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Capri Steinkuhler
University of Nebraska Medical Center

Kaitlin Rogge
University of Nebraska Medical Center

University of Nebraska Medical Center

College of Nursing

DOCTOR OF NURSING PRACTICE (DNP)

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By

Kaitlin (Kueny) Rogge BS, BSN, RN

Capri Steinkuhler BS, BSN, RN

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DNP Project Faculty Advisors

Dr. Sue Barnason, Ph.D., RN, APRN-CNS, BC, CEN, CCRN, FAEN, FAHA, FAAN

Dr. Jennifer Miller, Ph.D., APRN-NP, BC

Introduction

Pressure injuries are one of the leading causes of injury to hospitalized patients (National Pressure Injury Advisory Panel [NPIAP], 2019). Hospital acquired pressure injuries can cause unnecessary pain for patients and lengthen patient hospitalization (NPIAP, 2019). Pressure injuries (PI) are a concern for healthcare facilities due to the financial impact of reduced care reimbursement (Visscher et al., 2015). The NPIAP recognizes this issue and has published best practice recommendations for PI care and prevention (NPIAP, 2019). Studies estimate that approximately 34.5% or in some cases as high as 61-81% of PIs are due to a medical device (Bowen et al, 2020). Over the last few years, non-invasive ventilation (NIV) has caused a dramatic increase in PIs due to the increased utilization of NIV during the pandemic. Given the dramatic increase in the use of NIV in acute care hospitalizations and the associated risk for PI, this study focused on the implementation of a nurse-led clinical algorithm to reduce facial PIs caused by use of NIV devices.

Problem Statement

Medical device related PIs are a preventable type of injury that can be mitigated with assessment and appropriate preventative care (Barakat-Johnson et al., 2019). According to a large survey of over 100,000 medical records by NPIAP (2019), medical device related PIs had a prevalence of 0.6% (n=601) in sample of 99,876 patients. Multiple factors increase the risk of developing a PI from a medical device. The NPIAP recommends routine skin assessments under the device, proper mask fit, protective barrier, moisture reduction, and interdisciplinary collaboration in order to prevent PIs due to NIV devices. Currently there are an increase in numbers of patients experiencing medical device related PIs associated with NIV devices. The use of NIV often necessitates long wear-time of the device due to the respiratory needs of the

patient population requiring this therapy. Respiratory related medical devices PIs constitute the highest incidence of medical related devices at the study site.

Review of the Literature

Skin Assessment

A key element of current practices includes the assessment of skin integrity and the skin beneath and surrounding the NIV facial device. The NPIAP (2019) encourages regular assessment of the skin for prompt detection of pressure related injuries promoting early identification of risks. Then strategies can be used to redistribute pressure. This is pertinent to PIs related to NIV use, as the skin of the face has less depth of tissue, which makes it more prone to breakdown (Miske et al, 2017).

NIV masks sit on the bridge of the nose where PIs can rapidly develop into Stage 4 PIs (Miske et al, 2017). Some studies recommend that the skin should be assessed at least every twelve hours (Nist et al., 2016; Cooper et al., 2020), while others recommend assessing the skin under the device every four hours (Acorda & Gordon, 2015; Lauderbaugh et al., 2019; Miske et al., 2016) with continuous NIV use. The evidence supports more frequent assessment of the skin performed every two to four hours, as PIs have been shown to develop in just four to six hours under continuous load (Alqahtani & AlAhmari, 2018). The device needs to be lifted not only to assess the skin but to relieve pressure momentarily to prevent medical device related PIs. Nurses are accountable for the assessment and protection of the patients' skin, which is essential in providing quality care (Barnard & Copson, 2016).

Early recognition of skin breakdown can lead to early intervention and stop development of a stageable PI. A recent systematic review by Shikama et al (2018), concluded that patients with non-blanchable erythema are more likely to develop new pressure injuries than those

without. Therefore, clinicians should assess the skin regularly and take preventive action if non-blanchable erythema is present (Fletcher, 2019). Studies have shown that early identification of redness and discerning between blanchable and non-blanchable erythema with subsequent intervention is the best way to prevent the formation of stage two or greater PIs (Acorda & Gordon, 2015; Black & Kalowes, 2016; Miller et al., 2018; Raurell-Torreda et al., 2017). Testing for blanchable redness helps determine if there is good perfusion; blanchable redness is when reddened skin becomes white when light pressure is applied then red again shortly after lifting pressure (Barnard & Copson, 2016; Hess, 2020; Lauderbaugh et al., 2019).

Mask Fit

Proper mask fit is important to reduce both pressure and friction (Alqahtani & AlAhmari, 2018; Lauderbaugh et al., 2019; Raurell-Torreda et al., 2017; Worsley et al., 2016). Mask fit assessment includes mask strap tension, air leak, patient discomfort and mask choice and size. According to the NPIAP (2019) guidelines, tension of strap and comfort of patients is also important in addition to mask fit. The patient's tolerance of NIV device and the prevention of pressure injuries can be considerably impacted by the correct choice of interface as well as the correct method of application (Alqahtani and AlAhmari, 2018).

It is important to consider alternating between different masks to potentially prevent skin breakdown. Different mask options include nasal mask, nasal pillow, oronasal mask (most common), total face mask, and helmet interfaces (Miske et al., 2017 and Alqahtani & AlAhmari, 2018). Shikama et al. (2018) proposed a personalized fitted mask using 3D scanning technology as a means of preventing PIs. While the results showed improved comfort and decreased facial PIs the cost of this may be a limitation and may not be a realistic option.

