ISSNe: 2182.2883 | ISSNp: 0874.0283
Available: http://dx.doi.org/10.12707/RIV16015

RESEARCH PAPER (ORIGINAL)

Facial pressure ulcers in inpatients undergoing non-invasive ventilation in intermediate care units

Úlceras de pressão na face em doentes submetidos a ventilação não invasiva hospitalizados em cuidados intermédios

Úlceras por presión en la cara en pacientes sometidos a ventilación no invasiva hospitalizados en cuidados intermédios

Matilde Delmina da Silva Martins*; Patricia Sofia Costa Ribas**; Joana Raquel Almeida Sousa***; Norberto Anibal Pires da Silva****; Leonel São Romão Preto*****; Teresa Isaltina Gomes Correia******

Abstract

Background: Facial pressure ulcers are one of the most common complications associated with non-invasive ventilation (NIV).
Objectives: To determine the frequency of facial pressure ulcers in patients admitted to an intermediate care unit (ICU) and submitted to NIV, as well as to identify the associated factors.
Methodology: A prospective study was conducted between September and December 2015. Inclusion criteria: age ≥ 18 years, admitted to ICU, submitted to NIV and without facial ulcers at time of admission. A sample of 30 participants was obtained. Data were collected through a questionnaire, the Braden Scale and the Glasgow Scale.
Results: The frequency of facial pressure ulcers was 26.7%, 16.7% of stage II and with a mean onset of 3.3 days. Most participants were male (70.0%), and the mean age was 74.2 years. Patients undergoing more hours of VNI per day, more days of NIV and more days of hospitalization had a higher frequency of facial pressure ulcers.
Conclusion: Given that the number of hours of NIV increased the frequency of Facial pressure ulcers, we suggest periods of interruption of NIV use.

Keywords: non-invasive ventilation; ulcer; pressure ulcer; skin ulcer; face

Resumo

Enquadramento: A úlcera da face é uma das complicações mais frequentes associada à prática de ventilação não invasiva (VNI).
Objetivos: Determinar a frequência de úlceras da face em doentes internados numa unidade de cuidados intermédios (UCI) submetidos a VNI e identificar fatores associados.
Metodologia: Estudo prospetivo realizado entre setembro e dezembro de 2015. Critérios de inclusão: idade ≥ 18 anos, internamento em UCI, com VNI e sem úlcera da face na admissão, resultando numa amostra de 30 participantes. Os dados foram obtidos através de um questionário, da escala de Braden e de Glasgow.
Resultados: A frequência de úlcera foi de 26,7%, 16,7% de grau II e o tempo de aparecimento médio de 3,3 dias. Predominou o género masculino 70,0%, a média de idade foi 74,2 anos. Doentes submetidos a mais horas de VNI por dia, maior número de dias de VNI e mais dias de internamento apresentaram frequência superior de úlceras.
Conclusão: O número de horas de VNI aumenta a frequência de ulceras por pressão (UP), sugere-se a interrupção dos períodos de utilização.

Palavras-chave: ventilação não invasiva; úlcera; úlcera por pressão; úlcera cutânea; face

Resumen

Marco contextual: Las úlceras faciales son una de las complicaciones más frecuentes asociadas con la práctica de la ventilación no invasiva (VNI).
Objetivos: Determinar la frecuencia de úlceras faciales en pacientes ingresados en una Unidad de Cuidados Intermedios (UCIM) sometidos a una VNI e identificar los factores asociados.
Metodología: Estudio prospectivo realizado entre septiembre y diciembre de 2015. Los criterios de inclusión fueron: edad ≥ 18 años, hospitalización en la UCIM, con VNI y sin úlcera facial en la admisión, lo que dio como resultado una muestra de 30 participantes. Los datos se obtuvieron mediante un cuestionario de la escala de Braden y Glasgow.
Resultados: La frecuencia de úlceras fue del 26,7 % y del 16,7 % de grado II, y el tiempo medio de aparición de 3,3 días. Predominaron los varones, el 70,0 %, y la edad media fue de 74,2 años. Los pacientes sometidos a más horas de VNI al día, más días de VNI y más días de hospitalización presentaron mayor frecuencia de úlceras.
Conclusión: El número de horas de VNI aumenta la frecuencia de las úlceras por presión, se propone la interrupción de los períodos de utilización.

