Review Article

Noninvasive ventilation for acute respiratory failure due to community-acquired pneumonia: A concise review and update

Antonello Nicolini, Catia Cilloniz[1], Ines Maria Grazia Piroddi, Paola Faverio[2]

Respiratory Diseases Unit, Hospital of Sestri Levante, Italy, [1]Department of Pneumology, Institute Clinic del Tórax, Hospital Clinic, University of Barcelona, Barcelona, Spain, [2]Department of Health Science, University of Milan Bicocca, Clinica Pneumologica, AO San Gerardo, Monza, Italy

ABSTRACT

Strong evidence supports the use of noninvasive ventilation (NIV) in acute respiratory failure (ARF) to prevent endotracheal intubation (ETI) in patients with acute exacerbations of chronic obstructive pulmonary disease (COPD), cardiogenic pulmonary edema, and immunocompromised patients. However, weaker evidence supports NIV used in acute respiratory distress syndrome (ARDS) and ARF due to community-acquired pneumonia (CAP) in immunocompetent patients owing to high rates of treatment failure. In all patients, NIV should be applied under close monitoring for signs of treatment failure and, in such case, ETI should be promptly available. A trained team, at an appropriate location, with careful patient selection and optimal choice of devices can optimize NIV outcome. In this short review we examine past and more recent literature regarding the use of NIV in ARF due to CAP, discussing the application of both continuous positive airway pressure (CPAP) and pressure support ventilation (PSV).

Key words: Community-acquired pneumonia, noninvasive ventilation, severe respiratory failure

INTRODUCTION

The use of noninvasive ventilation (NIV) in acute respiratory failure (ARF)is now extensive, even if, in more severe cases, such as acute respiratory distress syndrome (ARDS), the evidence is mainly linked to small cohort series.[1] Among the benefits of NIV there is the possibility of avoiding invasive mechanical ventilation (IMV) and associated morbidity (increased risk of ventilator-associated pneumonia, ventilator-induced lung injury, increased need of sedation, prolonged ventilation, complications of upper airways, and mortality).[2]

In community-acquired pneumonia (CAP), the most important rationale for using NIV is to overcome an episode of severe respiratory failure avoiding the need of IMV and, if possible, the admission to the intensive care unit (ICU).[3,4]

However, the evidence regarding use of NIV in CAP is much less strong than the one related to other diseases such as exacerbation of chronic obstructive pulmonary disease (COPD).[1]

Patients with ARF due to CAP treated with NIV often show poor outcome,[2,4] particularly when compared to COPD exacerbation and acute cardiogenic pulmonary edema.[5,6]

The aim of this short review is to examine past and more recent literature regarding the use of NIV for CAP. We will

Address for correspondence:
Dr. Antonello Nicolini, Respiratory Diseases Unit,
Via Terzi 43, 16049 Sestri Levante, Italy.
E-mail: antonellonicolini@gmail.com

Access this article online	
Quick Response Code:	Website: www.caijournal.com
	DOI: 10.4103/2225-6482.159224

discuss the application of both continuous positive airway pressure (CPAP) and pressure support ventilation (PSV).

THE EARLY YEARS

The first study on NIV including only patients with pneumonia was a multicenter randomized controlled trial (RCT) by Confalonieri *et al*., in 1999 who divided 56 patients with CAP and ARF into two groups: 28 patients were treated with standard medical therapy and 28 with standard medical therapy plus NIV.[7] This study showed significant benefits of NIV only in the subgroup of patients with associated COPD.[7-9] Two years later Jolliet *et al*., published a study on 24 patients with severe CAP and no prior history of chronic lung disease admitted to the ICU. Despite initial improvement in arterial oxygenation and respiratory rate in 22 out of 24 patients, the intubation rate was very high (66%).[10] Similar results with high rates of NIV failure in patients with pneumonia and severe ARF were reported by different groups in the subsequent years.[6,12-16] In 2003, Ferrer*et al*., in a RCT involving 105 patients (54 treated with medical therapy vs 51 with medical therapy plus NIV) reported a significantly lower rate of intubation, mortality, fatal complications, and length of hospital stay in the NIV group.[11]

We previously referred to the increased risk of pulmonary infections related to IMV compared to NIV. Given these data, different authors described particular benefit from the application of NIV on patients at high risk of pulmonary infection (such as immunocompromised patients) who showed reduced intubation and mortality rate.[17,18]

Therefore, the evidence from these preliminary data seemed to show that patients with ARF due to pneumonia were less likely to benefit from NIV when compared to other causes of ARF such as COPD exacerbation and cardiogenic pulmonary edema. However, some subgroups of patients seemed to show particular benefit from a NIV trial, including immunocompromised patients and patients with associated COPD.

