REVISTA DE ENFERMAGEM REFERÊNCIA
homepage: https://rr.esenfc.pt/rr/
ISSNe: 2182.2883

RESEARCH ARTICLE (ORIGINAL)

Non-invasive ventilation in patients hospitalized in internal medicine services: A retrospective study

Ventilação não invasiva em pessoas internadas em serviços de medicina: Estudo retrospetivo

Ventilación no invasiva en personas hospitalizadas en servicios médicos: estudio retrospectivo

Natália Soares da Silva [1, 2]
https://orcid.org/0000-0001-9227-9130

Catarina Salomé Dias Baptista [1, 2]
https://orcid.org/0000-0002-4726-7517

Elsa Maria de Oliveira Pinheiro de Melo [2]
https://orcid.org/0000-0003-0530-2895

João Paulo de Almeida Tavares [2]
https://orcid.org/0000-0003-3027-7978

[1] Baixo Vouga Hospital Center, Intensive Care Medicine, Aveiro, Portugal

[2] University of Aveiro, School of Health, Aveiro, Portugal

Corresponding author
Nome: Natália Soares da Silva
E-mail: nataliasilva@ua.pt

Received: 03.08.24
Accepted: 35.01.24

Abstract
Background: Non-invasive ventilation is a therapeutic strategy for patients with acute respiratory failure.
Objective: To analyze the relationship between the sociodemographic and clinical variables of patients hospitalized in internal medicine services and the adaptation to and complications of non-invasive ventilation.
Methodology: A retrospective observational cohort study was carried out with a sample of 239 patients. Data were collected from electronic records in the information system *SClínico*, using a data extraction guide.
Results: A total of 25.1% of the participants did not adapt to non-invasive ventilation, and this was significantly associated with oral feeding, confusion, and the use of mechanical restraint measures. Complications occurred in 33.5% of the sample. The most frequent complications were secretions, nasal injuries, and vomiting. There was a statistically significant association between the number of complications and patients fed by nasogastric tube, confused, with mechanical restraint measures, and wearing an oronasal mask.
Conclusion: The monitoring of patients on non-invasive ventilation should be carried out by a specialized nursing team. Protocols should be implemented to prevent complications and promote patient adaptation to non-invasive ventilation.

Keywords: noninvasive ventilation; complications; risk factors; patient safety

Resumo
Enquadramento: A ventilação não invasiva (VNI) constitui uma estratégia terapêutica à pessoa com insuficiência respiratória aguda (IRA).
Objetivo: Analisar a relação entre as variáveis sociodemográficas e clínicas, das pessoas internadas na medicina interna, e a adaptação e complicações da VNI.
Metodologia: Estudo observacional retrospetivo de coorte, com amostra de 239 pessoas. A colheita de dados foi efetuada através de registos eletrónicos no SClínico, utilizando um guia de extração de dados.
Resultados: Verificou-se que 25,1% das pessoas estavam inadaptadas à VNI, associando-se significativamente com a alimentação oral, confusão e uso de contenção mecânica. As complicações verificaram-se em 33,5% da amostra, sendo as mais frequentes secreções, lesão no nariz e vómitos. Constatou-se uma associação estatisticamente significativa entre o número de complicações e pessoas alimentadas por sonda nasogástrica (SNG), confusas, com medidas de contenção mecânica e a utilizarem máscara oro-nasal.
Conclusão: A vigilância da pessoa submetida a VNI deve ser assegurada por uma equipa de enfermagem especializada. Devem ser implementados protocolos conducentes à prevenção de complicações e promotores de adaptabilidade à VNI.