Another important component of appropriate mask fit is air leak, strap tension and how they interrelate. Research reports on the direct effects of air leak and strap tension as factors associated with facial PI (Alqahtani & AlAhmari, 2018; Lauderbaugh et al., 2019; Miske et al., 2017; Raurell-Torreda et al., 2017; Shikama et al., 2018 and Worsley et al., 2016). Lauderbaugh et al. (2019) identified a statistically significant association between NIV mask air leaks and the incidence of facial PI formation. Similarly, Shikama et al. (2018) describes an association between excessive air leaks and the development of NIV mask-related PIs. Furthermore, it reports that when air leaks are detected by clinicians, they tend to press the NIV mask tightly against the face to decrease the leak. Without proper training when nurses discover an air leak they will tighten the straps to achieve a better seal and this tightening causes undue pressure to the nasal bridge increasing the likelihood of PI development. Multiple studies report best practices to address mask fit to reduce pressure. Miske et al. (2017) recommends tightening the mask straps slowly, only tightening when necessary, in order to minimize but not eliminate the air leak. Patient's self-reported comfort is another great way to assess pressure and mask fit while at the bedside to reduce skin breakdown. Training for staff is necessary to educate on mask choice, minimizing air leak, avoiding over-tightening of straps and patient comfort as recommended by Shikama et al. (2018).

Barrier and Moisture

Several studies found that use of a prophylactic dressing, as a barrier between the mask and the patient's skin, is a key component in preventing facial PIs. Cohen et al. (2019) measured the amount of force applied to a patient's face at different points under the mask and compared data with and without prophylactic dressing. Contact forces at the bridge to the nose were decreased 25% after applying the dressing cuts. This finding is consistent with the NPIAP (2019)

recommends a prophylactic dressing at the skin-device interface to reduce the incidence of medical device related PIs. However, it remains important to complete skin assessments beneath the device even with a prophylactic dressing in place (NPIAP, 2019).

Reducing the moisture of the skin beneath the device is a key PI prevention practice. Alqahtani & AlAhmari (2018), Black & Kawoles (2016), and Raurell-Torreda et al. (2017) agreed that keeping the skin dry and clean under medical equipment is necessary to prevent maceration and minimize friction. Another study (Black, 2020) suggests that when removing the mask for assessment to cleanse the skin each time, and to clean the mask routinely each shift.

Education and Collaboration

PIs are primarily caused by a lack of awareness and understanding by clinicians on how to check the skin, how to disconnect the NIV device and how to properly seal the mask to prevent air leak without excessive strap tension (Alqahtani & AlAhmari, 2018). While some studies included education training programs, others included super users to serve as unit resources. Collaboration with respiratory therapy is a critical component of preventing NIV device related PIs as they are trained on both the NIV device settings and mask fit. Collaborative rounds between respiratory therapy, bedside nurse and the wound care nurse can also be useful for PI prevention (PIP). These collaborative rounds consisted of assessing the patient's skin, reviewing documentation, risk scoring, prevention interventions (Padula et al., 2017). This strategy would encourage communication and collaboration between disciplines to provide consistent preventative PIP care measures for patients requiring NIV. In summary, the key evidence-based practices that can reduce the incidence of PI associated with NIV medical devices includes mask fit and strap tension, skin assessment, barriers and moisture, and collaboration and education.

Theoretical Framework

The RE-AIM conceptual framework (Glasgow, Vogt, & Boles, 1999) is an evidence-based implementation model used to guide this study that examined the implementation of the nurse-led NIV PIP algorithm for acute care patients. The five components of the RE-AIM framework are: Reach, Efficacy, Adoption, Implementation, and Maintenance (Gaglio & Glasgow, 2013). In this study, r*each* included the number of patients requiring NIV in the selected acute care hospital units included in this pilot study. The *Effectiveness* of the intervention protocol compared pre-implementation and post-implementation incidence of NIV medical device PIs. The *adoption* component of the nurse-led clinical algorithm adoption included pre- and post-intervention knowledge and application of algorithm use; and the nurses' perceptions of usefulness and feasibility of using the algorithm in the clinical setting. *Implementation* in this study focused on the fidelity of the nurse-led clinical NIV PIP algorithm. In this study, potential *maintenance* or how to sustain use of the algorithm and integrated into nursing practice was assessed by the nurses' report of barriers and facilitators for implementation of the NIV PIP algorithm. The use of the RE-AIM framework also defines the limitations of this pilot study which is the underlying rationale for the overall study purpose (Aerts et al., 2013).

Purpose and Aims

The purpose of this pilot study was to determine the impact of a nurse-led PIP educational protocol for NIV use and algorithm training on select hospitalized patients. This study expands the use of evidence-based research to a subgroup of patients requiring use of a NIV medical device and use of a clinical algorithm for the implementation component in this study. Appendix A delineates the nurse-led clinical algorithm and the education plan that was provided for the nursing staff. The specific aims of this study included:

1. Evaluate the reach of the nurse-led clinical algorithm for PIP associated with NIV use. (Number of patients requiring use of NIV during the study period compared to the number of patients receiving protocol interventions).
2. Assess the effectiveness of the nurse-led clinical algorithm for PIP educational protocol for NIV use and algorithm training. (Pre/post-implementation comparisons of total number patients requiring NIV and associated NIV medical devices associated PIs based on medical record documentation).
3. Describe the adoption of the nurse-led clinical algorithm for PIP associated with NIV use. (Nurses pre/post education outcomes, nurse perceptions of usefulness and feasibility of algorithm implementation).
4. Evaluate the implementation fidelity of the nurse-led clinical algorithm for PIP associated with NIV use (Nursing documentation of PIP intervention components for NIV patients, daily rounding observation data associated with nurse-led clinical algorithm use, and using the Systems Usability Scale (SUS) Questionnaire).
5. Assess the potential for maintaining the use of the nurse-led clinical algorithm for PIP associated with NIV. (Nurse perceptions of algorithm implementation barriers and facilitators).

METHODOLOGY

Design

A prospective pilot study design was used to evaluate the impact of the nurse-led education for PIP associated with NIV for hospitalized patients requiring NIV.

Setting

This pilot study was conducted at a Midwestern community medical center, with a total of 640 beds between two hospital campuses. In this pilot study, the nurse-led educational protocol for PIP associated with NIV was utilized on two of the nursing units. One of the units is a 25-bed cardiac medical progressive care unit and the second unit is a 20-bed neuro trauma intensive care unit. Approximately 5-10 patients per week requiring NIV therapy are cared for on the progressive care unit of study and 10-15 patients on the intensive care unit of study.