Palabras clave: ventilación no invasiva; úlcera; úlcera por presión; úlcera cutânea; cara

* Ph.D., Assistant Professor, School of Health, Polytechnic Institute of Bragança, 5300-121, Bragança, Portugal [matildemartins@ipb.pt]. Contribution to the article: literature search; data collection, statistical treatment and assessment, data analysis, discussion, and article writing. Address for correspondence: Rua da Lomba, lote B, nº 41, 5300-121, Bragança, Portugal.
** RN, School of Health, Polytechnic Institute of Bragança, 5300-121, Bragança, Portugal [patriciasofiaribas@gmail.com]. Contribution to the article: literature search; data collection, statistical treatment and assessment, data analysis, discussion, and article writing.
*** RN, School of Health, Polytechnic Institute of Bragança, 5300-121, Bragança, Portugal [joana_raquel9@live.com.pt]. Contribution to the article: literature search; data collection, statistical treatment and assessment, data analysis, discussion, and article writing.
**** MSc., Specialist Nurse, Urgency, Emergency and Intensive Care, Local Health Unit of Nordeste Bragança, 5300-587, Bragança, Portugal [norbertosilva@sapo.pt].
Contribution to the article: literature search; data collection, statistical treatment and assessment, data analysis, discussion, and article writing.
***** Ph.D., Coordinating Professor, School of Health, Polytechnic Institute of Bragança, 5300-121, Bragança, Portugal [leonelpreto@ipb.pt]. Contribution to the article: literature search; data collection, statistical treatment and assessment, data analysis, discussion, and article writing.
****** Ph.D., Coordinating Professor, School of Health, Polytechnic Institute of Bragança, 5300-121, Bragança, Portugal [teresaicorreia@ipb.pt]. Contribution to the article: literature search; data collection, statistical treatment and assessment, data analysis, discussion, and article writing.

Received for publication: 29.02.16
Accepted for publication: 11.07.16

Introduction

Non-invasive ventilation (NIV) is a ventilation modality using a mask as patient-ventilator interface without the need for an artificial airway and sedation, thus improving patient comfort and reducing hospital length of stay (Cruz & Zamora, 2013). NIV has proven to be effective in the treatment of respiratory failure (RF) of various causes. The use of NIV in the treatment of patients with acute or chronic RF has certainly been one of the greatest advances in mechanical ventilation in recent decades (Silva et al., 2013). For 20 years now, its application in clinical practice has increased, as well as the availability of technological resources for its implementation, being currently considered the first-line treatment of acute RF (Cruz & Zamora, 2013). Although NIV is a safe and effective ventilation modality which is more comfortable for the patient than invasive mechanical ventilation (IMV), evidence shows that its implementation can lead to the development of facial pressure ulcers and ulceration of the nasal dorsum (Maruccia, Ruggieri, & Onesti, 2015; Silva et al., 2013). Pressure ulcers (PUs) are localized areas of the body surface exposed to prolonged high pressure, friction or shearing, so as to prevent local circulation, with consequent tissue destruction and/or necrosis (Ministério da Saúde, Direcção-Geral da Saúde, Rede Nacional de Cuidados Continuados Integrados, 2007). Maruccia et al. (2015) argue that facial skin breakdown is very often, and can range from 2.0 to 70.0%. In Portugal, studies on the frequency and incidence of facial pressure ulcers in patients with NIV are rare. Thus, this study aims to determine the frequency of facial pressure ulcers in patients admitted to an intermediate care unit (ICU) and submitted to NIV, as well as to identify associated factors.

Background

NIV is a ventilation support method applied to the patient's airway through masks (facial/nasal) or respirators, instead of endotracheal tubes, and operate as patient/ventilator interface (Marcelino, 2009). This ventilation modality is used in several situations, such as deterioration of gas exchange, hypercapnic respiratory failure and respiratory acidosis, dyspnea with use of accessory muscles and/or paradoxical breathing, tachypnea, exacerbation of chronic obstructive pulmonary disease (COPD), asthma, facilitation of extubation, cardiogenic pulmonary edema, pneumonia, acute respiratory distress syndrome, immunosuppressed patients, postoperative period, extubation failure, end-of-life stage, pre-intubation oxygenation, and facilitation of bronchoscopy (Cruz & Zamora, 2013). However, despite the broad spectrum of indications, contraindications should be taken into account, namely cardiac arrests and/or respiratory disorders, severe encephalopathy with Glasgow Coma Scale (GCS) <10 with risk of aspiration, severe upper gastrointestinal bleeding, hemodynamic or electrocardiographic instability, facial deformity or trauma, upper airway obstruction, inability to protect the airways, inability to remove secretions, severe hypoxemia, untreated pneumothorax, need for sedation, increased risk of aspiration, multiple organ failure, and acute myocardial infarction (Marcelino, 2009; Cruz & Zamora, 2013). The primary benefit of using such a ventilation method is the prevention of complications from invasive ventilation, such as the aspiration of gastric contents, oropharynx trauma, ventilator-associated pneumonia, tracheal stenosis, and pneumothorax (Passarini, Zambon, Morcillo, Kosour, & Saad, 2012). NIV also maintains the ability to speak and cough, reduces the need for sedation, the risk of hemodynamic instability, and delirium, preserves the activity of respiratory muscles, and leads to less time on mechanical ventilation, ICU stay, and increased survival (Marcelino, 2009; Cruz & Zamora, 2013). However, it has been shown that one of the most common complications during this ventilation method is the ulceration of the nasal dorsum (Maruccia et al., 2015; Silva et al., 2013). The National Pressure Ulcer Advisory Panel (NPUAP) defines pressure ulcer as a localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear, associated with a number of factors yet to be elucidated (National Pressure Ulcer Advisory Panel [NPUAP], 2015). PUs are divided into four stages: I, II, III and IV, which correspond to non-blanchable erythema, partial thickness skin loss, full thickness skin loss, and full thickness skin loss, respectively (Direção Geral de Saúde [DGS], 2011; NPUAP, 2015). Some researchers in this area