THE LESSON OF INFLUENZA A/H1N1 PANDEMIC

During the influenza A/H1N1 pandemic in 2009, a large number of patients with severe ARF were managed in the ICUs. Based on the Toronto experience with severe acute respiratory syndrome (SARS), the use of NIV was discouraged because of inhalation risk. This concept was later questioned by Simonds *et al*., who found that the droplets generated during NIV are unlikely to remain airborne.[3,19] However, available evidence did not recommend the extensive use of NIV because its inappropriate application could lead to unnecessary intubation delay.[16,20]

In the published studies, NIV use ranged from 5 to 100% of the cases with a success rate from 23to 76%.[20-37] The most extensive study on influenza A/H1N1 pneumonia, enrolling a total of 685 patients, including 337 subjects with confirmed influenza A/H1N1, showed a NIV success rate of 41 and 67%, respectively.[22] This was associated with less radiographic extension and no need of vasopressor therapy.[16,23] Besides, in most studies the avoidance of intubation was associated with significantly fewer infectious complications, mainly sepsis and septic shock, but also catheter-related infections.[3,36]Surprisingly, Masclans *et al*., described a similar mortality in patients who failed NIV trial and in those intubated at presentation.[23]

MORE RECENT ADVANCES: CAN WE PREDICT NIV FAILURE?

Recently a number of authors investigated potential predictors of NIV success and failure [Table 1]. Carron and coworkers evaluated cardiorespiratory parameters potentially predictive of NIV failure. Patients who failed NIV had higher Simplified Acute Physiology Score (SAPS) II, lower arterial pH, lower PaO_2/FiO_2 (partial pressure of arterial oxygen to the fraction of inspired oxygen) ratio at admission, lower postNIV-preNIV deltas of PaO_2/FiO_2 and higher oxygenation index (determined by mean airway pressure × FiO_2 × 100/PaO_2).[38] PaO_2/FiO_2 and oxygenation index were the parameters that most helped the decision to intubate. A following study prospectively assessed 184 patients with severe ARF: It showed that patients with *de novo* ARF failed NIV more frequently than patients with previous cardiac or respiratory disease (46% of patients with *denovo* ARF vs 26% of patients with cardiac or respiratory disease). Maximum Sequential Organ Failure Assessment (SOFA) score during NIV, worsening chest X-ray infiltrates 24 h after NIV onset, heart rate after 1 h from NIV starting, PaO_2/FiO_2 ratio after

Table 1: Factors predictive of NIV failure

	Factors predictive of NIV failure
Carron M *et al.* J Crit Care 2010	Post-NIV to pre-NIV deltas of PaO_2/FiO_2 ratio Post-NIV to pre-NIV deltas of oxygenation index
Carrillo A *et al.* Intensive Care Medicine 2012	Worsening radiologic infiltrate 24 hours after admission Maximum sepsis-related organ failure assessment (SOFA) score Higher heart rate after 1 hour of NIV (compared to pre-NIV) Lower PaO_2/FiO_2 ratio after 1 hour of NIV (compared to pre-NIV) Lower serum bicarbonates after 1 hour of NIV (compared to pre-NIV)
Nicolini A *et al.* Clin Respir J 2014	Extensive chest X-ray involvement on admission Chest X-ray worsening 24 hours after admission Lower PaO_2/FiO_2 ratio after 1 hour of NIV (compared to pre-NIV) Higher A-aDO_2 after 1 hour of NIV (compared to pre-NIV)
Murad A *et al.* J Crit Care 2015	Vasopressor use at 2 hours after NIV initiation

