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Literature review

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Use of non-invasive ventilation in ARDS and secondary pneumonia H1N1: systematic review

Uso da ventilação não invasiva na SDRA e pneumonia secundária a H1N1: revisão sistemática

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RESUMO | INTRODUÇÃO: A influenza A é uma infecção respiratória aguda, associada a epidemias e pandemias, sendo um vírus de comportamento sazonal. O uso precoce da ventilação não invasiva tem se mostrado um tratamento de primeira linha em pacientes com síndrome do desconforto respiratório e pneumonia secundaria a influenza A H1N1, resultando em menores taxas de mortalidade. **OBJETIVO:** Investigar através de revisão sistemática o uso da ventilação não invasiva em pacientes diagnosticados com Influenza A H1N1, secundário a pneumonia e a síndrome do desconforto respiratório agudo. **MATERIAIS E MÉTODOS:** Foram realizadas buscas nas bases de dados do Periódicos Capes, Science Direct, SciELO, e Pubmed, selecionando-se os estudos desenvolvidos nos últimos 10 anos, não sendo imposta restrição de idiomas para a pesquisa. A qualidade metodológica dos estudos foi apontada utilizando a escala de PEDro. **RESULTADOS:** 16 estudos preencheram o critério de elegibilidade e foram incluídos neste estudo segundo escore de PEDro. Nove estudos mostraram que o uso da ventilação não invasiva foi eficiente em pacientes de média e baixa hipoxemia, diminuindo a taxa de intubação orotraqueal e doenças associadas, menor permanência hospitalar e menores taxas de mortalidade. **CONCLUSÃO:** O uso da VNI em pacientes com Síndrome do Desconforto Respiratório Agudo e pneumonia secundária ao vírus influenza A H1N1 mostrou-se relevante na reversão da hipoxemia moderada e leve. Critérios, parâmetros e protocolos bem estabelecidos, torna-se muito útil, juntamente com profissionais experientes e preparados, visando assim uma menor taxa de intubação orotraqueal e doenças associadas, e consequentemente uma menor permanência hospitalar e menores taxas de mortalidade.

PALAVRAS-CHAVE: Ventilação Não Invasiva. Vírus da Influenza A Subtipo H1N1. Síndrome do Desconforto Respiratório Agudo.

ABSTRACT | INTRODUCTION: Influenza A is an acute respiratory infection, associated with epidemics and pandemics, being a virus with seasonal behavior. Early use of noninvasive ventilation has been shown to be first-line treatment in patients with respiratory distress syndrome and influenza A H1N1 secondary pneumonia, resulting in lower mortality rates. **OBJECTIVE:** To investigate through a systematic review the use of noninvasive ventilation in patients diagnosed with influenza A H1N1, secondary to pneumonia and acute respiratory distress syndrome. **MATERIALS AND METHODS:** Searches were carried out in the Capes, Science Direct, SciELO, and Pubmed journals, selecting the studies developed in the last 10 years, with no language restriction for the research. The methodological quality of the studies was indicated using the PEDro scale. **RESULTS:** 16 studies met the eligibility criteria and were included in this study according to PEDro score. Where 9 studies showed that the use of noninvasive ventilation was efficient in patients with medium and low hypoxemia, decreasing the rate of orotracheal intubation and associated diseases, shorter hospital stay and lower mortality rates. **CONCLUSION:** The use of NIV in patients with Acute Respiratory Distress Syndrome and influenza A H1N1 secondary pneumonia has been shown to be relevant for reversing moderate and mild hypoxemia. Well-established criteria, parameters and protocols become very useful, along with experienced and prepared professionals, thus aiming at a lower rate of orotracheal intubation and associated diseases, and consequently a shorter hospital stay and lower mortality rates.

KEYWORDS: Non-invasive Ventilation. Influenza A Virus H1N1 Subtype. Serious Acute Respiratory Syndrome.

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Introduction

There are four types of seasonal influenza viruses: A, B, C and D. The causes of seasonal epidemics are influenza viruses type A and B[1]. Influenza A can be classified into subtypes based on combinations of two surface proteins, hemagglutinin (HA) and neuraminidase (NA). Circulating subtypes in humans are A H1N1 and A H3N2. A H1N1, also known as A (H1N1) pdm09, was responsible for the 2009 pandemic virus and subsequently replaced the circulating seasonal A (H1N1) influenza. All known pandemics and epidemics were caused by influenza A virus[1].