argue that there are a number of risk factors for the development of PUs, such as advanced age, moisture, malnutrition, loss of lean body mass, length of hospital stay, reduced mobility, mechanical forces and shearing, level of consciousness, sensory perception, and skin characteristics (Rogensk & Santos, 2005; Campos, Chagas, Costa, França, & Jansen, 2010; Furman et al., 2010). They also believe that some comorbidities and associated disorders play a key role in the development of PUs, such as diabetes mellitus, hypertension, anemia, infection, cardiovascular diseases (CVD), and neurological, respiratory or terminal diseases (Rogenski & Santos, 2005; Campos et al., 2010; Furman et al., 2010). The DGS (2011) estimates that approximately 95.0% of PUs are avoidable through early identification of the risk level. The knowledge of the etiology and risk factors associated with the development of PUs are key to the success of prevention strategies (DGS, 2011). Thus, the risk of developing PUs should be assessed in all care settings within the first 6 hours after patient admission (DGS, 2011). According to Fernandes and Torres (2008), in a study on the incidence and risk factors of PUs in ICU patients, the most common PU sites are the sacrum (40.0%), the calcaneus (36.0%), the ears (8.0%), and the nose (4.0%). Schallom et al. (2015) conducted a study on the use of full-face or oronasal masks in patients undergoing NIV, concluding that the development of PUs differed significantly ($p < 0.001$) between both masks: 20.0% of patients with oronasal masks developed PUs on the nose or the face area under the mask, 16 patients developed stage I PUs, and four patients developed stage II PUs. The identification of PUs during the use of oronasal mask occurred during the data collection period with the identification of three to six ulcers per month (Schallom et al., 2015). In 2014, in a study conducted by Yamaguti et al. involving 375 participants undergoing NIV, 54 (14.4%) of them developed PUs: 49 (13.1%) developed stage I PUs, and 5 (1.3%) developed stage II PUs (Yamaguti et al., 2014). No differences were found between the groups, with and without PUs, according to age, gender, body mass and primary medical diagnosis (half of the sample presented lung disease as the primary medical diagnosis). Fifty of the 54 patients who developed PUs used an oronasal mask (42.0%) and the remaining 4 patients (1.6%) used a full-face mask (Yamaguti et al., 2014).

Based on the records of the ICU where this study was conducted, 634 patients were admitted in 2013, 386 (61.0%) of whom underwent NIV.

Research questions

What is the frequency of facial pressure ulcers in ICU patients undergoing NIV?
Which factors are associated with the development of facial pressure ulcers in ICU patients undergoing NIV?

Methodology

A prospective study was conducted in an ICU of a hospital in the northern area of Portugal, between 30 September and 21 December 2015.
The following inclusion criteria were applied to obtain the sample: patients aged 18 years or more, admitted to ICU, undergoing NIV and without facial PUs at admission. The study included all participants admitted to the ICU during the study who fulfilled the above-mentioned criteria. A convenience sample of 30 participants was obtained.
We designed a questionnaire for data collection on the sociodemographic and clinical characteristics of patients: age, gender, date of admission, diagnosis at admission, medical history, ulcers at admission, weight, height, body mass index (BMI), sensitivity changes, characteristics of NIV during hospital stay, such as mask status, facial skin characteristics, length of NIV in hours/day and days, number of days for facial pressure ulcer development, and length of hospital stay. BMI was assessed in accordance with the DGS guidelines, which relates weight with height and ranges from a minimum value < 18.5 Kg/m^2 to a maximum value ≥ 30.0 Kg/m^2. Within these values, participants were classified as being low weight with BMI < 18.5 Kg/m^2, normal weight with BMI between 18.5 kg/m^2 and 24.9 Kg/m^2, pre-obese with BMI between 25.0 kg/m^2 and 29.9 Kg/m^2, and obese with BMI $= 30.0$ kg/m^2. Patient sensitivity was assessed by one of the researchers by touching the patients' extremities, hands and feet with the tip of the finger. Patients were unable to see this intervention. Patients were considered to have sensitivity changes if they showed no verbal reaction or otherwise to the stimulus. The Braden Scale was used to assess the