NIV = Non-invasive ventilation; PaO_2/FiO_2 = Partial pressure of arterial oxygen to the fraction of inspired oxygen; A-aDO_2 = Alveolar-arteriolar oxygen gradient

1 h from NIV onset, and serum bicarbonates 1 hour after NIV onset were the variables independently associated with NIV failure.[39] In patients with *de novo* ARF who failed NIV, the authors observed an increased mortality associated with a longer duration of NIV. The authors concluded that, in presence of predictors of NIV failure, NIV avoidance would potentially minimize mortality.[39,16] A more recent series of 127 patients with severe CAP and ARF treated from the beginning with NIV has reported a 25% failure rate. Parameters associated with less severe underlying illness (lower SAPS II and serum lactate dehydrogenase (LDH), limited chest X-ray involvement, higher PaO_2/FiO_2, and alveolar–arterial oxygen concentration gradient (A-aDO_2) at admission) were predictors of NIV success.[16,40] In 2015 a retrospective cohort study including 209 critically-ill patients with ARF due to CAP reported an initial NIV trial in 56% of subjects. Of those, 76% failed NIV, though clinical characteristics at onset suggested a more favorable prognosis. Higher Acute Physiology and Chronic Health Evaluation (APACHE) II score at admission and need of vasopressor use within 2 h after initiation of NIV were strictly related to NIV failure.[41]

Recently, some prospective studies reported good outcomes related to the use of NIV in patients with CAP.[42-44] A wide retrospective cohort study on immunocompromised patients hospitalized with pneumonia (1,946 patients - 717 received NIV) described a beneficial association between the use of NIV and mortality: NIV use was associated with lower 30- and 90-day mortality compared to IMV.[43] Finally, two RCTs recently published demonstrated the usefulness of NIV in ARF due to CAP: The authors showed that the use of helmet CPAP 10 cmH_2O rapidly improved gas exchange and reduced the risk of meeting endotracheal intubation (ETI) criteria compared to oxygen therapy alone.[44,45]

Therefore, an accurate and prompt evaluation of factors that can predict NIV success or failure may help to select those that are most likely to respond to NIV and may avoid delay in ETI.

WHAT HAVE WE LEARNED?

Risom *et al*., in a retrospective study showed that NIV is less efficient in pneumonia than in COPD exacerbation (NIV failure rate 5% in COPD exacerbation vs 49% in CAP, $P < 0.0001$; and in-hospital mortality 14% in COPD exacerbation vs 21% in CAP, $P < 0.01$).[5] Although the main reason for choosing NIV in patients with severe ARF due to CAP is to avoid the complications associated with IMV, clinicians should carefully consider elements that may predict NIV failure, thus preventing dangerous delay in ETI [Figure 1].[46-48] Patients with CAP and severe ARF evolving into ARDS (acute onset, bilateral infiltrates on chest X-ray, and PaO_2/FiO_2 ratio <200 according to the new