Influenza is an acute respiratory infection caused by viruses A and B[2]. It is a virus with seasonal behavior and has an increase in the number of cases between colder climatic seasons, and there may be years with smaller or larger circulation of the virus[3]. Usually each year more than one type of influenza circulates concomitantly (example: influenza A (H1N1) pdm09, influenza A (H3N2) and influenza B)[2].

Influenza, or seasonal influenza, usually starts with a high fever, followed by muscle pain, sore throat, headache, runny nose, and dry cough. Fever is the most important symptom, lasting around three days. Respiratory symptoms such as cough and others become more evident with the progression of the disease and generally remain for three to five days after fever subsides[2]. Some cases have serious complications, such as pneumonia, requiring hospitalization[4]. Due to the common symptoms, it can be confused with other respiratory viruses that cause a cold[2].

Influenza surveillance in Brazil consists of sentinel surveillance of influenza syndrome (IS), severe acute respiratory syndrome (SARS) in patients admitted to intensive care units (ICU) and universal surveillance of SARS[2]. Sentinel surveillance has a network of units distributed in all geographic regions of the country and its main objective is to identify circulating respiratory viruses, as well as to monitor the demand for care for this disease[2]. SARS universal surveillance monitors hospitalized cases and deaths in order to identify influenza behavior in the country to guide decision-making in situations that require new positions from the Ministry of Health and State and Municipal Health Departments[2].

The first outbreak caused by influenza A H1N1 occurred in March 2009 in Mexico[5,25]. The virus spread rapidly causing a pandemic and several international agencies issued warnings, including the World Health Organization[5,6].

The main complaints presented by the patients were Acute Respiratory Distress Syndrome (ARDS), respiratory insufficiency and severe pneumonia[4] and non-invasive ventilation was offered to these patients in an attempt to reverse the complications caused by the virus.

Noninvasive ventilation (NIV) has been shown to be a first-line treatment for acute respiratory failure. NIV can be considered as an important emerging intervention. According to Nava (2013)[7], "emerging applications are those for which the evidence has not reached level A, and mainly because the number or size of the study sample does not allow a conclusive meta-analysis". Thus, its potential use is due to diseases caused by respiratory failure caused by Acute Respiratory Distress Syndrome (ARDS) and pandemic diseases in which its early use was effective[8]. Acute respiratory distress syndrome is characterized by acute onset respiratory failure with diffuse pulmonary opacity and severe hypoxemia while pneumonia is characterized by a pulmonary infection caused by an anatomopathological entity reflecting accumulation of granulation tissue decreasing terminal airway light[4].

Current studies demonstrate the importance of early noninvasive ventilation in patients with influenza A H1N1 virus resulting in success and low mortality rate, preventing endotracheal intubation in patients with acute respiratory infection and minimizing related complications[4,7,10–18].

The aim of this paper is to conduct a systematic review to verify the effects of noninvasive ventilation in patients with Acute Respiratory Distress Syndrome and influenza A H1N1 secondary pneumonia and their related impacts on reversal of hypoxemia.

Methods

This systematic review was performed according to the criteria of PRISMA MOHER, et al. (2010), by 2 independent researchers[9]. For selection criteria, priority was given to studies reporting their experiences with influenza A H1N1 virus at the height of its 2009 and 2010 pandemic using noninvasive ventilation as a first-step maneuver, then consideration was given to articles that showed experiences with noninvasive ventilation in pneumonia and ARDS, and articles reporting major NIV failures. Articles that did not address NIV as an intervention measure for reversal of hypoxemia were excluded.

It is noteworthy that this review was registered in Prospero - (International Bank for Registration of Systematic Reviews) under identification number 130455. For this review, a search was made in the databases published in the last 10 years. For this purpose, the Capes Periodicals, Science Direct, SciELO, and Pubmed database were used, using the following keywords in the English language: "Non-invasive Ventilation", "Influenza A Virus H1N1", "Pneumonia", "Acute Respiratory Distress Syndrome". The search strategy for the databases is shown in Chart 1.

Chart 1. Research strategy in the data library of Capes Periodicals, Science Direct, SciELO and Pubmed

#1 (((Non-invasive Ventilation OR Influenza A Virus H1N1) OR Influenza A Virus H1N1 Subtype) OR Acute Respiratory Distress Syndrome) AND (((((((Non-invasive Ventilation OR positive pressure ventilacion) OR NIV) OR NPPV) OR CPAP) OR BIPAP) OR Intermittent posite pressure ventilacion) OR Noninvasive positive pressure ventilacion). #2 Non-invasive Ventilation OR Influenza A Virus H1N1 OR Serious Acute Respiratory Syndrome OR Pneumonia.

