Review Article

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The Worldwide Spread of Noninvasive Ventilation; Too Much, Too Little or Just Right?

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In the past 20 years, use of noninvasive ventilation (NIV) has increased from rare to highly prevalent in many ICUs around the world. In a single 26-bed French ICU, NIV use for patients with acute respiratory failure (ARF) due to COPD and cardiogenic pulmonary edema (CPE) increased from 20% of ventilator starts in 1994 to nearly 90% in 2001, associated with reductions in health care acquired pneumonias and ICU mortality from 20 to 8% and 21% to 7%, respectively (1). In a serial survey of European ICUs performed in 1997 and 2002 (2,3), NIV use increased from 16 to 23% of overall ventilator starts. In another serial survey conducted in more than 40 countries enrolling more than 18,000 ventilated patients, overall NIV use increased from 4.4% to 11.1% and to 14% in 1998, 2004 and 2010, respectively (4,5). Between 1998 and 2004, use in patients with ARF due to COPD and ACPE increased from 48 to 78% and from 35 to 65% of ventilator starts, respectively (4), and between 1998 and 2010, mortality fell significantly from 31% to 28% (5).

These trends are reflected in North American surveys, but these also detected large practice variations. A mailed 2002 survey of acute care hospitals in Massachusetts and Rhode Island revealed an overall estimated ventilator start rate of 20%, but within individual hospitals, usage rates varied from none to 50% (6). Among a selected subgroup of survey respondents, NIV use among ventilated COPD patients was estimated at only 33%. A follow-up on-site survey performed at some of the hospitals in the previous survey in 2006-9 revealed that the overall NIV initiation rate had risen to 38.5% of all ventilator starts and to 80% for ventilated COPD patients (7).

More recently, information from some large US-based clinical databases reflects these trends. Chandra et al. (8) analyzed over 7.5 million hospital admissions for COPD exacerbations in the US Healthcare Cost and Utilization Project's Nationwide Inpatient Sample. Between 1998 and 2008, NIV starts increased as a percent of all COPD admissions increased from 1% to 4.5% while use of IMV dropped from 6% to 3.5% (42% decrease). These authors detected a slight decline in overall mortality among admitted COPD patients, but raised concerns about the group that transitioned from NIV to IMV, indicative of NIV failure. This group had a 61% higher risk of death compared to those begun on IMV initially.

The above analyses, using a variety of survey techniques, all underscore the increasing adoption of NIV over the past 15 years to treat various forms of ARF, mainly those caused by COPD and CPE. These trends are encouraging because they are based on established evidence that NIV for patients with these forms of ARF respond favorably to NIV, with more rapid improvements in dyspnea, vital signs and gas exchange, associated with reduced intubation and mortality rates (9). This evidence is compelling and justifies the recommendations from recently published guidelines that NIV be used for such patients in the absence of standard NIV exclusions.

Consistent with the improved outcomes reported in randomized controlled trials and meta-analyses, as mentioned above, several of the large epidemiologic studies have detected declining mortality rates for mechanically ventilated patients associated with these increasing NIV utilization rates (1,5,8,9).

However, a number of concerning observations also derive from these surveys. The large variability in use between institutions detected by the Maheshwari study (6) suggests that adoption of NIV has been inconsistent. Further concern regarding suboptimal use derives from a US survey of respiratory therapists at Veterans Administration hospitals in which 2/3 of respondents opined that NIV was used less than half the time when it was clinically indicated (10). This concern extends internationally, as evidenced by a 2003 national audit in the UK that found that 39% of ICUs were not applying NIV to COPD patients at all (11). Another survey from Korea found that only 2 of 24 university ICUs were using NIV, constituting only 4% of total ventilator starts (12). Epidemiologic data on use of NIV for ARF is entirely lacking from most countries in the world, although personal communications from physicians in a number of those countries, indicates that NIV is not often used, even in situations when it is clearly indicated.

Other concerning trends detected in some of the above-described epidemiologic surveys are the rapid increase in use of NIV for non-COPD causes of ARF as well as the increased mortality among patients switched from NIV to IMV during their hospitalizations (indicative of NIV failure), compared to those intubated from the start (8,9). With the exception of patients with CPE, the use of NIV for non-COPD diagnoses is not supported by strong evidence and should be reserved only for carefully selected, closely monitored patients. The rapidly increasing use of NIV for non-COPD diagnoses and the increased mortality among NIV failures raise the concern that NIV may be over-utilized in some situations – that patients better managed using IMV from the start are begun on NIV and suffer worse outcomes because appropriate invasive ventilator support is delayed until a crisis occurs, raising the risks of complications and mortality.

This accumulating evidence suggests that NIV is being used too little in some circumstances, too much in others and raises the question of how to optimize the use of NIV. Clearly, there is no one optimal rate of NIV use that is applicable to all institutions at all times. Different hospitals serve different patient populations with quite variable prevalences of COPD and CPE. Furthermore, admissions of patients with these diagnoses vary from time to time, with more COPD exacerbations typically occurring during colder months. Considering that the diagnoses of COPD and CPE are the main drivers for NIV use, optimal use would then vary from institution to institution and from time to time depending on admission rates of patients with appropriate diagnoses for NIV.

Furthermore, the decision to initiate NIV, like that to intubate patients, is based on a clinical judgment that balances the likelihood of benefitting the patient (i.e. avoiding intubation and its potential complications) with the risk of doing harm (i.e. NIV failure with the potential complications of emergency intubation). This judgment considers the patient's diagnosis, need for ventilatory assistance and presence of contraindications (excessive secretions, agitation and the like), as well as the experience and skill of the institution with NIV. For example, it might be appropriate to use NIV to manage ARF in a challenging patient with hypoxemic respiratory failure in a highly experienced ICU, something that might be excessively dangerous in another that lacks such experience.

The global experience with NIV is certainly not unique among emerging techniques. With any such technique, there are always "early adopters" and "laggards" (13), contributing to the variability in use between institutions. Given encouragement and support from administrators, the early adopters become "champions" for the new approach, leading by example and encouraging adoption by others. As institutions gain experience and skill and have favorable experiences, the technique becomes a routine part of the therapeutic armamentarium. Variations

in use are still to be expected, because individual clinicians operating within acceptable standards of care will make different judgments. Furthermore, optimal practices are always in a state of evolution as new technologies, evidence and guidelines for use are incorporated.

So how to avoid underuse or overuse of NIV and achieve the right level of use? At the global level, international societies play an important role by providing educational sessions at their meetings, publishing high quality clinical studies in their journals and formulating guidelines. At the level of individual countries, professional societies again play an important role in disseminating information and guidelines. Resources also have to be made available by policymakers so that appropriate equipment can be purchased and practitioners adequately trained. But the most important level is institutional, where individual practitioners can become "champions" and help others learn the new techniques and gain relevant experience. They can make sure that other practitioners are appropriately educated, becoming aware of the evidence and guidelines and gaining valuable experience. This is how the use of a technique like NIV, proven to improve outcomes for patients with ARF due to etiologies like COPD and CPE, has been spreading worldwide. However, it is important that the spread continues and that institutions and countries currently underutilizing NIV undertake measures to encourage its adoption, with the goal of optimizing patient outcomes.

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