Palavras-chave: ventilação não invasiva; complicações; fatores de risco; segurança do paciente

Resumen
Marco contextual: La ventilación no invasiva (VNI) es una estrategia terapéutica para las personas con insuficiencia respiratoria aguda (IRA).
Objetivo: Analizar la relación entre las variables sociodemográficas y clínicas de las personas ingresadas en medicina interna y la adaptación y complicaciones de la VNI.
Metodología: Estudio observacional retrospectivo de cohortes con una muestra de 239 personas. Los datos se recogieron a través de registros electrónicos en SClínico, mediante una guía de extracción de datos.
Resultados: Se observó que el 25,1% de las personas no eran aptas para la VNI, lo que se asoció significativamente con la alimentación oral, la confusión y el uso de contención mecánica. Se produjeron complicaciones en el 33,5% de la muestra, y las más frecuentes fueron secreciones, lesiones en la nariz y vómitos. Se encontró una asociación estadísticamente significativa entre el número de complicaciones y las personas alimentadas por sonda nasogástrica (SNG), confusas, con medidas de contención mecánica y que utilizaban mascarilla oronasal.
Conclusión: La persona sometida a VNI debe ser controlada por un equipo de enfermería especializado. Deben aplicarse protocolos para prevenir complicaciones y favorecer la adaptabilidad a la VNI.

Palabras clave: ventilación no invasiva; complicaciones; factores de riesgo; seguridad del paciente

How to cite this article: Silva, N., Baptista, C., Melo, E., & Tavares, J. (2024). Non-invasive ventilation in patients hospitalized in internal medicine services: A retrospective study. *Revista de Enfermagem Referência, 6*(3), e32475. https://doi.org/10.12707/RVI23.95.32475

Introduction

In recent years, non-invasive ventilation (NIV) has played an increasingly important role as a first-line treatment for various conditions that cause acute respiratory failure (ARF; Isidoro et al., 2019). Compared with invasive ventilation, the use of NIV, if implemented on time, can reduce mortality in patients with ARF, as well as relieve discomfort and prevent complications (Wang et al., 2021). However, NIV is not without risks and complications, the most common of which are feelings of claustrophobia, facial pressure injuries, pain, and secretion accumulation (Fernandes et al., 2019).

Monitoring patients on NIV, particularly their adaptation and the prevention of associated complications, is crucial for patient safety and treatment success. Patients on NIV are mostly found in emergency departments and intensive/intermediate care units and wards (Isidoro et al., 2019). Our study aims to analyze the relationship between the sociodemographic and clinical variables of patients hospitalized in internal medicine services and the adaptation to and complications of NIV.

Background

NIV consists of delivering mechanical ventilation to the lungs without the need for an artificial airway, using mechanical ventilators to reduce the work of breathing (Bezerra et al., 2019).

Because NIV is an open system, the flow programmed by the ventilator may differ from the flow delivered to the patient (Quintero et al., 2020). This can lead to asynchrony and patient discomfort and non-adaptation. Patient monitoring and early detection of complications are vital, as the success of NIV depends on several factors, namely the patient's eligibility, clinical status, and multimorbidities, the health professional's experience with NIV, and the patient's tolerance to NIV (Alqahtani & Alahmari, 2018). Lazovic et al. (2022) reported high tolerance rates in patients on NIV but highlighted that the treatment is not without minor complications, which are mostly considered tolerable. Rolle et al. (2022) noted that some of the major complications of NIV include pneumothorax, NIV-related pneumonia, gastric insufflation, agitation, and encephalopathy, with hemodynamic, respiratory, and neurological effects that can lead to cardiorespiratory arrest.

Research question

How do the sociodemographic and clinical variables of patients admitted to internal medicine services relate to NIV adaptation and complications?

Methodology

This is a single-center, retrospective, observational cohort study focusing on the internal medicine services of a public hospital in the central region of Portugal during the years 2018 and 2019. This study was approved by the Health Ethics Committee of the institution where it was conducted, under process number 12 of June 4, 2021.

The study population consisted of 309 patients who were on NIV at any time during their hospitalization. Of these, 70 patients were excluded because they (a) used NIV as usual treatment and the reason for admission was other than respiratory decompensation, (b) had more than one hospital admission during the study period, and (c) were hospitalized for less than 24 hours. Convenience sampling was used, based on the data available in the information system *SClínico*. This resulted in a study sample of 239 patients.