The articles were searched in the mentioned databases using the cited keywords. After reading them, inclusion and exclusion criteria were established to assess the methodological quality, using the PEDro scale.

Methodological quality assessment

For this analysis, we used the PEDro scale (Portuguese version), which uses a scoring system that varies from 1-11 points, whose higher scores reflect the higher methodological quality of the studies. The PEDro scale is based on the Delphi list, developed by Vergen et al. A study by MOHER et al. (2015)[9] and a recent review by Sherrington et al. in 2010[19], considered the PEDro scale with substantial reliability to evaluate the methodological quality of randomized clinical trials in physiotherapy.

The selected articles were classified as methodological "high quality" when they had a score ≥ 4 points on the PEDro scale or as "methodological low quality" when scores < 4 points were obtained.

Data extraction

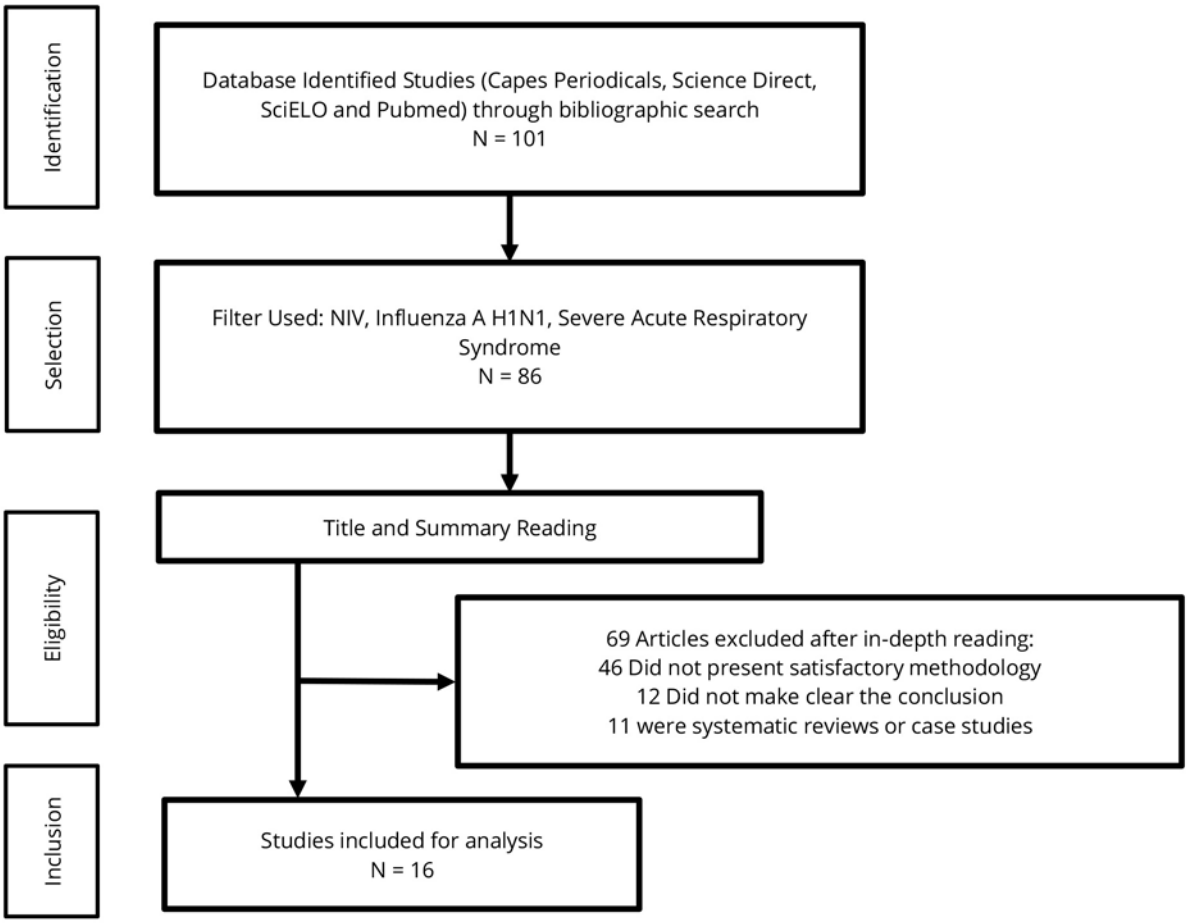
Initially, the selection of studies was based on the verification of the study titles, as well as the analysis of available abstracts. Subsequently, the full study reports were compared against pre-established inclusion criteria to determine their relevance to the systematic review using noninvasive ventilation as treatment therapy in patients with pneumonia and H1N1 secondary ARDS. Articles that did not use noninvasive ventilation as a form of therapy for patients with H1N1 were excluded.