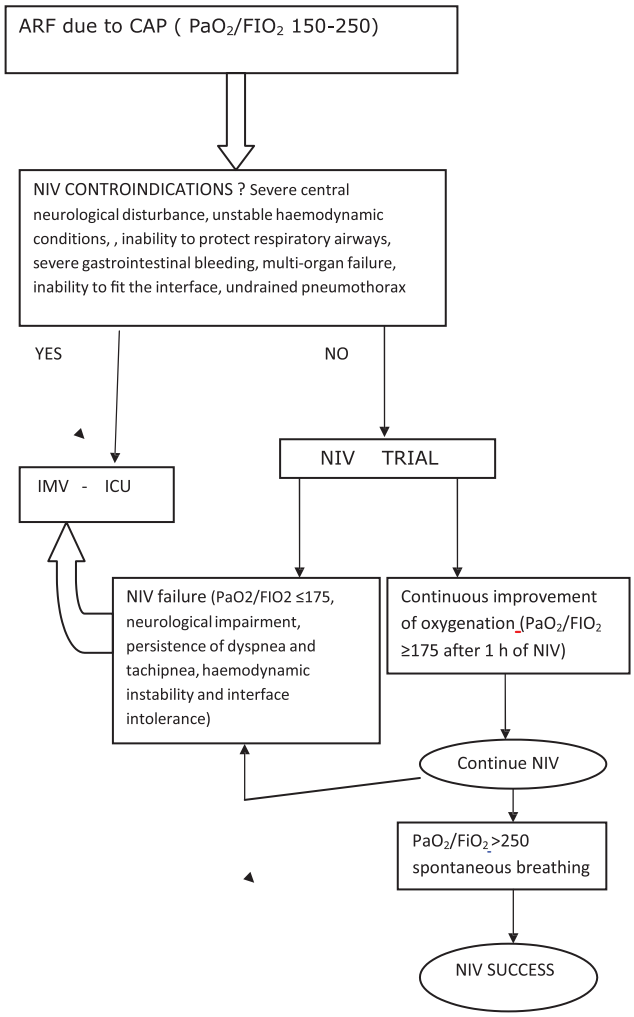

Figure 1: Flow chart to decide NIV appropriateness and success. ARF = Acute respiratory failure, CAP = Community-acquired pneumonia, IMV = Invasive mechanical ventilation, ICU = Intensive care unit, NIV = Noninvasive ventilation

Berlin definition[46,49]) could safely be treated up to a PaO_2/FiO_2 ratio as low as150 using assisted ventilation with a target tidal volume of 6-8 mL/kg and positive end-expiratory pressure (PEEP) of 5-10 cmH_2O.[20,40,50,51] The ventilator (ventilators specifically designed for NIV to compensate for air leak) and interface choice to optimize patient's comfort and ventilatory efficiency are also considerable points for NIV success.[3,47,52-54] Location and timing are other two crucial points in determining the success of NIV: These patients need a continuous monitoring to avoid delayed intubation.[51,55,56] High-dependency respiratory unit could be the ideal environment where to perform NIV.[57] Finally, medical and nursing staff experience and skills are key components to reach positive outcomes. Specific staff training has shown to reduce nosocomial infections, to improve survival in critically ill patients,[58] to allow treatment of more severe cases,[59,60] and to decrease time spent by nurses at patients' bedside.[10,56]

CONCLUSIONS

Although latest results are promising and NIV can be considered a valuable option to treat severe ARF due to CAP, a cautious approach is advisable, limiting the use of NIV to patients with less severe disease (SAPS II <34, PaO_2/FiO_2 at presentation >150, or PaO_2/FiO_2 after 1 h from NIV onset >175). Close monitoring and management by experienced personnel in order to early detect NIV failure and, thus, avoid ETI delay are two other key points for NIV trial success.