The data collection tool was developed based on the best practices for the review of retrospective studies (Vassar & Matthew, 2013) and the state of the art in NIV. An extraction manual was created, including (a) coding strategies and (b) the definition of extraction codes. Table 1 shows the variables extracted from *SClínico*. A pretest of the coding process was carried out by two researchers, who analyzed 20 records and reached an agreement level of 100%. The data were collected from June 14 to July 14, 2021.

Table 1

Variables extracted from SClinico

Category	Variables
Demographic	Age, sex, origin, social interaction;
Comorbidities	Hypertension, obesity, diabetes, dementia, osteoporosis, COPD, heart failure, stroke, acute myocardial infarction, kidney failure, cancer;
NIV	NIV at home, interface, indication for NIV, number of days on NIV, adaptation to NIV;
Self-care	Self-hygiene, self-dressing/ undressing, self-transfer, self-feeding, self-positioning
Clinical data	Braden Scale, pain during NIV, analgesia, confusion, mechanical restraint measures, laboratory data (Ph, PCo_2, Po_2)
NIV complications	Hypoxemia, nasal, facial, and eye injuries, claustrophobia, dry mouth, nasal congestion, erythema, secretions, aspiration pneumonia, barotrauma, hypotension, vomiting
Destination	Discharge (home, residential facility for older adults, integrated long-term care units), inter-hospital transfer, and death.

Note. NIV = Non-Invasive Ventilation; COPD = Chronic obstructive pulmonary disease.

IBM SPSS Statistics software, version 26.0, was used to analyze the data. A p-value < 0.05 was considered statistically significant. Descriptive statistics were used and the chi-square test was performed to examine the association between the sociodemographic and clinical variables and adaptation to NIV. When the chi-square assumptions were not met, Fisher's exact test was used. The normality of the variable was assessed by visual inspection of Q-Q plots and the Kolmogorov-Smirnov test (p < 0.05), with a non-normal distribution. Inferential statistics were performed using the Mann-Whitney test and the Kruskal-Wallis test to analyze statistical differences between the sociodemographic and clinical variables and NIV-related complications. When a statistically significant difference was found in the Kruskal-Wallis test, a post hoc analysis was performed using the Mann-Whitney U test with Bonferroni correction. Spearman's correlation coefficient was used to analyze the correlation between NIV-related complications, days on NIV, and age.

Results

The study sample consisted of 239 inpatients with a mean age of 81.06 ± 8.63 years, 54.8% were women, 88.3% came from home, and 73% lived with their families. After hospitalization, 72% were discharged and 26.4% died. The destinations after discharge were home (79.7%), residential facilities for older adults (14%), and integrated long-term care units (6.4%; Table 2).

Table 2

Sociodemographic characterization of the participants (n = 239)

Variable	***n* (%)**
Sex	
Male	108 (45.2)
Female	131 (54.8)
Origin	
Home	211 (88.3)
Residential facility	28 (11.7)
Social interaction	
Alone	33 (15.6)
Family	154 (73)
Home Support	12 (5.7)
Other (part-time caregiver)	12 (5.7)
Destination	
Discharge	172 (72)
Death	63 (26.4)
Inter-hospital transfer	4 (1.7)
Discharge	
Home	137 (79.7)
Residential facility	24 (14)
Long-term care unit	11 (6.4)
Continuous variables	***(M ± SD)***
Age	81.06 ± 8.63

Note. M = Mean; *SD* = Standard deviation.

The most common comorbidities were hypertension (81.2%) and heart failure (77.4%) and 54% of the participants had more than two comorbidities. Also, 25.9% had dysphagia based on the Rapid Dysphagia Identification Test (TRIDIS®) and 20.9% were fed by nasogastric tube (NGT). Most participants were at high risk of pressure injuries on admission (83.3%) and were highly dependent on self-care: self-hygiene (66.9%), self-transfer (56.1%), self-feeding (54%), self-positioning (54.4%) and self-dressing/undressing (63.6%). Of the participants in our study, 36% were confused (disorientation in space, time, and person) according to the nursing diagnosis, and mechanical restraint measures were used in 30.5%.