Results

In the search performed in the databases of Capes Periodicals, Science Direct, SciELO and Pubmed started in December/2018 by two researchers, a total of 101 articles were identified, reducing to 86 when applied the "filter": NIV, Influenza A H1N1, Severe Acute Respiratory Syndrome. After reading titles and

abstracts, 69 articles were excluded, of which 46 did not present a satisfactory methodology, 12 did not make clear the conclusion and 11 were systematic reviews or case studies. In the end, 16 articles were included in this systematic review according to eligibility criteria considering the PEDro scale. Figure 1 shows the process of selecting the flowchart of the PRISMA platform[9].

Figure 1. Search and selection of studies for inclusion in the systematic review according to the PRISMA methodology



Thus, it is observed that all 16 articles that had relevance (score between 4 and 9 on the PEDro methodological quality scale), presented eligibility criteria and subjects randomly distributed in the groups, as shown in Table 1.

Table 1. Methodological quality of the studies using the PEDro scale of the included articles

Study	Present Criteria	Total
Nicolini et al (2011) [4]	1, 4, 5, 6, 7, 9, 10, 11	8/11
Dominguez-Cherit et al (2009) [5]	1, 4, 5, 6, 7, 9, 10, 11	8/11
Timenetsky et al (2011) [10]	1, 4, 5, 6, 7, 8, 9, 10, 11	9/11
Kumar et al (2009) [11]	1, 4, 5, 6, 7, 8, 9, 10, 11	9/11
Nassar, Mocelin e Nunes (2010) [12]	1, 4, 5, 6, 7, 8, 9, 10, 11	9/11
Bai et al (2011) [13]	1, 4, 5, 6, 7, 8, 9	7/11
Belenguer-Muncharaz et al (2011) [14]	1, 4, 5, 6, 7, 8, 9	7/11
Paredes e Cevallos (2010) [15]	1, 4, 5, 6, 7, 8, 9, 10, 11	9/11
Masclans et al (2013) [18]	1, 4, 5, 6, 7, 8, 9, 11	8/11
Simonds et al (2010) [20]	1, 4, 5, 6, 7, 8	6/11
Estenssoro (2011) [21]	1, 4, 5, 6, 7, 8, 9, 11	8/11
Ferrer et al (2003) [22]	1, 2, 4, 5, 6, 7, 8, 9, 10, 11	10/11
Zhao et al (2003) [23]	1, 2, 4, 5, 6, 7, 8, 9, 10, 11	10/11
Nin et al (2011) [24]	1, 4, 5, 6, 7, 8	6/11
Gambhir e Rathod (2016) [26]	1, 4, 5, 6	4/11
Gogia, Kumar e Kakar (2017) [27]	1, 4, 5, 6	4/11

Legend: 1) Specification of inclusion criteria; 2) Random allocation; 3) Secrecy in the allocation; 4) Similarity of the groups in the initial or basal phase; 5) Masking of subjects; 6) Masking the therapist; 7) Masking the evalutor; 8) Measurement of at least one primary outcome in 85% of subjects allocated; 9) Analysis of intention to treat; 10) Comparison between groups of at least one primary endpoint and 11) Reporting of measures of variability and estimation of the parameters of at least one primary variable.

The articles included in this systematic review were published between 2003 and 2017. Among the different types of study, we have: cross-sectional study, observational study, randomized study, cohort study, prospective cohort study and historical cohort. Their sample size ranged from 10 to 685 individuals infected with Influenza A H1N1. NIV, invasive mechanical ventilation, corticoid therapy, antibiotic use and antiviral treatment were used as intervention measures. Table 2 presents a summary of the objectives, results and conclusion of each included study.