Subjects

The focus of this study was on the implementation of the nurse-led PIP associated with NIV by the nursing staff on two nursing units in this study. All qualified nursing staff on the two units, a progressive care unit and an intensive care unit, were trained on the study protocol by the research nurses. There are approximately 75 intensive care nurses and 40 progressive care nurses. Inclusion criteria for nurses in this study were: nurses employed on either of the two units during the study period. Exclusion criteria for this study were: nurses are employed as float staff or are working as a travel nurse and employed by an agency.

Nurse-Led Education for PIP Associated with NIV

The education focused on the four main components of PIP in patients using NIV in the acute care setting. These are facial skin assessment, NIV device mask fit, moisture reduction and prophylactic barrier, and interdisciplinary communication. The education program also focused on the enactment of the components by nurses when caring for patients requiring NIV devices. The educational program informing this study was supported by research studies reporting the particular value of integrating care management into this format to support the implementation of nursing interventions for PI prevention (Alqahtani & AlAhmari, 2018; Miller et al., 2018; Gefen

& Ousey, 2020; Rowe et al., 2018). An educational session was be provided to the staff nurses to decrease PI secondary to NIV.

Facial Skin Assessment

The educational session outlines for nurses what is expected for the skin assessment of the face under NIV masks as evidenced by previous literature. Skin assessment under the NIV mask is to occur every four hours on the patient receiving NIV therapy continuously (Alqahtani & AlAhmari, 2018; Acorda & Gordon, 2015; Lauderbaugh et al., 2019; Miske et al., 2016). Assessment of the skin included the evaluation of redness and/or open areas and palpation to assesses for blanchable or non-blanchable erythema (Acorda & Gordon, 2015; Black & Kalowes, 2016; Barnard & Copson, 2016; Hess, 2020; Lauderbaugh et al., 2019; Miller et al., 2018; Raurell-Torreda et al., 2017). If a dressing was in place, the skin underneath was to be assessed. Levels of skin integrity changes was discussed using examples of different patient scenarios. Appropriate documentation of nursing assessment of skin impairment findings was explained. Nurses were educated upon presence of non-blanchable erythema or open skin on the procedure: documentation with pictures of the skin impairment, wound nurse consult and consultations with respiratory therapy on an alternative NIV mask.

NIV Device Mask Fit

The second point of emphasis for the nursing educational session focused on proper mask fit. Respiratory therapists are the clinical experts in types of masks and how adjustments can be made to achieve proper fit. In collaboration with respiratory therapy a video was presented to the nursing staff to teach about proper mask fit and different mask options, like oronasal mask, nasal pillow, and total face mask (Miske et al., 2017 and Alqahtani & AlAhmari, 2018). The educational video demonstrated how to assess if the mask is fitting appropriately and steps to

take if the mask fit is incorrect. Strap tension is an important component to educate staff on to precent PIs (Alqahtani & AlAhmari, 2018; Lauderbaugh et al., 2019; Miske et al., 2017; Raurell-Torreda et al., 2017; Shikama et al.,2018; and Worsley et al,. 2016). The video demonstrated proper application of NIV mask and slow tightening of straps to reduce air leak. Nurses should also be able to assess if a mask is the proper size when looking at the patient.

Moisture Reduction and Prophylactic Barrier

Ways to prevent and correct moisture under the NIV masks and use of prophylactic skin barriers were emphasized in the third component of education provided to the nursing staff. The NPIAP recommends keeping skin dry and clean underneath all medical devices (Raurell-Torreda et al., 2017; NPIAP, 2019). NIV creates a unique challenge as it applies continuous pressure to the face and nasal bridge needed to achieve proper mask fit. There is often condensation in the tubing and mask secondary to humidification settings on the NIV device, heat from exhaled breath, and the patient's skin temperature. Moisture and pressure are precursors to PIs (Gefen & Ousey, 2020). Nurses were educated on the importance of cleaning the patient's face and NIV masks each shift if the patient is medically stable to remove device for a brief time. Research related to the pandemic has been useful for combatting moisture related issues on other types of masks. This evidence can be applied to NIV masks. Cleaning skin under masks that apply direct pressure, helps prevent skin breakdown (Black, 2020). Black states cleansing the skin using a pH-balanced product and applying moisturizer to the clean skin helps restore the skin's architecture (Estocado & Black, 2019). While the mask is off to assess skin integrity, this also gives patients a break from the moisture and pressure, while using this time to clean the skin and mask (Cai et al., 2019).

Nurses were educated that areas of facial skin that are under the NIV mask and are constantly moist, indicating a need for the use of a protective barrier (Fletcher, 2019). Prophylactic barriers are commonly used in PIP strategies for areas of the body and the NPIAP recommends this usage under medical devices (NPIAP, 2019). Protective barriers help prevent skin breakdown as pressure is offloaded, and skin is protected from the direct pressure and friction of the mask (Raurell-Torreda et al., 2017). Nursing staff was educated on the importance maintaining clean face, skin, and NIV mask in addition to using protective barriers to offload pressure to prevent NIV related PIs.

Interdisciplinary Communication

Interdisciplinary collaboration through communication between nurses and respiratory therapy is crucial to reduce NIV PIs. Nursing staff was coached on initiating communication with the respiratory therapy and the wound care nurse team. Wound description terminologies were provided to assist in electronic medical record documentation, defined from the text Wound, Ostomy, and Continence Nurses (WOCN) Society Core Curriculum: Wound management (McNichol et al., 2021). Definitions of erythema, blanchable, pressure injury, and mucosal membrane pressure injury were included in education. The book reports the standard of wound care practice and based on NPIAP recommendations.

Multiple studies report the value of collaborating with interdisciplinary team members to reduce NIV related PIs. Weekly bedside interdisciplinary rounding was a utilized by Acorda & Gordon (2015) during their study, and this ensured consistency and sustainability of practice. Furthermore, the study's primary focus was to develop a collaborative relationship between respiratory and nursing to take joint ownership of caring for patients on NIV support (Acorda & Gordon, 2015). Lack of communication between nursing and respiratory therapy has been found

to be a contributing factor of many issues (Acorda & Gordon, 2015). NPIAP recommends proper documented procedures and expectations to help staff prevent device specific PIs and increase nursing knowledge. The NIV algorithm is meant to guide nursing staff on when to contact the respiratory therapy and the wound care nurse teams for further NIV or wound assistance.