The majority of participants (76.2%) experienced pain during the period of NIV, most of which was managed with non-opioid analgesics (91.6%).

Of the sample, 12.2% were on NIV at home. During hospitalization, NIV was started for type 2 respiratory failure (40.2%) and global respiratory failure (38.9%). The analytical parameters were: acidosis (58.2%); hypercapnia (78.7%) and hypoxemia (50.6%). The most commonly used interface was the oronasal mask (92.1%). Complications occurred in 33.5% of participants and included the presence of secretions (30.5%), nasal injuries (17.2%), and lack of adaptation to NIV (25.1%). The mean number of days on NIV was 7.84 ± 6.57 (Table 3).

Table 3

Clinical data of the participants (n = 239)

Variable	*n* (%)
Comorbidities	
Hypertension	194 (81.2)
Heart Failure	185 (77.4)
Diabetes	105 (43.9)
COPD	105 (43.9)
Renal insufficiency	88 (36.8)
Obesity	85 (35.6)
Osteoarthritis	58 (24.3)
Neoplasms	51 (21.3)
Stroke	44 (18.4)
Dementia	43 (18)
Acute myocardial infarction	27 (11.3)
Number of comorbidities	
No comorbidities	31(13)
One comorbidity	79 (33.1)
More than two comorbidities	129 (54)
Swallowing	
Altered	62 (25.9)
Unaltered	158 (66.1)
Not applicable	19 (7.9)
Feeding	
Oral	189 (79.1)
Enteral Nutrition (NGT)	50 (20.9)
Braden Scale (on admission)	
High risk	199 (83.3)
Low risk	40 (16.7)
Self-care: self-hygiene	
High	160 (66.9)
Moderate	67 (28)
Low	9 (3.8)
Independent	3 (1.3)
Self-care: self-transfer	
High	134 (56.1)
Moderate	86 (36)
Low	11 (4.6)
Independent	8 (3.3)
Self-care: self-feeding	
High	129 (54)
Moderate	62 (25.9)
Low	35 (14.6)
Independent	13 (5.4)
Self-care: self-positioning	
High	130 (54.4)
Moderate	68 (28.5)
Low	18 (7.5)
Independent	23 (9.6)
Self-care: self-dressing/undressing	
High	152 (63.6)
Moderate	71 (29.7)
Low	12 (5)
Independent	4 (1.7)
Confusion	
Yes	86 (36)
No	153 (64)

Mechanical restraint measures	
Yes	73 (30.5)
No	166 (69.5)
Pain during NIV	
Yes	182 (76.2)
No	57 (23.8)
Medication	
Non-opioid analgesics	219 (91.6)
Opioid analgesics	96 (40.2)
Psychoactive drugs	138 (57.7)
NIV at home	
Yes	29 (12.2)
No	210 (87.8)
Indication for NIV	
Type 1 RF	50 (20.9)
Type 2 RF	96 (40.2)
Global RF	93 (38.9)
Ph	
Acidosis	139 (58.2)
Normal	70 (29.3)
Alkalosis	30 (12.6)
PCO^2	
Hypocapnia	30 (12.6)
Normal	21 (8.8)
Hypercapnia	188 (78.7)
PO^2	
<60	121 (50.6)
>60	118 (49.4)
Interface	
Nasal mask	18 (7.5)
Oronasal mask	220 (92.1)
Full face mask	1 (0.4)
Number of complications	
No complications	159 (66.5)
One complication	67 (28)
More than two	13 (5.5)
Complications	
Secretions	73 (30.5)
Nasal injury	41 (17.2)
Vomiting	11 (4.6)
Hypoxemia	5 (2.1)
Facial injury	5 (2.1)
Claustrophobia	2 (0.8)
Hypotension	1 (0.4)
Nasal injury	
Stage 2 PI	15 (36.6)
Other (classified as wound)	11 (26.8)
Stage 1 PI	6 (14.6)
Stage 4 PI	4 (9.8)
Stage 3 PI	3 (7.3)
Suspected deep injury	1 (2.4)
Not classifiable	1 (2.4)
NIV Adaptation	
Yes	179 (74.9)
No	60 (25.1)
Continuous variables	***(M ± SD)***
Days on NIV	7.84 ±6.57