Table 2. Sample characterization, methodology, result and conclusion of included studies (to be continued)

AUTHOR	KIND OF STUDY	GOAL	SAMPLE	INTERVENTION	RESULTS	CONCLUSION
Nicolini et al (2011) [4]	Prospective observational	To describe the characteristics of patients with influenza A (H1N1) pneumonia treated at two hospitals in the Ligurian region, Italy, and to describe their treatment and outcomes.	40 patients with confirmed diagnosis of influenza A (H1N1)	NIV and invasive mechanical ventilation	The average hospitalization time was 11.6 ± 8.2 days. Of the 27 patients, 20 had respiratory failure, 4 needed IMV and 5 needed NIV. 1 patient died.	Patients with influenza A (H1N1) infection should be brought to negative pressure isolation units as soon as possible with proactive management.
Dominguez-Cherit et al (2009) [5]	Observational	Describe the characteristics, treatment and results of patients with influenza A H1N1	58 confirmed patients of influenza A H1N1	Antibiotics, corticosteroids, neuraminidase inhibitors, and invasive mechanical ventilation.	All patients received invasive mechanical ventilation due to disease severity.	The death of young patients was associated with severe acute respiratory distress syndrome, shock, and had a high fatality rate.
Timenetsky et al (2011) [10]	Observational	Describe the benefit of NIV use in patients with confirmed AH1N1 influenza diagnosis	20 patients hospitalized with H1N1	Invasive mechanical ventilation and NIV	14 patients who developed ARF, 85.7% required NIV and 14% required invasive MV on admission. Our success rate (41.6%) with NIV was higher than that described by others. The hospital mortality rate was 2.1%.	High success and low mortality rates with noninvasive ventilation in patients with influenza A H1N1.
Kumar et al (2009) [11]	Prospective Observational	To describe characteristics, treatment and outcomes of critically ill patients with influenza A (H1N1) infection in 2009.	168 patients admitted with H1N1 influenza A	Antibióticos, corticoide, inibidores de neuraminidase e ventilação mecânica invasiva	Overall mortality was 14.3%	Severity was associated with severe hypoxemia, multisystem failure, and prolonged need for MV.

Table 2. Sample characterization, methodology, result and conclusion of included studies (continuation)

AUTHOR	KIND OF STUDY	GOAL	SAMPLE	INTERVENTION	RESULTS	CONCLUSION
Nassar, Mocelin e Nunes (2010) [12]	Historical cohort	To describe the clinical presentation and evolution of patients admitted with a diagnosis of pandemic influenza (H1N1) infection in two intensive care units of private hospitals in São Paulo.	22 patients hospitalized with H1N1	Invasive mechanical ventilation, NIV and Oseltamivir.	Five (22.7%) patients underwent mechanical ventilation, but high expiratory pressures were required (median 16cm H2O and interquartile ranges 10-25cmH2O). The noninvasive ventilation failure rate was 50%.	The success of NIV was due to young, less severe patients, which explains the lower mortality rate and need for MV.
Bai et al (2011) [13]	Observational	Analyze radiographs of patients with H1N1 influenza A-associated pneumonia	65 cases studied	Invasive mechanical ventilation, NIV, Oseltamivir, Corticosteroids.	NIV success was achieved in 54.2% of patients.	Decreased diffusion capacity were the main abnormalities observed at 3-month follow-up of A (H1N1) survivors.
Belenguer-Muncharaz et al (2011) [14]	Observational	Analysis of the use of NIMV in patients admitted to the (ICU) affected by the new severe hypoxemic influenza A (H1N1) virus.	10 inpatients with H1N1	CPAP Boussignac, Helmet system and BiPAP Vision were used.	No death	In light of the results, greater use of NIMV could be considered in the face of future epidemics.
Paredes e Cevallos (2010) [15]	Cohort Prospective	To evaluate mortality after the application of a rigorous ventilatory management protocol and to describe the clinical characteristics of H1N1 influenza A patients.	24 ARDS patients and H1N1 secondary pneumonia	NIV, invasive mechanical ventilation, antiviral treatment and Oseltamivir.	ICU mortality was 16.6%.	Protocol application and rigorous ventilatory management were fundamental for a better outcome.

Table 2. Sample characterization, methodology, result and conclusion of included studies (conclusion)

