al., 2004) [1+] (Yong et al., 2005) [1+] (Collins et al., 2014) [1+] (Newnam et al., 2014) [1+] (Gunlemez et al., 2010) [2+] (Xie, 2014) [2+].

Recommendation 2

*Use of translucent nasal interfaces to provide non-invasive NCPAP support*

Grade of recommendation: A

Evidence: Application of translucent nasal interfaces makes the nurses observe the blood circulation and integrity of the neonates’ skin easily, even the babies under different body positions (Buettiker et al., 2004) [1+] (Yong et al., 2005) [1+].

Recommendation 3

*Perform regular clinical observation and nursing assessment of neonate’s skin (per 4 hours)*

Grade of recommendation: A

Evidence: Studies suggested the regular nursing observation let the nurses assess the skin condition of the pressure points which various among the neonates. This makes the nurses could discover that any excoriation and erythma on the neonate’s skin, and to take the relative treatment to prevent the worse skin condition, such as nostril ulceration, columellar necrosis and granulation. In addition, the removal of NCPAP devices is suggested to promote the blood circulation and pressure relief when the neonate’s vital signs are all stable (Collins et al., 2014) [1+] (Newnam et al., 2014) [1+] (Gunlemez et al., 2010) [2+] (Xie, 2014) [2+].
Recommendation 4

*Apply hydrocolloid nasal protective dressing to the neonates under NCPAP support*

Grade of recommendation: A

Evidence: The use of nasal protective dressing is suggested by the studies to be a barrier between the nasal interfaces and neonate’s skin, because the protective layer could reduce the friction between the surface of nares and the NCPAP interfaces, also reduce the probability of the neonates to develop friction-induced ulceration. (Collins et al., 2014) [1+] (Newnam et al., 2014) [1+] (Gunlemez et al., 2010) [2+] Moreover, a study showed that hydrocolloid type dressing is significantly effective to reduce the incidence of pressure-related skin breakdown and nasal injuries in neonates who receiving NCPAP (Xie, 2014) [2+]. In addition, it is essential for the nurses to apply the protective dressing carefully to prevent the cover of nares that may obstruct the airway and deteriorate the respiratory status of the babies.

Recommendation 5

*Apply the nasal mask and nasal prong alternatively to the same neonate (per 4 hours)*

Grade of recommendation: B

Evidence: For reducing the incidence the NCPAP-related skin breakdown and nasal injury, the instruction to the nurses about applying the NCPAP interfaces should be clear. Furthermore, a study showed the rotation application of nasal mask and nasal Prong was clinically significant to reduce the severity of the symptoms of NCPAP-related ulceration, including excoriation and erythema, thus the systematic rotation of NCPAP interfaces method was suggested (Newnam et al., 2014) [1+]. Clinically, the alternative change of nasal mask and nasal prong to the neonates per 4 hours is suggested, since the change of the devices could promote the blood perfusion of the nasal skin, increase the blood supply to the tissue and also prevent the chronic pressure point form by using the single type of nasal interface.
## Appendix 9. Project timeline

<table>
<thead>
<tr>
<th>Task</th>
<th>Organizer(s)</th>
<th>Target(s)</th>
<th>Months</th>
</tr>
</thead>
</table>
| Approvals seeking | Project coordinator | • COS  
• DOM  
• NC  
• Consultants (Medicine)  
• WM | ![Week 1](image1) |
| Project director recruitment | Project coordinator | NC | ![Week 2](image2) |
| Project team member recruitment | • Project coordinator  
• NC (Project director) | APNs (Total: 12) | ![Week 2](image3) |
| Project team meeting | • Project coordinator  
• ** Members in ‘Project team’ | ![Week 3-5](image4) |
| Project development | • Project coordinator  
• Project director | Members in ‘Project team’ | ![Week 6](image5) |
| Guideline promotion | • Members in ‘Project team’  
• Medical officers  
• Nursing staff | ![Week 7-8](image6) |
| Staff training | • APNs in ‘Project team’  
• Nursing staff | ![Week 12](image7) |
| Pilot test | Members in ‘Project team’  
• Nursing staff  
• Patients | ![Week 9](image8) |
| Pilot test review | Members in ‘Project team’  
• Nursing staff  
• Patients | ![Week 10](image9) |
| Pilot test report | • Project coordinator  
• Project director  
• Nursing staff  
• Patients | ![Week 11](image10) |
| Implementation | All operational staff (Nurses and MOs)  
• Patients | ![Week 12](image11) |
| Evaluation - Project report  
- Evaluation report | • Project coordinator  
• Project director | • Hospital  
• Administrators in Pediatrics department | ![Week 12](image12) |

** Members of ‘project team’ include NC (Project director), Project coordinator and twelve recruited APNs.
### Appendix 10. Data collection sheet

#### XXX Hospital

**Department of Pediatrics and Adolescent Medicine**

*Data collection sheet for neonate(s) with NCPAP*

- Parental consent (verbal) obtained: **YES / NO**
- Consent obtained time: ___________ (DD/MM/YY) @___________ (TIME)

#### Part I. Demography information

(This part should be filled IMMEDIATELY after the neonate(s) being recruited.)