Note. COPD = Chronic obstructive pulmonary disease; NIV = Non-invasive ventilation; RF = Respiratory failure; Ph= Potential of Hydrogen; PCO_2 = Partial pressure of carbon dioxide; PO_2 = Partial pressure of oxygen; PI = Pressure injury, M = Mean; *SD* = Standard deviation.

The adaptation to NIV showed statistically significant associations with the variables feeding ($p < 0.017$), confusion ($p < 0.001$), and mechanical restraint measures ($p = 0.002$; Table 4). The chi-square analysis (with adjusted residuals) showed that participants who were fed orally, confused, and subjected to mechanical restraints did not adapt to NIV. Our study also observed that non-adapted patients had, on average, more days on NIV than adapted patients (9.71 ± 7.36 versus 7.20 ± 6.1; $p < 0.01$). No significant associations were observed for age and sex.
Regarding complications associated with NIV, significant differences were observed in the variables destination ($U = 3770$; $p < 0.01$), feeding ($U = 3346$; $p < 0.001$), confusion ($U = 5667$; p = 0.046), "mechanical restraint measures" ($U = 5131$; $p = 0.035$), and "interface" ($U = 1294$; $p = 0.006$). Patients who were fed via NGT, were confused, had mechanical restraints, wore an orofacial mask, and died had the highest number of complications associated with NIV. No significant differences were reported regarding the age and sex variables.
There was a weak positive correlation between "days on NIV" and NIV-related complications ($rs = 0.166$; $p = 0.01$), in the sense that more time spent on NIV corresponded to a greater number of complications.

Table 4

Relationship between sociodemographic and clinical variables and NIV adaptation/complications (only significant results; n = 239)

Variables	Adaptation			Complications	
	Yes ($n = 179$) *n* (%)	No ($n = 60$) *n* (%)	Statistical results	M ± *SD*	Statistical results
Feeding					
Oral	135 (71.4)	54 (28.6)	$X^2(1) = 5.775$	0.48 ± 0.65	$U = 3346$
Enteric	44 (88)	6 (12)	$p = 0.017$	0.92 ± 0.82	$p < 0.001$
Confusion					
Yes	53 (61.6)	33 (38.4)	$X^2(1) = 12.577$	0.69 ± 0.75	$U = 5667$
No	126 (82.4)	27 (17.6)	$p < 0.001$	0.50 ± 0.68	$p = 0.046$
Use of restraint measures					
Yes	45 (61.6)	28 (38.4)	$X^2(1) = 9.816$	0.72 ± 0.76	$U = 5131$
No	134 (80.7)	32 (19.3)	$p = 0.002$	0.51 ± 0.68	$p = 0.035$
Interface					
Nasal mask	15 (83.3)	3 (16.7)	$X^2(1) = 0.689$	0.22 ± 0.73	$U = 1294$
Oronasal mask	164 (74.5)	56 (25.5)	$p = 0.573$	0.60 ± 0.70	$p = 0.006$
	M ± *SD*	**M ± *SD***	**Statistical results**	**Correlation coefficient**	
Days on NIV	7.20 ± 6.17	9.71 ± 7.36	$U = 4175$ $p = 0.01$	$r_s = 0.166$ $p = 0.01$	

Note. NIV = non-invasive ventilation; *M* = mean; *SD* = standard deviation; X^2 = Chi-square; *U* = Mann-Whitney test; H = *Kruskal*-Wallis test.