risk of PU. This scale was validated for the Portuguese population and is recommended by the DGS (2011). It consists of six subscales: sensory perception, moisture, activity, mobility, nutrition, and friction/shear. The first five subscales are scored from 1 to 4, where 1 represents the less favorable score and 4 the most favorable score. The sixth subscale is scored from 1 to 3. The score obtained in the Braden scale ranges from a minimum of six to a maximum of 23. Scores ≤16 indicate high risk of PU and ≥ 17 low risk of PU (DGS, 2011). The GCS was used to assess the participants' level of consciousness. It consists of the observation of three parameters: eye, motor and verbal responses. It implies the application of standardized stimuli to achieve a homogenous and independent assessment. Eye response ranges from a minimum score of 1 to a maximum of 4, in which 1 corresponds to *no eye opening* and 4 to *spontaneous eye opening*. Motor response ranges from a minimum of 1 to a maximum of 6, in which 1 corresponds to *no response to pain* and 6 to *obeying command*. Verbal response ranges from a minimum of 1 to a maximum of 5, in which 1 corresponds to *no verbal response* and 5 to *oriented*. The maximum score is 15, which corresponds to a fully awake and aware person, and the minimum score is 3, which corresponds to deep coma. The researchers or the nurse responsible for the patient performed the direct observation of skin characteristics on a daily basis, during facial hygiene care, which allowed identifying the onset of the facial pressure ulcer. All data collection tools were applied to each participant at admission. PU development was recorded when identified. The NIV in hours and days and the length of hospital stay were collected at discharge. During the study, the researchers collected the data at patient admission or, when absent, in the following shift based on the existing records and with the collaboration of the nurse who had admitted the patient to the unit. Permission for data collection was previously requested to the Chairman of the Board of Directors, who, after consulting with the Ethics Committee, ruled in favor on 19 January 2016. Data were coded and entered into a database in the Social Package Statistical Science® software, version 23, with a code number, thus ensuring the participants' confidentiality and anonymity. Data were analyzed using descriptive statistics with estimation of absolute and relative frequencies for ordinal variables, and means and standard deviations for continuous variables. Using the Kolmogorov-Smirnov test, we checked for the distribution of variables. Since the variables were not normally distributed, we used non-parametric tests. Spearman's correlation was used to analyze the association between the facial PU development and the other variables. The level of significance was set at 0.05%.

Results

Of the 30 participants, 8 (26.7%) developed PUs. The mean age was 74.2±10.3 years, ranging from 57 to 92 years. Patients who developed PUs had a mean age higher than $\dot{X} = 76.5$ years. Twenty-one were male (70.0%), 7 (23.3%) of whom developed PUs. The mean weight was 76.43 Kg, the mean height was 1.64 meters and the mean BMI was 28.4 kg/m², ranging from 20.9 to 58.5 Kg/m² (Table 1).

Table 1

Absolute and relative distributions of the participants according to the presence of pressure ulcer, age, gender and BMI

		Presence of PU		Total n (%)
		No n (%)	Yes n (%)	
Age	<65 years	7 (23.3)	2 (6.7)	9(30.0)
	≥ 65 years	15 (50.0)	6 (20.0)	21 (70.0)
Gender	Male	14 (46.7)	7 /23.3)	21 (70.0)
	Female	8 (26.7)	1 (3.3)	9 (30.0)
BMI	Normal weight	5 (16.7)	2 (6.7)	7 (23.4)
	Pre-obese	13 (43.3)	4 (13.3)	17 (56.6)
	Obese	4 (13.3)	2 (6.7)	6 (20.0)
$\dot{X}_{Weight}$ = 76.43 Kg, $\dot{X}_{Height}$ = 1.64 meters, $\dot{X}_{BMI}$ = 28.4 Kg/m²				

BMI-Body Mass Index

We found that 18 (60.0%) of the participants had a high risk of developing PUs according to the Braden Scale, 6 (20.0%) of whom developed PUs. Eleven patients (36.7%) had sensitivity changes in the extremities, 5 (16.7%) of whom developed PUs. Respiratory failure, alone or in association with other diseases, was the most common disease in the patients' medical history. A higher frequency of PU development was found in participants with intact and dry skin 5 (16.7%). RF was the most common diagnosis at admission leading to NIV, with 6 (20.0%) of these patients developing PUs (Table 2).