AUTHOR	KIND OF STUDY	GOAL	SAMPLE	INTERVENTION	RESULTS	CONCLUSION
Masclans et al (2013) [18]	Cohort	To evaluate the use of NIV in a pneumonia (H1N1) cohort.	685 patients analyzed	NIV and invasive mechanical ventilation.	NIV success by 40.7%	NIV success was associated with shorter hospital stays and similar mortality for unventilated patients.
Simonds et al (2010) [20]	Observational	Assess droplet dispersion during NIV	Patient with chronic infectious diseases in their acute phase.	NIV and oxygen therapy	NIV did not increase droplet counts at any size range.	Health professionals who provided care to these patients were not infected.
Estenssoro (2011) [21]	Cohort	Analyze patients with H1N1-infected pneumonia undergoing NIV	337 patients	NIV, mechanical ventilation, prone position	Mortality was 46%	High mortality rate due to disease severity, multiple organ failure.
Ferrer et al (2003) [22]	Randomized	Analyze the effect of NIV in patients with acute severe hypoxemia.	105 patients acute severe hypoxemia	NIV and oxygen therapy	Improvement in arterial hypoxemia and tachypnea was greater in the noninvasive ventilation group.	The use of NIV prevented intubation, reduced the incidence of septic shock and improved the survival of these patients compared with oxygen therapy.
Zhao et al (2003) [23]	Cohort	Analyze care protocols in SARS patients.	190 patients with SARS	NIV, oxygen therapy, antibiotics, invasive mechanical ventilation	NIV-added antibiotic (CPAP) provided the best result.	The use of NIV along with high doses of antibiotics offered better results.
Nin et al (2011) [24]	Observational	Describe the clinical characteristics and outcome of patients with influenza A H1N1.	96 patients diagnosed with ARDS.	NIV and Invasive Mechanical Ventilation.	NIV used in 45% of patients and failed in 77% of them.	High mortality due to refractory hypoxemia.
Gambhir e Rathod (2016) [26]	Observational	Study the outcome of NIV with ARI secondary to Influenza A H1N1 and identify its failures.	66 patients with ARF secondary to Influenza A H1N1.	NIV	Of the 66 patients 40 were successfully treated with NIV.	NIV can be very well used in patients with viral pneumonia.
Gogia, Kumar e Kakar (2017) [27]	Transverse	To analyze the treatments and mortality of the H1N1 pandemic in India.	151 patients diagnosed with H1N1.	Antibiotics, oseltamivir, Invasive mechanical ventilation, NIV, and oxygen therapy.	Mortality of 8.6% of patients.	Low mortality due to the set of treatments.

Discussion

Of the 16 articles selected, NIV played a key role in the final outcome to reverse mild and moderate hypoxemia, Acute Respiratory Distress Syndrome, Pneumonia, and Acute Respiratory Infection secondary to Influenza A H1N1, along with well-established protocols and experienced and skilled professionals lower orotracheal intubation rate and associated diseases, consequently lower hospital stay and mortality rates. In the case of NIV failure, it was mainly due to the severity of the disease, the empirical application of the professionals, the disability and convenience that mechanical ventilation leaves to health professionals, according to studies developed by Dominguez-Cherit et al. (2009)[5], Estenssoro (2011)[21] and Nin et al. (2011)[24].

As described by Kumar et al. (2015)[11], 136 (81.0%) patients were mechanically ventilated on the first day of ICU admission; 128 (76.2%) invasive and 55 (32.7%) noninvasive. Of these, forty-seven patients (85.4%) who received noninvasive ventilation eventually required invasive ventilation[11]. The main reported causes of death included severe acute respiratory distress syndrome, hypoxemia and its complications[11]. Eighteen patients died within the first 14 days and 24 died within 28 days of disease onset[11].

The authors admit that the focus of severe disease requires ICU admission, which may not reflect important features in less severe cases. Continuous deaths throughout the study period suggest the possibility of late deaths after the observation period, ie patients have reached the severely ill ICU and the main cause of death was organ dysfunction in which major organs stopped functioning. This may result in a final in-hospital mortality rate that exceeds the reported mortality rate[11], ie the study admits that its focus on disease severity reflects high mortality requiring prolonged mechanical ventilation and frequent use of rescue therapies.

Some studies have also reported other risk factors that may influence mortality in H1N1 infection, such as increased age and comorbidities (diabetes, hypertension, chronic lung diseases, and others)[4,26,27]. According to Gambhir and Rathod (2016)[26], of the sixty six patients studied, forty were successful with the use of NIV. After the initial 24 hours, factors associated with late NIV failure were pregnancy (including postpartum period), admission tachycardia, and high total counts during the course of treatment (suggesting developing bacterial pneumonia)[26]. The authors add that comorbidities cannot be considered a strong predictor of NIV failure and that by avoiding intubation, complications can be reduced, particularly in immunocompromised patients[26].

In another study reporting the experience of the 2009 pandemic[12], 22 patients admitted with H1N1 influenza symptom with an average age of 30 years were analyzed. Noninvasive ventilation was administered to 4 (18.2%) patients, with a failure rate of 50%. The failures were seen within less than 12 hours from the non-invasive ventilation onset. Patients without non-invasive ventilation failure were continuously under it for at least 24 hours, with equal or lower than 50% inspired oxygen fractions and lower than 10 cmH2O positive end expiratory pressure[12]. These data indicate that the use of noninvasive ventilation in patients with severe acute respiratory syndrome secondary to influenza A (H1N1)/2009 should be avoided or at least used with caution and monitoring[12].