Discussion

Our study analyzed the adaptation to and complications of NIV use in a sample of 239 patients admitted to internal medicine services. Patients on NIV were over 72 years old and had a high level of dependence on self-care, similar to the results of the study by Fernandes et al. (2019), in which participants were over 75 years old. According to Sousa et al. (2019), most patients admitted to medical services are older adults with polypathology and self-care dependency. Nursing interventions during NIV represent a challenge for the health team as care must be centered on the individuality of each patient (Grilo & Alminhas, 2017).
Regarding the adaptation to NIV, a quarter of our sample was not adapted, mostly due to the variables of feeding, confusion, mechanical restraint measures, and days on NIV. Our study reports confusion as a nursing diagnosis. This did not allow the assessment of whether or not it was acute confusion (*delirium*). However, confusion is reported as a factor that may influence the success of NIV. Confusion is common during hospitalization, particularly in older adults (Rieck et al., 2019), due to factors such as cognitive impairment, dementia, advanced age, infection, poor nutrition, functional capacity, and illness severity (Lenardt et al., 2022). Nurses have an active role in the promotion of sensory stimulation and orientation, family involvement, pain management, environmental management, sleep promotion, and early mobilization and positioning (Sousa et al., 2019). The presence of confusion may be associated with the increased use of restraint measures. On the other hand, the use of NIV may be a precipitating factor for confusion.
Nurses also play an essential role in patient adaptation to

NIV. Educating patients about NIV procedures, interface selection and adaptation, and continuous monitoring are crucial to treatment success.

In our study, 28% of the participants had at least one complication. The most frequent were the presence of secretions, nasal injuries, and vomiting, which aligns with the data reported by Carron et al. (2013). Fernandes et al. (2019) in a study carried out in an emergency department with 8h-, 24h-, and 48h-assessments found that patients also had accumulated secretions due to the development of productive cough.

The observation of nasal injuries associated with the NIV interface is supported by Gay's (2009) study, which found them in approximately 10-20% of his sample. Fernandes et al. (2019) also reported that most patients had mask marks and erythema in the contact area at all assessment moments. In our study, facial injuries were found in 2.1% of participants, but with fewer complications. Fernandes et al. (2019) also found a low incidence of open wounds in the contact area, 8.33% up to 24 hours.

Selecting the appropriate interface, and identifying individual issues and risk factors are essential to preventing facial pressure injuries (Alqahtani & Alahmari, 2018). Strategies such as the use of polyurethane foam, followed by transparent films and hyperoxygenated fatty acids (linoleic acid) are employed to prevent pressure injuries associated with NIV (Costa et al., 2022).

The number of complications was higher in participants who had been on NIV for longer. This may be due to the use of interfaces that impede the elimination of secretions (with high incidence in our study) and the continuous pressure of the device, which predisposes to pressure injuries.

NGT feeding may also be associated with a higher risk of complications, particularly pressure injuries and discomfort. A study by Quintero et al. (2020) concluded that the use of an NVI interface adapter to the orogastric tube or NGT is beneficial because it reduces air leakage and improves patient comfort.

Rolle et al. (2022) also pointed out that the lack of specialized skills in multidisciplinary health teams, including nurses and physicians, is associated with a higher incidence of clinical complications. Custodero et al. (2021) highlighted the importance of the multidimensional prognostic index based on a comprehensive geriatric assessment in the selection of candidates for NIV and the definition of short-term prognosis in older adults with ARF.

Duan et al. (2019) developed the HACOR - heart rate, acidosis (assessed by pH), consciousness (assessed by Glasgow coma score), oxygenation, and respiratory rate - score with good predictive power for NIV failure in patients with chronic obstructive pulmonary disease (COPD) in the first 48 hours. The inclusion of the HACOR score in future studies will be relevant to defining the risk score of patients on NIV.

Our study has limitations. The retrospective study design limited data collection to the information system *SClínico*. In addition, care documentation should be improved, by including the parameterization of complications, causes of non-adaptation, and recording of NIV parameters.