REFERENCES

1. Simonds A, Hare A. New modalities for non-invasive ventilation. Clin Med 2013;13:s41-5.
2. Ferrer M, Cosentini R, Nava S. The use of non-invasive ventilation during acute respiratory failure due to pneumonia. Eur J Inter Med 2012;23:420-8.
3. Nava S. Behind a mask: Tricks, pitfalls and prejudices for noninvasive ventilation. Respir Care 2013;58:1367-76.
4. Restrepo MI, Anzueto A. Severe community acquired pneumonia. Infect Dis Clin North Am 2009;23:503-20.
5. Risom MB, Kjaer BN, Risom E, Guldager H. Non invasive ventilation is less efficient in pneumonia than in chronic obstructive pulmonary disease exacerbation. Dan Med J 2014;61:A4799.
6. Domenighetti G, Gayer R, Gentilini R. Noninvasive pressure support ventilation in non-COPD patients with acute cardiogenic pulmonary edema and severe community-acquired pneumonia: Acute effects and outcome. Intensive Care Med 2002;28:1226-32.
7. Confalonieri M, Potena A, Carbone G, Porta RD, Tolley EA, Umberto Meduri G. Acute respiratory failure in patients with severe community-acquired pneumonia. A prospective randomized evaluation of noninvasive ventilation. Am J Respir Crit Care 1999;160:1585-91.
8. AlYami MA, AlAhmari MD, Alotaibi H, AlRabeeah S, AlBalawi I, Mubsaher M. Evaluation of efficacy of non-invasive ventilation in Non-COPD and non-trauma patients with acute hypoxemic respiratory failure: A systematic review and meta-analysis. Ann Thorac Med 2015;10:16-24.
9. Conti G, Costa R. Noninvasive ventilation in patients with hypoxemic nonhypercapnic acute respiratory failure. Clin Pulm Med 2011;18:83-7.
10. Jolliet P, Abajo B, Pasquina P, Chevrolet JC. Non-invasive pressure support ventilation in severe community-acquired pneumonia. Intensive Care Med 2001;27:812-21.
11. Ferrer M, Esquinas A, Leon M, Gonzales M, Alarcon A, Torres A. Noninvasive ventilation in severe hypoxemic respiratory failure: A randomized clinical trial. Am J Respir Crit Care Med 2003;168: 1438-44.
12. Rana S, Jenad H, Gay PC. Failure of noninvasive ventilation in patients with acute lung injury: Observational cohort study. Crit Care 2006;10:R79.
13. Honrubia T, Garcia-Lopez FJ, Franco N. Noninvasive vs conventional mechanical ventilation in acute respiratory failure: A multicenter, randomized controlled trial. Chest 2005;128:3916-24.
14. Antro C, Merico F, Urbino R, Gai V. Noninvasive ventilation as a first-line treatment for acute respiratory failure: "Real life" experience in the emergency department. Emerg Med J 2005;22:772-7.
15. Schettino G, Altobelli N, Kacmarek RM. Noninvasive positive pressure ventilation in acute respiratory failure outside clinical trials: Experience at the Massachussetts General Hospital. Crit Care Med 2008;36:441-7.
16. Ferrer M, Torres A. Noninvasive ventilation for acute respiratory failure. Curr Opin Crit Care 2015;21:1-6.
17. Hilbert G, Gruson D, Vargas F, Valentino R, Gbikpi-Benissan G, Dupon M, *et al*. Noninvasive ventilation in immunosuppressed patients with pulmonary infiltrates, fever and acute respiratory failure. N Engl J Med 2001;344:481-7.
18. Confalonieri M, Calderini E, Terraciano S, Chidini G, Celeste E, Puccio G, *et al*. Noninvasive ventilation for treating acute respiratory failure in AIDS patients with Pneumocystis carinii pneumonia. Intensive Care Med 2002;28;1233-8.