Procedures

The nurse-led education for PIP associated with NIV was delivered by video, developed by the principle investigators of this study. The video education provided training to the nurses for implementing the nurse-led NIV PIP algorithm on the selected nursing units at the study site. The procedures are as follows.

Educational Video

An interdisciplinary educational video was developed to discuss the four key components for this study: facial skin assessment, mask fit and strap tension, prophylactic barrier and moisture reduction, and interdisciplinary communication. This education was administered by the principal investigators during unit staff meetings to the consenting nursing staff. Nurses who are unable to attend the staff meeting were emailed the video. This video was easily accessible for staff to refer back to if needed. The NIV PIP algorithm can be a quick reference guide as a reminder of the steps for nurses.

The video began by explaining the hospital's statistics with NIV related PIs. Next, the video addressed the four components of the algorithm: skin assessment, NIV device mask fit, moisture reduction and prophylactic barrier and interdisciplinary communication. Lastly, the video summarized three common patient scenarios and problem solving strategies to manage scenarios. Refer to Appendix B with the detailed outline of the video.

Clinical Algorithm

The clinical algorithm for this study was developed using evidence-based guidelines and to serve as a guide for nurses to use in their decision making with PIP associated with NIV patients. The goal was to prompt an interdisciplinary consultsation with respiratory therapists and wound nurses are necessary to best prevent facial PIs. Ideally, the algorithm will guide nurses to take the corrective action and provide interventions for PIPs associated with NIV use. Refer to Appendix A for the algorithm.

Preparation for Implementation

Meetings between the respiratory department and wound care team were initiated by the research team, to collaborate on the nurse-led education for PIP associated with NIV. Both specialties were involved in the development of the educational program and the clinical algorithm. Prior to the educational session and data collection, a meeting with the nurse managers was held to promote buy in for the study implementation.

Measurement

Pre and Post Nurse Education Surveys

Nurses participating in the educational sessions completed both pre and post surveys focused on PIPs associated with NIV use. The survey assessed nurses' knowledge, comprehension and application pertaining to implementation of the algorithm components. The content of the survey questionnaire is presented in Appendix C. The investigator developed survey tool is comprised of multiple choice questions. Surveys were administered to all eligible nursing staff of the two study nursing units one week before their staff meeting, prior to the start of the pilot study implementation on the respective nursing units. The post-survey was administered to the nurses one week following the completion of the educational video.

Retrospective and Prospective Incident Report Audits

The study's principal investigators collected PI trends for the hospital using its incident reporting system to gather baseline PI data. Only incident reports from both study units that are related to NIV therapy patients were reviewed. Data was collected on location of PI and stage of injury, how long patient was receiving NIV therapy, what discipline entered the incident report, and any identified risk factors. This data was collected one month before the educational session. The same variables were collected after the two week bedside rounding period and clinical algorithm implementation.

Retrospective Medical Record Review

A retrospective chart audit was completed on all NIV patients on the units of study. A list of all patients was obtained from unit managers for study units of all patients that were on NIV on the study units during the two week study time frame. Researchers reviewed documentation to see if proper charting by the nurses occurred for the proper interval of times (every four hours). This review occurred each day during bedside rounding to check the bedside practice. See appendix D for medical record documentation reviewing questions.

Bedside Rounding

Implementation of the nurse-led education for PIP associated with NIV was evaluated by bedside rounding with the staff nurses, in addition to the retrospective incident reports and medical record review. Investigators interviewed floor nurses outside of the patient's room after they completed a facial skin assessment on a NIV patient during one of their every four-hour nursing assessments. Research nurses discussed the PIP associated NIV assessments completed. The bedside nurse and principal investigators discussed the use of the algorithm with nursing staff caring for NIV patients. Rounding with staff occurred once every day for two weeks during a skin assessment interval on each study unit. Bedside rounding was not repeated on the same

staff nurses if caring for multiple NIV patients during this pilot study. Investigators encouraged the use of the algorithm by providing a physical copy to each nurse caring for a patient on NIV therapy during the study. Evaluation of algorithm utilization included following the appropriate pathway based on physical examination findings of the skin under the device. The study's principal investigators asked specific rounding questions to evaluate understanding and utilization of the algorithm in real time in order to elicit qualitative feedback from the nurses. See appendix E for the specific rounding questions that researchers investigated.

SUS Questionnaire

The SUS questionnaire was provided to the nursing staff after having received the initial educational session and at the end of the study. The SUS questionnaire provides a quick and individualized reference score for the nurse-led education for PIP associated with NIV clinical algorithm's usability, rated by the bedside nursing staff enrolled in this study. The SUS questionnaire is composed of 10 statements that are scored on a 5-point Likert scale, with higher scores indicating better usability (Bangor, Kortum, Miller, 2008). To calculate the overall score, first the contributions for each item must be added. Each item's score contribution ranges from 0-4. The sum is then multiplied by 2.5 and can range from 0-100 for the final score (Brooke, 1995). Reliability data has been collected on the SUS questionnaire with Cronbach's alpha ranging from 0.70-0.95. The measure has demonstrated both content and construct validity (Lewis, 2018). See appendix F for the outline of the standardized SUS questionnaire.

Results

Algorithm Reach

During the two week study period there were 16 patients utilizing NIV therapy on the two nursing units. On the intensive care unit there were seven NIV patients and nine NIV patients on the progressive care unit. Out of the total 16 patients, 14 patients, or 87.5% of the NIV patients were receiving protocol interventions and PIP care. Two of the patients were not included as they were not receiving care from NIV PIP algorithm oriented nursing staff.

Algorithm Effectiveness

During the month prior to the study, there were no NIV PI that occurred based on the results of incident reports for the nursing units included in the study. Similarly, during the two week feasibility study period, there were no NIV PI that occurred on the either of the units of study. However, during the feasibility study period, there were two NIV associated PI on two patients of study that had PI prior to transfer to nursing units participating in this study.