It is clear that further prospective studies are required in this area to allow the implementation of protocols favoring patient adaptation to NIV and of measures by the multidisciplinary health team to prevent NIV-related complications.

Conclusion

The data showed that patients on internal medicine inpatient services who eat orally, are confused, require mechanical restraints, and undergo more days of treatment do not adapt to NIV. Secretions, nasal injuries, and vomiting are the most common complications observed.

NGT feeding, confusion, need for mechanical restraints, use of orofacial masks, and days on NIV were related to the highest number of complications.

Patient adaptation to NIV and prevention of NIV-related complications are critical to the success of this treatment, which should be provided by a health team with specialized training. The use of action protocols for the early recognition of complications and adaptation to NIV are vital to ensure excellent clinical practice and improve the quality of care for patients on NIV.

Author contributions

Conceptualization: Silva, N., Melo, E., Tavares, J.
Data Curation: Silva, N., Tavares, J.
Formal analysis: Silva, N., Melo, E., Tavares, J.
Investigation: Silva, N.,
Methodology: Silva, N., Melo, E., Tavares, J.
Writing – Original Draft: Silva, N., Baptista, C., Melo, E., Tavares, J.
Writing – Review & Editing: Silva, N., Baptista, C., Tavares, J.

References

Alqahtani, J. S., & Alahmari, M. D. (2018). Evidence based synthesis for prevention of noninvasive ventilation related facial pressure ulcers. *Saudi Medical Journal*, *39*(5), 443–452. https://doi.org/10.15537/smj.2018.5.22058

Bezerra, V. S., Sousa, A. J., Silva, I. P., Lima, A. P., Porto, F. M., & Vieira, F. R. (2019). *O uso da ventilação não invasiva em pacientes com DPOC: Revisão sistemática*. https://www.even3.com.br/anais/mpct2018/86718-o-uso-da-ventilacao-nao-invasiva-em-pacientes-com-dpoc--revisao-sistematica/

Carron, M., Freo, U., Bahammam, A. S., Dellweg, D., Guarracino, F., Cosentini, R., Feltracco, P., Vianello, A., Ori, C., & Esquinas, A. (2013). Complications of non-invasive ventilation techniques: A comprehensive qualitative review of randomized trials. *British Journal of Anaesthesia*, *110*(6), 896–914. https://doi.org/10.1093/bja/aet070

Costa, O. D., Gonçalves, O. S., & Loureiro, M. (2022). Prevenção de lesões por pressão na face associadas à ventilação não invasiva: Scoping review. *Revista Científica Internacional da Rede Académica das Ciências da Saúde da Lusofonia, 4*(3). https://doi.org/10.51126/revsalus.v4i3.202

Custodero, C., Gandolfo, F., Cella, A., Cammalleri, L. A., Custureri,

R., Dini, S., Femia, R., Garaboldi, S., Indiano, I., Musacchio, C., Podestà, S., Tricerri, F., Pasa, A., Sabbà, C., & Pilotto, A. (2021). Multidimensional prognostic index (MPI) predicts non-invasive ventilation failure in older adults with acute respiratory failure. *Archives of Gerontology and Geriatrics*, *94*, 104327. https://doi.org/10.1016/j.archger.2020.104327

Duan, S. W., Liu, P. X., Tian,Y. F., Zhou. J., Mou, J., Qin, Q., Yu, J., Bai, L., Zhou, L., & Zhang, R. (2019). Early prediction of noninvasive ventilation failure in COPD patients: Derivation, internal validation, and external validation of a simple risk score. *Annals of Intensive Care, 9*(1), 1–10. https://doi.org/10.1186/s13613-019-0585-9

Fernandes, S. M., Branco, M. A., & Rodrigues, P. A. (2019). A pessoa em situação crítica submetida a ventilação não invasiva num serviço de urgência. *Referência*, *4*(22), 13–22. https://doi.org/10.12707/RIV19027