19. Simonds AK, Hanak A, Chatwin M, Morrell M, Hall A, Parker KH, *et al*. Evaluation of droplet dispersion during non-invasive ventilation, oxygen therapy, nebulizer treatment and chest physiotherapy in clinical practice: Implications for management of pandemic influenza and other airborne infections. Health Technol Assess 2010;14:131-72.
20. Santo M, Bonfiglio M, Ferrera L, Nicolini A, Senarega R, Ferraioli G, Barlascini C. High success and low mortality rates with early use of noninvasive ventilation in Influenza A H1N1 pneumonia. Infect Dis Clin Pract 2013;21:247-52.
21. Winck JC, Goncalves M. H1N1 infection and acute respiratory failure: Can we give non invasive ventilation a chance? Rev Port Pneumol 2010;16:907-11.
22. Estenssoro E, Rios FG, Apezteguia C, Reina R,Neira J,Ceraso DH, *et al*; Registry of the Argentinian Society of Intensive Care SATI. Pandemic 2009 influenza A in Argentina: A study of 337 patients on mechanical ventilation. Am J Respir Crit Care Med 2010;182:41-8.
23. Masclans JR, Perez M, Almiral J, Lorente L, Marques A, Socias L, *et al*; H1N1 GTEI/SEMICYUC Investigators. Early non invasive ventilation treatment for severe influenza pneumonia. Clin Microbiol Infect 2013;19:249-56.
24. Rello J, Rodriguez A, Ibanez P, Socias L, Cebrian J, Marquez A, *et al*; H1N1 SEMICYUC Working Group. Intensive care Adult patients with severe respiratory failure caused by Influenza A (H1N1) in Spain. Crit Care 2009;13:R148.
25. Kumar A, Zarychanski R, Pinto R, Cook DJ, Marshall J, Lacroix J, *et al*; Canadian Critical Care Trials Group H1N1 Collaborative. Critically ill patients with 2009 influenza A (H1N1) infection in Canada. JAMA 2009;302:1872-9.
26. Ugarte S, Arancibia F, Soto R. Influenza A pandemics: Clinical and organizational aspects: The experience in Chile. Crit Care Med 2010;38:e133-7.
27. Dominguez-Cherit G, Lapinsky SE, Macias AE, Pinto R, Espinosa-Perez L, de La Torre A, *et al*. Critically ill patients with 2009 influenza A(H1N1) in Mexico. JAMA 2009;302:1880-7.
28. Chacko J, Gagan B, Ashok E, Radha M, Hemanth HV. Critically ill patients with 2009 H1N1 infection in an Indian ICU. Indian J Crit Care Med 2010;14:77-82.
29. Grasselli G, Bombino M, Patroniti N, Foti G, Benini A, Babbruzzese C, *et al*. Management of acute respiratory complications from influenza A (H1N1) infection: Experience of a tertiary-level Intensive Care Unit. Minerva Anestesiol 2011;77:1-8.
30. Kirakli C, Tatar D, Cimen P, Edipoglu O, Coksun M, Celikten E, *et al*. Survival from severe pandemic H1N1 in urban and rural Turkey: A case series. Respir Care 2011:56:790-5.
31. Timenetsky KT, Aquino SH, Saghabi C, Taniguchi C, Silvia CV, Correa L. High success and low mortality rates with non-invasive ventilation in influenza A H1N1 patients in a tertiary hospital. BMC Res Note 2011;28:375.
32. Xi X, Xu Y, Jiang L, Li A, Duan J, Du B; Chinese Critical Care Clinical Trial Group. Hospitalized adult patients with 2009 influenza A (H1N1) in Beijing, China: Risk factors for hospital mortality. BMC Infect Dis 2010;10:256.
33. Li H, Ma RC. Clinical analysis of 75 patients with severe influenza A H1N1 in Qinghai Province. Zhon W Zhon Bing J J Yi Xue 2010;22:164-5.
34. Paredes G, Cevallos C. Acute respiratory distress syndrome during the 2009 H1N1 influenza A pandemic in Ecuador. Med Intensiva 2010;34:310-7.
35. Liu L, Zhang RF, Lu HZ, Lu SH, Huang Q, Xiong YY, *et al*. Sixty-two severe and critical patients with 2009 influenza A (H1N1) in Shanghai. China Chin Med J 2011;124:1662-6.