Adoption of Algorithm by Nursing Staff

During the staff meetings a total of 44 intensive care nurses and 25 progressive care nurses received the video education. There were 35 nurses who completed the pre-educational survey with a mean score of 66.57% (SD 12.82). 10 nurses completed the post-educational survey; their mean score increased to 77.78% (SD 20.48). Please refer to appendix G for individual question results and findings

Immediately after the video education was presented, there were 21 nurses who had completed the System Usability Scale (SUS) Tool and mean score 83.33% (SD 10.73). After the two week feasibility study, there were five nurses who completed the post-SUS tool, improving the overall average score to 85.63% (SD 8.26). Appendix H delineates the SUS tool findings

During the two week study period, bedside rounding was completed with 22 nurses. Of those nurses who were interviewed during bedside rounding, five intensive care nurses and one progressive care nurse had not completed the video education. However, six intensive care nurses and ten progressive care nurses had completed the video education. Nurse interviews determined that 82% of the nurses reported utilizing the NIV PIP algorithm to assist them in their care of NIV patient. Overall, the feedback regarding the algorithm was positive and data revealed that 86% of staff felt the algorithm was not challenging to use, did not negatively impact their workflow, and liked the algorithm. When asked if they thought the algorithm was helpful, 100% felt it could be helpful, but two specified it would be a great resource for newer nurses. Bedside rounding found that two nurses were not planning on using the algorithm as they had not received the education despite being offered to watch the video. Nursing staff who completed the education felt the algorithm gave them a guide in frequency of assessment, when to consult wound nurses and collaboration with RT. However, it was stated by 100% of staff that the algorithm was appreciated as a resource and guidance caring for the NIV patient. Please see appendix I for the summary table of bedside rounding answers with nursing.

Implementation Fidelity

Fidelity of implementing the NIV PIP algorithm included audits of nursing NIV documentation during a two week data collection period. Audits included assessing frequency of assessments and whether a prophylactic barrier was in place. The number of assessments related to NIV were based on the length of time the patient utilized NIV and it was determined how many possible every four hour assessments should have been completed by nursing staff. Documentation assessment found an average of 54% of the every four hour NIV PI assessments

were completed on the NIV PI patients of study during the two week period. Please see appendix J with medical record data.

Prophylactic barrier was assessed during medical record review and discussed during bedside rounding with nurses. Of the 16 NIV patients during the study, medical record review found three (18.75%) patients had a prophylactic barrier placed on initiation of NIV. It was found that one patient had a prophylactic barrier placed within six hours of initiation and one patient had a prophylactic barrier placed within 24 hours of NIV initiation. It was found that for both patients with preexisting NIV related PI from previous bedside units, that documentation was inconsistent with documenting any skin breakdown present or prophylactic barrier being used to further prevent skin injury. Inconsistencies were found in documentation. There were no incident reports submitted for any patient during the study, but redness or skin breakdown was documented on six of the patients during medical record review of NIV PI assessment.

Potential for Maintaining Use of NIV PIP Algorithm

Implementation Facilitator

There is great potential for maintaining the use of the nurse-led clinical algorithm for NIV PIP. During bedside rounding there were several staff members who had not received the training and still were interested in using the algorithm in their daily practice and felt it was a helpful resource. One staff member suggested the algorithm should be laminated and attached to each NIV machine. While rounding with staff a nurse who received the education, but was not caring for an NIV patient stated, “the education has made me more cognizant of assessing skin under other oxygen devices including my patient on AirVo.” Overall, the education and the algorithm did not increase workflow for the staff and majority felt the algorithm assisted their critical thinking. With the algorithm being characterized as easy to use and clear, this will assist

in staff utilizing the algorithm in their daily practice. Staff had adopted the use of the algorithm despite it being new to their current practice. Some themes surrounding the algorithm that were expressed by staff during bedside rounding were that the algorithm was helpful, especially for newer nurses, easy to comprehend and use, and did not have a negative impact on workflow. Several staff felt the NIV PIP algorithm was a great resource and supported them in their role.

Limitations

Several opportunities to improve and support maintenance of using the NIV PIP algorithm were identified from data collected in this study. Medical record review found that under reporting of PI may have occurred based on assessment documentation, as documentation was not always congruent with NIV care actions taken. There were multiple areas of inconsistency in documentation as found in the medical record review of assessments. Some assessment documentation would identify skin breakdown yet the following assessment documentation would indicate "clean, dry, intact." This occurred for six of the NIV patients utilized during the study. Although bedside rounding found that 100% of staff felt the algorithm was useful, only 68.18% felt they would continue to use education in practice after the study. Another limitation was the motivation of staff to complete NIV PIP algorithm interventions and to sustain these practices after the feasibility study was completed. Sustaining change in providing nursing care based on the NIV PIP algorithm is challenging. In addition, it is difficult to monitor and track the utilization of the algorithm in the medical record. "Real time" strategies such as bedside rounding are needed to solidify nursing practices and to support collaborative communication between bedside nurses, wound care nurses, and respiratory therapy.

The study included only 16 patients over the two week study period on two nursing units, creating a small data pool of NIV patients. In addition, a smaller number of nursing staff completed the post education and post SUS surveys. Not every nurse interviewed for bedside rounding completed the educational video and not every nurse that completed the surveys was interviewed for bedside rounding. Data may not represent learning of those with education with

their survey results. Limited data warrants further study to implement strategies for the uptake of the NIV PIP algorithm implementation. Adding more beneficial data can improve the stregnth of the study.

Discussion

This study was conducted to investigate evidence-based strategies to prevent NIV pressure injuries. Research surrounding NIV PIP is limited. There were several articles discussing interventions from mask fit and prophylactic barriers under the mask to skin assessment under the device. However, the literature was lacking in regard to specific education for nurses on these interventions and proper implementation of these PIP interventions. Through this feasibility study we investigated a way to educate nursing staff on key NIV PIP techniques found in literature through use of video education and use of an algorithm to guide them in their decision making. The education not only taught about interventions for prevention, but also encouraged interdisciplinary collaboration. During this study there were no pressure injuries recorded in the two weeks prior to the education and none during the two weeks of the bedside rounding.