In a study conducted by Bai et al. (2011)[13], of the 65 cases studied with a mean age of 41 years, acute respiratory distress syndrome was studied in 33 patients, of whom 24 were initially treated with noninvasive ventilation[13]. In this group noninvasive ventilation was successful in 13 (54.2%) and 10 (41.7%) failed and were intubated about 16 hours after admission; the only one who refused intubation died[13]. Of the 10 patients who were intubated, eight died. Therefore, the authors believe that the success and safety of treating patients with influenza A (H1N1) pneumonia using noninvasive ventilation requires adequate procedures and infection control[13].

In the latter study, the authors acknowledge that the use of NIV requires assessment criteria, professional knowledge and procedures appropriate to the patient's demand[13]. The researchers pointed out the concern with cross-infection of health professionals exposed to this type of infection[13]. Simonds et al. (2010)[20], found that the use of NIV in pandemic diseases does not pose a risk of infection to professionals. This is because the droplets generated during NIV are larger than 10 µm, so they are unlikely to remain in the air[20].

In the study by Bellenger et al. (2011)[14], the use of noninvasive ventilation in severe pneumonia due to influenza A H1N1 was attended to a total of 10 admitted patients, NIV was used in 70% of patients, and there was failure by 28%. In the hypoxemic group analyzed (five patients), the effectiveness of NIV was 100% in terms of gasometric and clinical improvement, avoiding intubation of all these patients. The (average) duration of ventilation was 6 days and ICU stay was 9 days. The study confirms that the use of NIV presents lower complication rates, mainly due to the lower incidence associated with mechanical ventilation, showing a higher tolerance to the hypoxemic patient showing good results, because it improves oxygenation, reduces fatigue, intubation and reduces mortality[14]. Thus, the success rate of this study is due to the lower severity of patients, professionals qualified for NIV use and criteria for its application.

Paredes and Cevallos (2010)[15], studied 24 patients diagnosed with acute respiratory distress syndrome caused by influenza A H1N1 virus with a mean age of 41.1 years. A rigid protocol was used, in which all patients used NIV for a period of 20 minutes, then proceeded to orotracheal intubation, invasive mechanical ventilation maneuvers, and recruitment. A single patient was treated exclusively with NIV, presenting a 70% improvement in PaO2 / FIO2 after CPAP recruitment maneuve[15]. Among the evaluated patients, only one patient died, the researchers suggest that 20 minutes of noninvasive ventilation followed by mechanical ventilation were critical for better outcomes, such as reversing hypoxemia and reducing intubation time. The only patient who was treated with NIV showed a 70% improvement in PaO2 / FIO2 after CPAP recruitment maneuver. It is noteworthy that all patients had severe hypoxemia, but the team was careful and prepared with protocoled ventilation procedures[15].

Estenssoro et al. (2010)[21] studied 337 mechanically ventilated patients with ARF due to H1N1 pneumonia. Sixty-four received NIV, and despite the relatively low success rate, NIV was associated with better outcomes, possibly because physicians selected NIV for less hypoxemic patients[21]. In all studies included in the review, avoidance of intubation is associated with significantly fewer infectious complications, especially sepsis and septic shock, but also catheter-related infections. In summary, this latest study shows that the use of NIV in critically ill hypoxemic patients is not advisable; it should be limited to hemodynamically stable patients, mild to moderate in severity, with skilled staff[21].

Masclans (2012)[18] conducted a cohort study of 177 patients on NIV use associated with H1N1 pneumonia. NIV was successful in 72 patients (40.7%), the remainder required intubation. Patients in whom NIV was successful required shorter ventilation time, shorter ICU stay and hospitalization. In patients who failed NIV, delayed intubation did not increase mortality (26.5% versus 24.2%). Physicians used NIV in 25.8% of influenza A (H1N1) pneumonias admitted to the ICU, and treatment was effective in 40.6% of them. NIV success was associated with shorter hospital stay and mortality. NIV failure was associated with mortality similar to those that were intubated from the outset[18].

The success of Masclans's study[18] was due to the preparation of the team using NIV, the severity of the patients, that is, the most severe ones increased the mortality rate, which confirms the use of NIV for this type of patient mild to medium severity. The author made comparisons with delayed intubation in patients with NIV failure, comparing those intubated due to NIV failure with those intubated on ICU admission, but they did not show significantly different rates of ventilator-associated pneumonia (19.2 versus 11.1%)[18].