36. Nicolini A, Tonveronachi E, Navalesi P, Antonelli M, Valentini I, Melotti RM, *et al*. Effectiveness and predictors of success of noninvasive ventilation during H1N1 pandemics: A multicenter study. Minerva Anestesiol 2012;78:1333-40.
37. Nicolini A, Cilloniz C, Cuenca C, Torres A. Influenza A (H1N1) Pneumonia: A review and update. Clin Pulm Med 2012;19:246-53.
38. Carron M, Freo U, Zorzi M, Ori C. Predictors of failure of noninvasive ventilation in patients with severe community-acquired pneumonia. J Crit Care 2010;25:540e9-14.
39. Carrillo A, Gonzales-Diaz, Ferrer M, Martinez-Quintana ME, Lopez-Martinez A, Llamas N. Non-invasive ventilation in community-acquired pneumonia and severe acute respiratory failure. Intensive Care Med 2012;38:458-66.
40. Nicolini A, Ferraioli G, Ferrari-Bravo M, Barlascini C, Santo M, Ferrera L. Early non invasive ventilation treatment for respiratory failure due to severe community-acquired pneumonia. Clin Resp J 2014.
41. Murad A, Li PZ, Dial S, Shahin MS. The role of noninvasive positive pressure ventilation in community-acquired pneumonia. J Crit Care 2015;30:49-54.
42. Ibrahim BJ, Jaber DK. The effectiveness of non-invasive ventilation in management of respiratory failure in Palestine. A prospective observational study. Egypt J Crit Care 2014;2:29-36.
43. Johnson CS, Frei CR, Metersky M, Anzueto AR, Mortensen EM. Non invasive mechanical ventilation and mortality in elderly immunocompromised patients hospitalized with pneumonia: A retrospective cohort study. BMC Pulm Med 2014;14:7.
44. Cosentini R, Brambilla AM, Aliberti S, Bignamini A, Nava S, Maffei A, *et al*. Helmet continuous positive airway pressure vs oxygen therapy to improve oxygenation in community-acquired pneumonia. A randomized controlled trial. Chest 2010;138:114-20.
45. Brambilla AM, Aliberti S, Prina E, Nicoli F, Del Forno M, Nava S, *et al*. Helmet CPAP vs oxygen therapy in severe hypoxemic respiratory failure due to pneumonia. Intensive Care Med 2014;40:942-9.
46. De Pascale G, Bello G, Tumbarello M, Antonelli M. Severe pneumonia in intensive care: Cause, diagnosis, treatment and management: A review of the literature. Curr Opin Pulm Med 2012;18:213-21.
47. Mas A, Masip J. Noninvasive ventilation in acute respiratory failure. Int J Chron Obstruct Pulmon Dis 2014;9:837-52.
48. Antonelli M, Conti G, Esquinas A, Montini L, Maggiore SM, Bello G, *et al*. A multiple-center survey on the use in clinical practice of noninvasive ventilation as a first-line intervention for acute respiratory distress syndrome. Crit Care Med 2007;35:18-25.
49. ARDS definition Task Force. Ranieri VM, Rubenfeld GD, Thompson BT, Ferguson ND, Caldwell E, Fan E, *et al*. Acute respiratory distress syndrome: The berlin Definition. JAMA 2012;307:2526-33.
50. Thille AW, Contou D, Fragnoli C, Cordoba-Izquierdo A, Boissier F, Brun-Buisson C. Non-invasive ventilation for acute hypoxemic respiratory failure: Intubation rate and risk factors. Crit Care 2013;17:269.
51. Pelosi P, Rocco PR, de Abreu MG. Use of computed tomography scanning to guide lung recruitment and adjust positive-end expiratory pressure. Curr Opin Crit Care 2011;17:268-74.
52. Esquinas Rodriguez AM, Papadakos PJ, Carron M, Cosentini R, Chiumello D. Clinical review: Helmet and non-invasive mechanical ventilation in critically ill patients. Crit Care 2013;17:223.
53. Nava S, Navalesi P, Gregoretti C. Interfaces and humidification noninvasive mechanical ventilation. Respir Care 2009;54:71-84.
54. Sferrazza-Papa GF, DiMarco F, Akoumianaki E, Brochard L. Recent advances in interfaces for non invasive ventilation: From bench studies to practical issues. Minerva Anestesiol 2012;78:1146-53.
55. Brochard L, Lefebvre JC, Cordioli RL, Akoumianaki E, Richard JC. Noninvasive ventilation for patients with hypoxemic acute respiratory failure. Semin Respir Crit Care Med 2014;35:492-500.
56. Ozyilmaz E, Ozsanack A, Nava S. Timing of noninvasive ventilation failure: Causes, risk factors, and potential remedies. BMC Pulm Med 2014;14:9.
57. Scala R, Corrado A, Confalonieri M, Marchese S, Ambrosino N; Scientific Group on Respiratory Intensive Care of the Italian Association of Hospital Pneumologists. Increased number and expertise of Italian Respiratory High-dependency care units: The second national survey. Respir Care 2011;56:1100-7.
58. Girou E, Brun-Buisson C, Taille S, Lemaire F, Brochard L. Secular trends in nosocomial infections and mortality associated with noninvasive ventilation in patients with exacerbations of COPD and pulmonary edema. JAMA 2003;290:2985-91.
59. Carlucci A, Del Mastro M, Rubini F, Fracchia C, Nava S. Changes in practice of non-invasive ventilation in treating COPD patients over 8 years. Intensive Care Med 2003;29:419-25.
60. Contou D, Fragnoli C, Córdoba-Izquierdo A, Boissier F, Brun-Buisson C, Thille AW. Noninvasive ventilation for acute hypercapnic respiratory failure: Intubation rate in an experienced unit. Respir Care 2013;58:2045-52.

How to cite this article: Nicolini A, Cilloniz C, Piroddi IM, Faverio P. Noninvasive ventilation for acute respiratory failure due to community-acquired pneumonia: A concise review and update. Community Acquir Infect 2015;2:46-50.
Source of Support: Nil, **Conflict of Interest:** None declared