There were several key take aways from this pilot study. Through the education, based on the survey, the staff improved their knowledge on NIV PIP. Pre educational survey scores increased from 66.57% before education to 77.78% after video education. In addition, perception of usefulness of the algorithm increased from 83.33% prior to using it to 85.63% after using it in practice.

However, it cannot be known how this education translated into practice. 54% of the time during the study NIV PI assessments were documented. Documentation of appropriate assessment and interventions did not reflect the knowledge staff gained from the education. There were not incident reports submitted by nurses although documentation showed six patients with skin redness or breakdown. Due to the lack of proper documentation is it difficult to know if

what the staff learned made it into daily practice. In addition, it was not possible to review medical record documentation and bedside round with each of the 69 staff nurses that completed the video education as they did not all have NIV patients during the study. 27.27% had not received the video education prior to the bedside rounding. This creates an additional challenge as they had not completed the full education prior to our interviews.

The NIV PIP algorithm was determined to be useful and there was positive feedback from staff. Bedside rounding found that nurses thought the algorithm was helpful, easy to use, and did not inhibit their workflow. It was anecdotally mentioned that education on assessing skin beneath the NIV mask also made staff more aware of assessing skin under other devices.

Implications

Implications of this study include creating an educational framework for bedside nursing staff, to improve PIP in patients using NIV. The data from this study can serve as a framework to support practice change and provide awareness of possible clinical barriers. Skin assessment and NIV education has been recognized as an area of improvement by the institution supporting this study. The intent is for this nurse-led education and clinical algorithm for PIP will improve patient care by preventing facial pain, discomfort, and possible long term deformity in patients using NIV therapy.

Conclusions

Findings from this study indicated the usefulness of improving nursing care for patients requiring NIV. Bedside rounding with nurses caring for patients requiring NIV supported and reinforced use of the evidence-based practices for NIV PIP. Further study is necessary to further refine the NIV PIP algorithm and interdisciplinary communication. In addition, opportunities to further integrate the NIV algorithm practices into nursing patient care exist.

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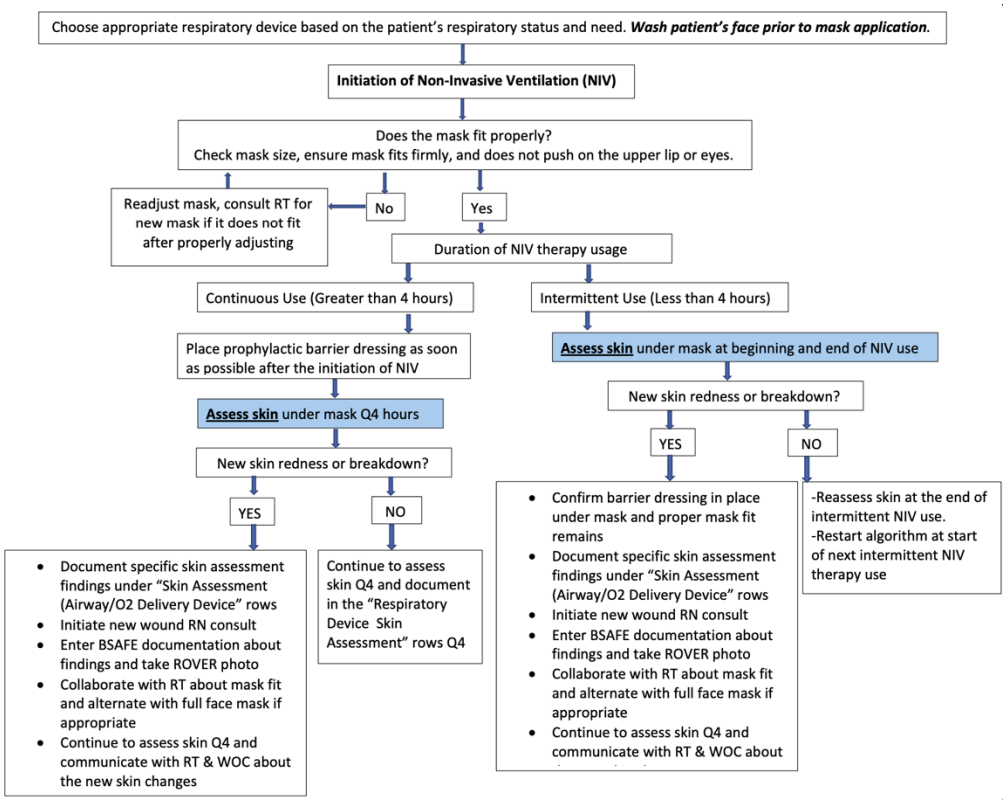
Appendix A

Figure 1

Nurse-Led Clinical Algorithm for Pressure Injury Prevention Associated with Non-Invasive Ventilation Medical Device



Appendix B

NIV PIP Video Education Outline

NIV PIP Video Education Outline	
Overview of the NIV Algorithm (4 Pieces)	● Provide data of NIV related PI specific to the medical center and explain the relevance of the study ● Introduce algorithm as a summary piece of the education, the NIV algorithm will be available for nurses to utilize in practice as a guideline
1) Skin Assessment	● Provide definitions of common skin facial assessment findings ● If wearing continuously and **able to maintain adequate respiratory status**, remove device to assess under device Q4 ● On continuous NIV initiation, place prophylactic barrier dressing **as soon as possible** and wash face prior to application ● Inspect and palpate all areas that the mask places pressure on the face ● Look for any signs of redness or breakdown, peel back dressing to inspect skin and put back flat after check. ● Document assessment findings under "Skin Assessment (Airway/O2 Delivery Device)" ● If new redness or wound present, photograph wound to link in chart using approved hospital device (Rover device). ● If **new** redness (blanchable or non-blanchable) or breakdown present, place wound nurse consult and communicate to

	respiratory therapy. If redness or wound already present, confirm that wound has been consulted already. ● If redness or breakdown present, collaborate with respiratory therapy to determine if alternating with full face mask is appropriate
2) Mask Fit	● Overall goal of improved nurse understanding of how to safely place mask and remove mask for skin assessments ● Video of respiratory therapy and RN adjusting different type of NIV masks ● Tips on how to recognize if a mask is not fitting properly due to size/shape ● Tips on strap tension and minimizing mask leak
3) Moisture Reduction and Prophylactic Barriers	● Educate how moisture impacts risk for pressure injury, ● Educate on the importance of cleaning the face at initiation of continuous NIV and the *minimum* of once per shift as it will be a constant moist environment due to NIV therapy humidification ● Place prophylactic dressing **immediately** after application for continuous NIV use ● If prophylactic barrier soiled or no longer functioning properly, replace with new prophylactic dressing
4) Communication between Nursing, Respiratory therapy and Wound Care Nurses	● Report **any** redness to respiratory therapy and wound care nurses immediately and initiate wound nurse consult