Table 2

Absolute and relative distributions of the participants according to the presence of pressure ulcer, Braden Scale, sensitivity changes, medical history, skin characteristics and diagnosis at admission

		Presence of PU		Total n(%)
		No n(%)	Yes n(%)	
Braden Scale	Low risk	10 (33.3)	2 (6.7)	12 (40.0)
	High risk	12 (40.0)	6 (20.0)	18 (60.0)
Sensitivity changes in the extremities	No	16 (53.3)	3 (10.0)	19 (63.3)
	Yes	6 (20.0)	5 (16.7)	11 (36.7)
Medical history	RF	4 (13.3)	2 (6.7)	6 (20.0)
	CVD	3 (10.0)	1 (3.3)	4 (13.3)
	RF + CVD + Diabetes	6 (20.0)	2 (6.7)	8 (26.7)
	RF + CVD	5 (15.7)	2 (6.7)	7 (23.3)
	RF + Diabetes	1 (3.3)	1 (3.3)	2 (6.7)
	CVD + Diabetes	3 (10.0)	0 (0.0)	3 (10.0)
Facial skin characteristics	Intact	2 (6.79)	0 (0.0)	2 (6.7)
	Intact and dry	14 (46.7)	5 (16.7)	19 (63.3)
	Intact and moist	4 (13.3)	3 (10.0)	7 (23.3)
	Injured and moist	2 (6.7)	0 (0.0)	2 (6.7)
Diagnostic at admission	RF	12 (40.0)	6 (20.0)	18 (60.0)
	CVD	0 (0.0)	1 (3.3)	1 (3.3)
	CVD + RF	6 (20.0)	1 (3.3)	7 (23.3)
	Others	4 (13.3)	0 (0.0)	4 (13.3)

RF- Respiratory failure; CVD- Cardiovascular disease

Twenty-seven (90.0%) patients used a reused mask, 8 of whom developed PUs (26.7%). Among these participants, 5 (16.6%) developed stage II PU, 2 (6.7%) developed stage III PU and 1 (3.3%) developed stage I PU. In case of NIV exceeding 18 hours, 8 patients (26.7%) developed facial PUs; in case of NIV between 4 -7 days and for more than 8 days, 6 patients developed facial PUs, 3 (10.0%) in each case; and in case of length of hospital stay between 5 and 10 days, 4 patients (13.3%) developed facial PUs. In case of GCS scores between 11 and 15, 7 patients (23.3%) developed facial PUs. The mean pressure applied in case of inspiratory positive airway pressure (IPAP) was 18.73 cmH_2O, ranging from 10 cmH_2O to 26 cmH_2O, whereas the mean pressure in case of expiratory positive airway pressure (EPAP) was 6.57 cmH_2O, ranging from 2 cmH_2O to 10cmH_2O (Table 3).

Table 3
Distribution of participants according to the presence of pressure ulcer, mask status, length of NIV in hours/day and GCS score

		Presence of PU		Total
		No *n* (%)	Yes *n* (%)	*n* (%)
Mask Status	New	3 (10.0)	0 (0.0)	3 (10.0)
	Reused	19 (63.3)	8 (26.7)	27 (90.0)
Length of NIV in hours	<8h	2 (6.7)	0 (0.0)	2 (6.7)
	≥ 8-18h	10 (33.3)	0 (0.0)	10 (33.3)
	≥ 18h	10 (33.3)	8 (26.7)	18 (60.0)
Length of NIV in days	1-3	16 (53.3)	2 (6.7)	18 (60.0)
	4-7	4 (13.3)	3 (10.0)	7 (23.3)
	≥ 8	2 (6.6)	3 (10.0)	5 (16.6)
Length of hospital stay	1-4	14 (46.7)	1 (3.3)	15 (50)
	5-10	6 (20.0)	4 (13.3)	10 (33.3)
	≥ 11	2 (6.7)	3 (10.0)	5 (16.6)
GCS score	6-10	0 (0.0)	1 (3.3)	1 (3.3)
	11-15	22 (73.3)	7 (23.3)	29 (96.7)
$\dot{X}_{IPAP} = 18.73$, $\dot{X}_{EPAP} = 6.57$, $\dot{X}_{Days\ of\ NIV} = 4.33$. $\dot{X}_{Days\ of\ hospital\ stay} = 6.33$				