1. Gender: **Male / Female**
2. Gestational age (weeks): __________
3. Height (cm): __________
4. Birth weight (g/kg): __________
5. Medical diagnosis: __________________________________________________________
6. Time of NCPAP initiation: ___________ (DD/MM/YY) @___________ (TIME)
   (Please record the accurate date and time)
7. Initial Nasal Trauma Score (NTS): __________

#### Part II. Intervention(s)

(** Item 1 and 2 should be filled when the clinical observation of NCPAP application done.**)

1. Use of translucent NCPAP interface(s): **YES / NO**
2. Apply intact hydrocolloid nasal protective dressing during NCPAP application: **YES / NO**
3. Perform regular skin assessment (per 4 hours) during NCPAP application: **YES / NO**
4. Apply the nasal mask and nasal prong ALTERNATIVELY (per 4 hours): **YES / NO**

#### Part III. Outcome(s) measurement

1. Time of NCPAP termination: ___________ (DD/MM/YY) @___________ (TIME)
   (Please record the accurate date and time)
2. Reason for NCPAP termination: **WEAN OFF / INTUBATED TO IMV**
3. NCPAP duration: ___________ (Days) ___________ (Hours)
4. Development of NCPAP related skin injury: **YES/NO**
5. Date of skin injury observed (DD/MM/YY): ______________________
6. Location(s) that developed NCPAP related skin injury: (*Can circle more than one options)
   - Internal nares (L/R) / External nares (L/R) / Philtrum / Septum
7. Highest total NTS: __________
8. Length of NICU stay (days): __________
Appendix 11. Modified ‘Nasal trauma score chart’ (Collins et al., 2014)

XXX Hospital
Department of Pediatrics and Adolescent Medicine

Modified ‘Nasal trauma score (NTS) chart’ for neonates receiving Nasal continuous airway pressure (NCPAP)

INSTRUCTIONS:
- NICU nurse(s) are required to perform nasal skin condition assessment to the neonate receiving NCPAP.
- Nasal skin assessment should be performed to the neonate at intervals of every 4 hours while receiving NCPAP.
- Nurse(s) should fill this form IMMEDIATELY after perform the assessment.
- Please RETURN this form to the collection box once neonate without NCPAP application.

<table>
<thead>
<tr>
<th>Date (DD/MM)</th>
<th>TIME</th>
<th>NCPAP Interface (Nasal mask/ Nasal Prong)</th>
<th>Intact Hydrocolloid protective dressing applied (Y/N)</th>
<th>Score</th>
<th>Total score</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
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* Score: 0=Normal, 1=Pink/Red, 2=Bleeding/Ulcer/Scab, 3=Skin tear
Appendix 12. Nurse satisfaction survey

XXX Hospital
Department of Pediatrics and Adolescent Medicine

Nurse Satisfaction Survey for the new-implemented nursing care guideline to the neonates with NCPAP in NICU

- To evaluate the effectiveness of the new-implemented nursing care guideline to the neonates with NCPAP in NICU, your comments are valuable to us.
- Please circle the appropriate number to describe your level of satisfaction towards the guideline implementation.
- Please fill the following blanks:
  - Year of experience in NICU: _____________
  - Rank: _____________

<table>
<thead>
<tr>
<th>Item(s)</th>
<th>Highly Disagree</th>
<th>Slightly Disagree</th>
<th>Neutral</th>
<th>Slightly agree</th>
<th>Highly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>I reckon the training session is useful and efficient to promote the staff’s competency.</td>
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<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>I understand the reason to apply this guideline into clinical area.</td>
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<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>I reckon the guideline is able to improve the quality of care in NICU.</td>
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<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
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<tr>
<td>I reckon the guideline is easy to be followed and be applied in the routine care.</td>
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<td>5</td>
<td>1</td>
<td>2</td>
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<tr>
<td>I am confident to demonstrate the NCPAP application technique as indicated by the proposed guideline.</td>
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<tr>
<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>I reckon the guideline implementation make inconvenient to me and others staff in NICU.</td>
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<tr>
<td>7</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
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<tr>
<td>I have received sufficient support from the project team during entire innovation.</td>
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<tr>
<td>8</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>In general, I am satisfied with the proposed guideline implementation in NICU.</td>
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<td>9. Any other comments or suggestions?</td>
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</tbody>
</table>


References


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Census and Statistics Department: Hong Kong Special Administrative Region.


Nursing council of Hong Kong. (2002). In *Code of professional conduct and code of ethics for nurses in Hong Kong*. Retrieved December 10, 2014 from