Ferrer et al. (2003)[22], with 105 patients, found the success of NIV in severe pneumonia compared with high-concentration O2 therapy, reducing the need for intubation, incidence of septic shock and thus ICU mortality, although seven patients with ARDS had an unfavorable outcome due to the severity of the disease. NIV use is associated with lower endotracheal intubation rates, consequently lower mortality rates[22]. Zhao et al. (2003)[23], during the SARS epidemic, analyzed 60 patients, found the best response with NIV for acute hypoxemia.

Timenetsky et al. (2011)[10] studied 20 ICU patients with acute respiratory failure secondary to influenza A H1N1 with a median age of 42 years. 85.7% of patients required NIV and 14% used invasive MV on admission. The success rate (41.6%) with NIV was higher than that described by other studies. The hospital mortality rate was 2.1%[10]. Noninvasive mechanical ventilation was instituted in influenza

A H1N1 confirmed when there were signs of acute respiratory failure at hospital admission or during ICU stay. Signs of acute respiratory failure were tachypnea (respiratory rate above 35 rpm), hypoxemia (PaO2 <80 mmHg), use of accessory muscles and need for high oxygen concentration (greater than 40% by simple face mask or mask with a non-respiratory system). NIV success was considered when the patient was able to improve oxygenation, respiratory rate (less than 35 rpm), carbon dioxide concentration, use of accessory respiratory muscles within 2 hours of NIV. If this improvement was not achieved or the patient did not tolerate NIV use, they were promptly intubated and assisted with invasive mechanical ventilation[10]. According to Belenguer-Muncharaz et al. (2011)[14], patients with PaO2 lower than 60 mmHg were initially administered with masks, but refused to use NIV, were promptly intubated on ICU admission, as well as those who had ICU admission low level of consciousness[14].

These studies have shown that the use of noninvasive ventilation in patients diagnosed with H1N1 influenza is very useful in reversing moderate and mild hypoxemia, with well-established protocols and parameters. In addition, the application of this technique by experienced professionals may reduce the rate of orotracheal intubation and associated diseases, and consequently lower hospital stay and mortality rates[12-15,18,21,22]. According to Belenguer-Muncharaz et al. (2011)[14], patients with PaO2 lower than 60 mmHg were initially given with masks, but refused to use NIV, were promptly intubated on ICU admission, as well as those who had ICU admission low level of consciousness[14].

NIV failures reported in studies by Dominguez-Cherit et al. (2009)[5], Estenssoro (2011)[21] and Nin et al. (2011)[24] included limiting factors such as disease severity during The admission of these patients or the organ dysfunction to which at least two organs are failing, especially the lung, in which there is an attempt to use NIV, not reverting hypoxemia, indicate intubation management. Another limiting factor of the study was the empirical approach in an attempt to reverse severe hypoxemia, implying unpreparedness, lack of experience, criteria and parameters based on evidence of the use of noninvasive ventilation (since it is an outbreak, an H1N1 pandemic that the emergency team was not prepared to deal with a new infectious disease, never before studied. These limitations deserve attention for pointing out the need for further studies, seeking the adoption of well-established methodologies, criteria and parameters for a better intervention. Associated with these, the constant training and improvement of professionals are of fundamental importance for the successful application of NIV, which makes it possible to revert hypoxemia, and consequently reduce the use of mechanical ventilation, the patient's length of stay and the rate of NIV mortality. It is also emphasized that the severity of the patient needs to be taken into account in the final result.

Conclusion

According to the studies available in this systematic review, the use of NIV in patients with Acute Respiratory Distress Syndrome and influenza A H1N1 secondary pneumonia has proven to be an efficient technique for reversing moderate and mild hypoxemia. However, NIV used in patients with severe hypoxemia is not a satisfactory modality to guarantee an improvement in pulmonary function without modifying complications and mortality rate, requiring mechanical orotracheal ventilation to reverse the condition.

It is noteworthy that more research is needed to investigate more accurately the use of NIV in patients with the diagnosis of H1N1 influenza A and its impacts related to the reversal of hypoxemia, using well-established criteria, parameters and protocols, aiming at thus greater efficiency.

Author contributions

Baraúna LH participated in the study conception and design, search and analysis of research data, interpretation of results, writing of the scientific article. Ferreira Neto F participated in the study conception and design, and correction of the writing.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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