NIV – Non-invasive ventilation

Discussion

In this study, the frequency of cases of facial PU development in patients undergoing NIV in the ICU was 26.7%. These data are in line with those found in another study which reported that face skin breakdown in patients with NIV can vary between 2.0 and 70.0% according to age, mask status, and treatment duration (Maruccia et al., 2015). In our study, we observed that most participants were older than 65 years (70.0%), with a mean age of 74.2 years, and that the mean age was higher among participants who developed facial ulcers (76.5 years). These data are corroborated by a Brazilian study, conducted in 2005, on the incidence of facial PUs that found a statistically significant difference ($p = .003$) between the groups' mean age, with it being higher in patients with facial PUs (Rogenski & Santos, 2005). Skin loses elasticity, thickness and resistance with age, making it more vulnerable when submitted to pressure or aggression, thus increasing the risk of ulceration, as shown by Maruccia et al. (2015) in a study on facial skin breakdown in patients with NIV treatment and prevention. This predisposition to develop facial PUs, mainly in areas with little subcutaneous tissue such as the nasal dorsum, can be associated with skin changes caused by aging (Maruccia et al., 2015). Moreover, another study conducted in Brazil, in 2014, on the frequency of PUs, risk factors and lesions in adult inpatients concluded that the frequency of PUs increases with age, with it being higher above 70 years of age (Silva, Oliveira, Diniz, & Fernandes, 2014). The changes resulting from the effects of senescence affect the organic systems, including the integumentary system, exposing the older person to the development of skin lesions (Silva et al., 2014). The gradual impairment of cellular activity in old age, especially of fibroblasts, directly affects the production of local collagen, which is the main protein responsible for the formation of the integumentary tensile structure and strength. Age brings about reduced elasticity, texture, decreasing frequency of cell replacement and increased length of the healing process, which can contribute to a greater risk of skin and tissue lesion (Furman et al., 2010).

In our sample, we found a predominance of male patients (70.0%), which can result from the fact that the study was conducted in a geographic region with a high rate of employment in mines, quarries, and wood

and furniture factories. According to the latest census, in this area, 9,430 of the 29,991 employed inhabitants develop their professional activity in one of the areas of Group 7 (workers, craftsmen and similar), which are mostly performed by men (Instituto Nacional de Estatística, 2012). Therefore, these workers are more exposed to the risk of developing respiratory diseases and, consequently, needing treatment with NIV. We found a higher frequency of facial PU development in male participants (23.3%), as did Silva et al. (2014), with a rate of 54.3% in men.

Facial PU development was higher in the group of participants with a pre-obese BMI (13.3%). Further studies pointed in the opposite direction, associating low weight with malnutrition and decreased percentage of body mass as a predisposing factor for developing PUs (Rogenski & Santos, 2005; Campos et al., 2010; Furman et al., 2010).

The Braden Scale showed a high percentage of patients at high risk of developing PUs (60.0%), in which 20.0% of the patients developed facial PUs. Silva, Barbosa, Araújo, Oliveira, & Melo (2011), in a study on the assessment of risk factors for the development of PUs in patients hospitalized in a university hospital, concluded that 33.3% of the participants admitted to medical units had a high risk of developing PUs, associating it with advanced age and comorbidities. Moreover, Rogenski and Santos (2005) found lower mean scores in participants who developed PUs. It should be noted that 6.7% of the participants with low risk of PU, developed facial PUs. This may be related to the worsening of the participants' clinical status and with an inadequate application of the scale.

RF, alone or in association with other disorders, was the most common disease in the participants' medical history. PU distribution according to the participants' previous history was more or less homogeneous, with the exception of CVD+diabetes where none of the participants developed facial PUs. Some studies argue that comorbidities such as diabetes mellitus, hypertension, anemia, infection, CVD, and neurological, respiratory or end-of-life diseases are essential for PU development (Rogenski & Santos, 2005; Campos et al., 2010; Furman et al., 2010). Furman et al. (2010) concluded that most participants with PUs were hypertensive, unlike those who did not develop PUs, among whom only 25.0% were hypertensive. They concluded that hypertension was a statistically significant variable for PU development ($p=.035$). Hypertensive patients show an increase of vascular resistance, along with a hypertrophy of the muscle layer, which worsen with other disorders, such as diabetes mellitus, and obesity. This clinical status promotes ischemia and cellular hypoxia, facilitating the development of PUs (Furman et al., 2010).

The diagnosis at admission which led to a greater use of NIV was RF (60.0 %) and 6 of the participants with this pathology developed facial PUs (20.0%). In addition, in the study of Silva et al. (2013) on the adaptation to different NIV interfaces in critically ill patients, 71.3% of the patients who needed NIV had RF, since acute RF leads to a severe deterioration of gas exchange (Silva et al., 2013). As mentioned above, ICU inpatients usually have a high risk of developing PUs. These patients often have sensitivity changes (36.7%), which make them less reactive to excessive pressure and more prone to lesions, which is in line with the results obtained by Rogenski & Santos (2005), Campos et al. (2010), Furman et al. (2010), and Albuquerque et al. (2014). This change may be associated with decreased sensory perception caused by sedatives, analgesics and muscle relaxants, which are commonly used in these units (Silva et al., 2011).