Gay, C. P. (2009). Complications of noninvasive ventilation in acute care. *Respiratory Care*, *54*(2), 246–258. https://pubmed.ncbi.nlm.nih.gov/19173756/

Grilo, C., & Alminhas, S. (2017). Ventilação não invasiva: Úlcera por pressão na face: Implicações para a prática clínica. *OncoNews*, *10*(34), 16–24. https://search.ebscohost.com/login.aspx?direct=-true&db=jlh&AN=124508835&site=ehost-live

Isidoro, D. T., Pocinho, R., Pires, P., Antunes, L., & Baptista, I. (2019). Ventilação não invasiva: Como identificar a resposta terapêutica? *Medicina Interna*, *26*(2), 113–119. https://doi.org/10.24950/rspmi/O/17/19/2/2019

Lazovic, B., Dmitrovic, R., Simonovic, I., Esquinas, A. M., Mina, B., & Zack, S. (2022). Unusual complications of non-invasive mechanical ventilation (NIV) and high-flow nasal cannula (HFNC): A systematic review. *Tuberkuloz ve Toraks*, *70*(2), 197–202. https://doi.org/10.5578/tt.20229810

Lenardt, M. H., Rodrigues, J. A., Cechinel, C., Kuznier, T. P., Kraus, R., & Guedez, J. B. B. (2022). Fatores de risco associados ao delirium em idosos hospitalizados para tratamento clínico: Revisão integrativa. *REME: Revista Mineira De Enfermagem*, *26,* e1484. https://doi.org/10.35699/2316-9389.2022.38832

Quintero, O. I., Sanchez, A. I., Chavarro, P. A., Casas, I. C., & Ospina Tascón, G. A. (2020). Impact of using a novel gastric feeding tube adaptor on patient's comfort and air leaks during non-invasive mechanical ventilation. *Archivos de Bronconeumologia*, *56*(6), 353–359. https://doi.org/10.1016/j.arbres.2019.10.002

Rieck, K. M., Pagali, S., & Miller, D. M. (2019). Delirium in hospitalized older adults. *Hospital Practice, 48*(supl 1), 3-16. https://doi.org/10.1080/21548331.2019.1709359

Rolle, A., Jong, A., Vidal, E., Molinari, N., Azoulay, E., & Jaber, S. (2022). Cardiac arrest and complications during non-invasive ventilation: A systematic review and meta-analysis with meta-regression. *Intensive Care Medicine*, *48*(11), 1513–1524. https://doi.org/10.1007/s00134-022-06821-y

Sousa, L., Oliveira, A. I., Marques, A. R., Mendes, M., Morais, J., Cardoso, R., Costa, S., & Capela, C. (2019). Avaliação geriátrica global em medicina interna: Um modelo mais adequado na avaliação dos doentes idosos internados. *Medicina Interna*, *26*(1), 40–46. https://doi.org/10.24950/rspmi/original/214/1/2019

Sousa, L., Simões, C., & Araújo, I. (2019). Prevenção da confusão aguda em doentes adultos internados em cuidados intensivos: Intervenções autónomas do enfermeiro. *Revista Portuguesa de Enfermagem de Saúde Mental*, *22,* 49-57. https://doi.org/10.19131/rpesm.0263

Vassar, M., & Matthew, H. (2013). The retrospective chart review: Important methodological considerations. *Journal of Educational Evaluation for Health Professions*, *10*, 12. https://doi.org/10.3352/jeehp.2013.10.12

Wang, Z., Wang, Y., Yang, Z., Wu, H., Liang, J., Liang, H., Lin, H., Chen, R., Ou, Y., Wang, F., Wang, Y., Wang, Y., Luo, W., Li, N., Li, Z., Xie, J., Jiang, M., & Li, S. (2021). The use of non-invasive ventilation in COVID-19: A systematic review. *International Journal of Infectious Diseases*, *106*, 254–261. https://doi.org/10.1016/j.ijid.2021.03.078