	● Example of what should be included in incident report for new pressure injury/wound ● Example of "Skin Assessment (Airway/O2 Delivery Device)" rows to assess and chart for NIV assessment, to be charted Q4 continuous wear and start/end of intermittent wear
Example Summary	● Will include three examples of patient scenarios accompanied with photos of different types of facial assessments and proper assessment documentation for each scenario

Appendix C

Pre and Post Survey Education Questions

	NIV PIP Education Pre/Post Survey Questions
1	What is the correct procedure for the facial skin assessment of the non-invasive ventilation patient:
2	How frequently should you assess the skin of the face under non-invasive ventilation devices?
3	How do you verify that proper mask fit is achieved? Select all that apply:
4	What should you do if the mask has an air leak?
5	What are some of the interventions that can be utilized to prevent pressure injuries on the face?
6	When do you place a prophylactic barrier on the face?
7	When should you consult wound care for a non-invasive ventilation patient with skin breakdown?
8	When should you collaborate with respiratory therapy about alternating non-invasive ventilation masks? Select all that apply:
9	What assessment findings are important to communicate to respiratory therapy? Select all that apply:
10	Nurses should document under the following EPIC flowsheet:

Appendix D

Medical Record Review Criteria

1. Prophylactic barrier present on initiation of continuous NIV use?
2. Was nurse documentation completed for entire Skin Assessment (Airway/O2 Delivery Device) section Q4 for continuous NIV use?
3. If abnormal assessment documented (new redness or wound):
    a. Was it properly documentation under Skin Assessment (Airway/O2 Delivery Device)?
    b. New wound consult initiated?
    c. Incident report written?
    d. Photo documentation in chart?
    e. Alternate mask initiated with RT?

Documentation Flowsheet Rows

Skin Assessment (Airway/O2 Delivery Device)		
Site Assessed (Airway/O2 Delivery Device)		
Site Assessment (Airway/O2 Delivery Device)		
Dressing Applied (Airway/O2 Delivery Device)		
Dressing Changed On (Airway/O2 Delivery Device)		
Skin Assessment Comments (Airway/O2 Delivery Device)		
Wound Present?		
Type of Wound (LDA)		

Note: Flowsheet rows used to document skin assessment under respiratory devices.

Appendix E

Bedside Rounding Questions for Nurses and Bedside Observation Checklist

1. Describe how you have used the NIV algorithm today.
2. What has been challenging when using the NIV algorithm?
3. How has this impacted your workflow?
4. Do you think the NIV algorithm is helpful to nurses?
5. What questions do you have?

Appendix F

SUS Tool- NIV PIP Algorithm

QUESTIONS	STRONGLY DISAGREE 1	2	3	4	STRONGLY AGREE 5
1) I think that I would like to use the NIV PIP Algorithm frequently.					
2) I found the NIV PIP Algorithm unnecessarily complex.					
3) I thought the NIV PIP Algorithm was easy to use.					
4) I think that I would need the support of an expert person to be able to use the NIV PIP Algorithm.					
5) I found the various functions in the NIV PIP Algorithm were well integrated.					
6) I thought that there was too much inconsistency in the NIV PIP Algorithm.					
7) I would imagine that most people would learn to use the NIV PIP Algorithm very quickly.					
8) I found the NIV PIP Algorithm very cumbersome to use.					
9) I felt very confident using the NIV PIP Algorithm.					
10) I needed to learn a lot of things before I could get going with the NIV PIP Algorithm.					

Note. Adapted from SUS -A quick and dirty usability scale by J. Brooke, 1995, Redhatch Consulting Ltd.

Appendix G

Educational Survey Results Table 1: Individual Questions

NIV PIP Education Pre/Post Survey Results by Individual Item				
#	Individual Item	Correct Answer	Pre Survey % correct (n = 35)	Post Survey % correct (n = 10)
1	What is the correct procedure for the facial skin assessment of the non-invasive ventilation patient:	If respiratory status is appropriate, remove mask to assess the face, remove protective barrier if present, wash and clean face, dry face, observe skin under mask, blanch bony prominences, if skin breakdown or erythema present photograph to link in chart, replace protective barrier removed or place new protective barrier, replace mask while maintaining proper mask fit	71.43%	90%
2	How frequently should you assess the skin of the face under non-invasive ventilation devices?	Every 4 hours	68.57%	70%
3	How do you verify that proper mask fit is achieved? Select all that apply:	The machine is not alarming anymore, The mask does not encroach on the upper lip or the eyes, Straps are fitted but a finger can be placed under both straps comfortably, Patient is comfortable	2.86%	10%
4	What should you do if the mask has an air leak?	Assess mask size, adjust fit and straps, communicate with respiratory therapist	100%	80%
5	What are some of the interventions that can be utilized to prevent pressure injuries on the face?	Protective barrier placed on initiation of non-invasive ventilation, washing and cleaning of face once per shift, maintaining proper mask fit, and proper skin assessment of the face	68.57%	90%
6	When do you place a prophylactic barrier on the face?	As soon as possible after initiation of non-invasive ventilation	91.43%	80%
7	When should you consult wound care for a non-invasive ventilation patient with skin breakdown?	When there is new skin redness/non-blanchable erythema or skin breakdown under the device	74.29%	70%
8	When should you collaborate with respiratory therapy about alternating non-invasive ventilation masks? Select all that apply:	65 yo female patient on continuous NIV for 12 hours, 80 yo male patient newly initiated on NIV, 40 yo male COVID patient on continuous NIV for 4 days, 50 yo female patient with redness on bridge of nose and continuous NIV for 2 day	5.71%	40%
9	What assessment findings are important to communicate to respiratory therapy? Select all that apply:	Bridge of nose is red, Patient is not comfortable with NIV mask fit, Wound present, Improper mask fit, A wound consult was placed	74.29%	80%
10	Nurses should document under the following EPIC flowsheet:	Yes	77.14%	90%