Some studies report that moisture is a risk factor for the development of PU (Rogenski & Santos, 2005; Furman et al., 2010). In our study, we found a higher frequency of facial PU development in participants with intact and dry skin (16.7%). This fact can be associated with dehydration in critically ill patients, as shown by Campos et al. (2010). Furman et al. (2010) also found dry skin in 73.1% of patients, which is described as a possible sign of dehydration that is characterized by a lower amount of water and total electrolytes in the body, making the skin dry and susceptible to breakdown due to decreased elasticity. Tolerance to friction is also lower.

One aspect which was not assessed in the questionnaire, although it raised the researchers' attention throughout the study, was the fact that most participants who developed PU had pale and cold skin in the extremities. According to Furman et al. (2010), this aspect may influence tissue perfusion and nutrition, which makes the individual more vulnerable to tissue damage. We believe that further studies should include this variable.

With regard to mask status, 90% of the masks were reused, with 26.7% of the patients developing facial PUs. Although the literature states that several

parameters should be taken into account when choosing the type of mask: age, severity of clinical status, level of surveillance, facial morphology, patient adherence and tolerance, Maruccia et al. (2015) reported that participants only used oronasal masks. As mentioned by Passarini et al. (2012), in most situations, the choice of equipment depends on its availability at the time of patient admission and the severity of the patient's condition, , which does not always allow using the most adequate mask. Mask use, and cleaning and sterilization procedures cause its clear deterioration. This will increase air leaks and, consequently, the need for greater pressure to adjust the mask and avoid these leaks. To prevent the occurrence of ulceration of the nasal dorsum, the authors suggest the use of special masks and that the mask contact surface should be inflated using water instead of air (Passarini et al., 2012).

In our study, we found that 60.0% of the participants had undergone NIV for 18 hours, being that 26.7% of these patients had developed facial PUs. NIV routine usually depends on its objective, based on medical indication and the patient's clinical status. In this study, as in the study by Silva et al. (2013), we found that participants sometimes had a very reserved prognosis, which made it impossible to remove NIV for facial rest, namely for feeding, oral hygiene, expectoration, and secretion aspiration. In relation to the time of NIV in days, we observed an increase of facial PUs after the fourth day. The mean time of facial PU development was 3.3 days, which leads us to infer that patients have a higher risk of developing facial PUs after three days of NIV.

We found a higher frequency of facial PUs with a hospital stay of 5 to 10 days, which can be explained by the fact that participants are more debilitated as they get older, and have a more severe clinical diagnosis, thus requiring a longer period of treatment. On the other hand, PU development can extend the length of hospital stay due to the specificities of their treatment (Primo et al., 2014; Rogenski & Santos, 2005).

Stage II facial PUs (16.7%) were the most frequent PU developed among the participants, which is similar to the results found by Sousa et al. (2013). We believe that nursing care, such as the daily inspection of facial skin, the use of a nasal protection, comfort massages and continuous monitoring, can minimize the development and worsening of lesions, since these lesions can be detected at an earlier stage.

This study had a few limitations, such as the short period of time for data collection and, consequently, the small sample, which did not allow us to establish associations or draw conclusions from the results. The reduced period was due to the fact that the researchers were only present at the unit during the development of the study. Therefore, we recommend the development of longitudinal studies with larger samples so as to identify the factors associated with facial PU development in patients undergoing NIV.

Conclusion

The frequency of facial PUs was higher in patients who underwent more than 18 hours of NIV per day. We recommend interruption of NIV, whenever possible, and the implementation of preventive actions, such as continuous nursing care, adequacy of equipment, and ongoing in-service training. We suggest the development of longitudinal studies with representative samples so as to assess the cause-effect relationship, taking into account the duration of NIV.

References

Albuquerque, A., Souza, M., Torres, V., Porto, V., Soares, M., & Torquato, I. (2014). Avaliação e prevenção da úlcera por pressão pelos enfermeiros de terapia intensiva: Conhecimento e prática. *Revista de Enfermagem UFPE, 8*(2), 229-239. doi:10.5205/reuol.4688-38583-1-RV.0802201401

Campos, S., Chagas, A., Costa, A., França, R., & Jansen, A. (2010). Fatores associados ao desenvolvimento de úlceras de pressão: O impacto da nutrição. *Revista de Nutrição, 23*(5),703-714. doi:10.1590/S1415-52732010000500002

Cruz, M., & Zamora, V. (2013). Ventilação mecânica não invasiva. *Revista HUPE, 12*(3), 92-101. doi:10.12957/rhupe.2013.7535

Direção Geral da Saúde. (2011). *Escala de Braden: Versão adulto e pediátrica*. Retrieved from http://www.dgs.pt/?cr=20377

Fernandes, N., & Torres, G. (2008). Incidência e fatores de risco de úlceras de pressão em pacientes de unidade de terapia intensiva. *Ciência Cuidado e Saúde, 7*(3), 304-310. doi:10.4025/cienccuidsaude.v7i3.6484

Furman, G., Rocha, A., Guariente, M., Barros, S., Morooka, M., & Mouro, D. (2010). Úlceras por pressão: Incidência e associação de fatores de risco em pacientes de um hospital universitário. *Revista enfermagem UFPE, 4*(3), 1506-514.

Instituto Nacional de Estatística. (2012). *Censos 2011: Resultados definitivos: Região norte*. Lisboa, Portugal: Autor.

Marcelino, P. (2009). *Manual de ventilação mecânica no adulto*. Loures, Portugal: Lusociência.

Maruccia, M., Ruggieri, M., & Onesti, M. (2015). Facial skin breakdown in patients with non-invasive ventilation devices: Report of two cases and indications for treatment and prevention. *International Wound Journal, 12*, 451-455. doi:10.1111/iwj.12135

Ministério da Saúde, Direcção-Geral da Saúde, Rede Nacional de Cuidados Continuados Integrados. (2007). Orientações de abordagem em cuidados continuados integrados: Úlceras de pressão prevenção. Retrieved from http://www.acss.minsaude.pt/Portals/0/%C3%9Alceras%20de%20Press%C3%A3o%20-%20Preven%C3%A7%C3%A3o.pdf

National Pressure Ulcer Advisory Panel. (2015). *NPUAP Pressure Ulcer Stages*. Retrieved from http://www.npuap.org/resources/educational-and-clinical-resources/npuap-pressure-injury-stages/

Passarini, J., Zambon, L., Morcillo, A., Kosour, C., & Saad, A. (2012). Utilização da ventilação não invasiva em edema agudo do pulmão e exacerbação da doença pulmonar obstrutiva crônica na emergência: Preditores de insucesso. *Revista Brasileira de Terapia Intensiva, 24*(3), 278-283. Retrieved from http://www.scielo.br/pdf/rbti/v24n3/v24n3a12.pdf

Primo, C., Baratela, M., Valladares, M., Alvarenga, S., Lima, E., & Leite, F. (2014). Fatores de risco associados à lesão nasal por dispositivo de pressão positiva em recém-nascidos. *Revista Enfermagem UERJ, 22*(1), 16-21. Retrieved from http://www.facenf.uerj.br/v22n1/v22n1a03.pdf

Rogensk, N., & Santos, V. (2005). Estudo sobre a incidência de úlceras por pressão em um hospital universitário. *Revista Latino-Americana Enfermagem, 13*(4), 474-480. Retrieved from http://www.scielo.br/pdf/rlae/v13n4/v13n4a03.pdf

Schallom, M., Cracchiolo, L., Falker, A., Foster, J., Hager, J., Morehouse, T., Watts, P., Weems, L., & Kollef, M. (2015). Pressure ulcer incidence in patients wearing nasal-oral versus full-face noninvasive ventilation masks. *American Journal of Critical Care, 24*(4), 349-356. doi:10.4037/ajcc2015386

Silva, D., Barbosa, M., Araújo, D., Oliveira, L., & Melo, A., (2011). Úlcera por pressão: Avaliação de fatores de risco em pacientes internados em um hospital universitário. *Revista Eletrônica de Enfermagem, 13*(1), 118-123. doi:10.5216/ree.v13i1.8295

Silva, M., Oliveira, S., Diniz, E., Fernandes, M., Universidade Federal de Paraíba João Pessoa, & Grupo de Estudos e Pesquisas em Tratamento de Feridas. (2014). Úlcera por compressão em pacientes hospitalizados: Análise da prevalência, fatores de risco e lesões instaladas. *Fiep Bulletin, 84*(esp. ed.).

Silva, R., Timenetsky, K., Neves, R., Shigemichi, L., Kanda, S., Maekawa, C., Silva, E., & Eid, R. (2013). Adaptação a diferentes interfaces de ventilação mecânica não invasiva em pacientes críticos. *Jornal Brasileiro de Pneumologia, 39*(4), 469-475. doi:10.1590/S1806-37132013000400011

Sousa, N., Bonfim, S., Vasconcelos, M., Bezerra, J., Silva, D., & Leal, L. (2013). Frequência de lesão do septo nasal em prematuros no uso de prongas nasais. *Revista Escola de Enfermagem da USP, 47*(6), 1285-1290.

Yamaguti, W., Moderno, E., Yamashita, S., Gomes, T., Maida, A., Kondo, C., Salles, I., & Brito, C. (2014). Treatment-related risk factors for development of skin breakdown in subjects with acute respiratory failure undergoing noninvasive ventilation or CPAP. *Respiratory Care, 59*(10), 1530-1536. doi:10.4187/respcare.02942