Educational Survey Results Table 2: Overall Scores

NIV SUS Toool: Pre/Post Survey Total Score	
Pre Survey (n = 21)	Post Survey (n = 5)
83.33% (10.73)	85.63% (8.26)

Appendix H

SUS Results Table 1: Individual

System Usability Tool (SUS): Pre and Post Study Implementation										
	Pre SUS Tool (21 Participants)					Post SUS Tool (5 Participants)				
SUS QUESTIONS	STRONGLY DISAGREE 1	2	3	4	STRONGLY AGREE 5	STRONGLY DISAGREE 1	2	3	4	STRONGLY AGREE 5
1) I think that I would like to use the NIV PIP Algorithm frequently.	n = 1 4.8%	n = 0 0%	n = 1 4.8%	n = 10 47.6%	n = 9 42.8%	n = 0 0%	n = 0 0%	n = 0 0%	n = 4 80%	n = 1 20%
2) I found the NIV PIP Algorithm unnecessarily complex.	n = 13 61.9%	n = 7 33.3%	n = 0 0%	n = 1 4.8%	n = 0 0%	n = 2 40%	n = 2 40%	n = 0 0%	n = 1 20%	n = 0 0%
3) I thought the NIV PIP Algorithm was easy to use.	n = 0 0%	n = 0 0%	n = 0 0%	n = 11 52.4%	n = 10 47.6%	n = 0 0%	n = 0 0%	n = 0 0%	n = 3 60%	n = 2 40%
4) I think that I would need the support of an expert person to be able to use the NIV PIP Algorithm.	n = 9 42.8%	n = 8 38%	n = 2 9.5%	n = 1 4.8%	n = 0 0%	n = 4 80%	n = 1 20%	n = 0 0%	n = 0 0%	n = 0 0%
5) I found the various functions in the NIV PIP Algorithm were well integrated.	n = 0 0%	n = 0 0%	n = 0 0%	n = 12 57.1%	n = 9 42.8%	n = 0 0%	n = 0 0%	n = 0 0%	n = 4 80%	n = 1 20%
6) I thought that there was too much inconsistency in the NIV PIP Algorithm.	n = 14 66.7%	n = 7 33.3%	n = 0 0%	n = 0 0%	n = 0 0%	n = 3 60%	n = 2 40%	n = 0 0%	n = 0 0%	n = 0 0%
7) I would imagine that most people would learn to use the NIV PIP Algorithm very quickly.	n = 1 4.8%	n = 0 0%	n = 1 4.8%	n = 11 52.4%	n = 8 38%	n = 0 0%	n = 0 0%	n = 0 0%	n = 3 60%	n = 2 40%
8) I found the NIV PIP Algorithm very cumbersome to use.	n = 14 66.7%	n = 4 19%	n = 2 9.5%	n = 1 4.8%	n = 0 0%	n = 1 20%	n = 3 60%	n = 0 0%	n = 0 0%	n = 1 20%
9) I felt very confident using the NIV PIP Algorithm.	n = 0 0%	n = 1 4.8%	n = 1 4.8%	n = 13 61.9%	n = 6 28.6%	n = 0 0%	n = 0 0%	n = 1 20%	n = 2 40%	n = 2 40%
10) I needed to learn a lot of things before I could get going with the NIV PIP Algorithm.	n = 10 47.6%	n = 8 38%	n = 3 14.3%	n = 0 0%	n = 0 0%	n = 3 60%	n = 2 40%	n = 0 0%	n = 0 0%	n = 0 0%

SUS Results Table 1: Overall

NIV SUS Toool: Pre/Post Survey Total Score	
Pre Survey (n = 35)	Post Survey (n = 10)
83.33% (10.73)	85.63% (8.26)

Appendix I

Bedside Rounding Themes Overall Themes

Bedside Rounding Data				
Describe how you have used the NIV algorithm today and walk me through what you did for your assessment.	Questions about facial skin assessment, proper mask fit, moisture and prophylactic barrier, or interdisciplinary communicatiton?	What has been challenging when using the NIV algorithm?	How has this impacted your workflow?	Do you think the NIV algorithm is helpful to nurses?
> Algorithm assisted stadd in frequency of assessment: Q4 assessments > Used algorithm to support actions > Helpful when there is changes to patient's skin	> Majority had no questions > One wanted the algorithm laminated and on each bipap > Questions about when to place wound consult > Questions about collab with RT and useing them as resource	> No challenges - 13/22 > Liked it/helpful - 6/22 > Hasnt been using - 2/22 > Added steps - 1/22	> No change/impact to workflow - 13/22 > No experience or negative impact - 3/22 > Helpful guide or resource - 6/22	> Yes/good - 16/22 > Helpful for new nurses - 2/22 > Helpful, easy to use, as a reference - 4/22

Appendix J

Medical Record Review Themes

Nursing documentation aduit			
How many possible Q4 assessments?	How many completed by RN Q4?	% Q4 RN assess	Mepilex from beginning?
24	3	12.50%	Y
2	1	50.00%	N
3	1	33.33%	N
34	21	61.76%	N
16	11	68.75%	N
29	7	24.14%	Y
6	1	16.67%	N
2	1	50.00%	N
1	1	100.00%	N
20	13	65.00%	N - 24 hours until placed
9	5	55.56%	Y
15	14	93.33%	N
8	6	75.00%	N - placed 6 hours after initiating
4	2	50.00%	N