

# How to Initiate a Noninvasive Ventilation Program: Bringing the Evidence to the Bedside

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**Summary**

Noninvasive ventilation (NIV) is under-utilized, despite robust evidence supporting its use in appropriately selected patients with acute respiratory failure. Diffusion of NIV into practice requires that clinicians view it as better than invasive ventilation, that it is perceived as compatible with existing approaches to mechanical ventilation, that it is not too difficult to apply, that it is trialable, and that its results are visible. Barriers to NIV use include lack of awareness of the evidence, lack of agreement with the evidence, lack of self-efficacy, unrealistic outcome expectations, and the inertia of previous practice. A flexible, tireless, enthusiastic, and knowledgeable clinical champion is important when initiating an NIV program. Knowledge and training are also important; ideally the training should be one-on-one and hands-on to the extent possible. Adequate personnel and equipment resources are necessary when implementing the program. Guidelines and protocols may be useful as educational resources, to avoid clinical conflict and consolidate authority. When initiating an NIV program it is important to recognize that NIV does not avoid intubation in all cases. Success often improves with experience. The available evidence suggests that NIV is cost-effective. For optimum success the multidisciplinary nature of NIV application must be recognized. The NIV program should be a quality-improvement initiative. Following these principles, a successful program can be initiated in any acute-care setting. *Key words: guidelines, noninvasive ventilation, NIV, mechanical ventilation, respiratory failure.* [Respir Care 2009;54(2):232–243. © 2009 Daedalus Enterprises]

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## Introduction

Noninvasive ventilation (NIV) has received considerable academic and clinical interest in the past 10 years. There have been dozens of randomized controlled trials and at least 12 systematic reviews and meta-analyses.<sup>1-12</sup> NIV decreases the need for endotracheal intubation and affords a survival benefit in appropriately selected patients. The greatest benefit is for patients with severe exacerbation of chronic obstructive pulmonary disease (COPD) or acute cardiogenic pulmonary edema. Benefit has also been reported in other patients, such as those who develop respiratory failure following lung-resection surgery<sup>13</sup> or solid-organ transplantation,<sup>14</sup> in patients with respiratory failure associated with immunocompromise,<sup>15</sup> and to prevent extubation failure.<sup>16</sup> NIV has also been reported to significantly reduce the risk of nosocomial pneumonia.<sup>17</sup>

It has been reported that about 30–40% of patients do not receive care according to best evidence.<sup>18,19</sup> NIV is under-utilized, despite the robust evidence supporting its use. In patients admitted to intensive care units (ICUs) with a diagnosis of either COPD or congestive heart failure exacerbation, only a third of the patients had a trial of NIV.<sup>20</sup> In a survey of the utilization of NIV in acute-care hospitals in Massachusetts and Rhode Island, Maheshwari et al<sup>21</sup> found that NIV is used in only about a third of patients with exacerbation of COPD or congestive heart failure, and in that study NIV was not used in some hospitals.

In this paper I will explore some of the obstacles related to transfer of evidence into practice—sometimes called knowledge transfer or diffusion of evidence to practice. I will then use that background to suggest some strategies to initiate an effective NIV program.

## Transferring Evidence Into Practice

Rogers<sup>22</sup> developed one of the better known theoretical approaches for diffusion of evidence into practice.<sup>23</sup> According to Rogers, there are 5 elements that affect the adoption of new evidence into practice: relative advantage, compatibility, complexity, trialability, and observability.

*Relative advantage* is the degree to which a new approach is perceived as better. In the case of NIV this can be a major obstacle, because it is difficult for clinicians who have years of experience caring for intubated mechanically ventilated patients to appreciate that NIV might be a better approach for some patients. In fact, many clinicians have been taught that securing the airway (ie, intubation) is the first step in initiating mechanical ventilation.

*Compatibility* is the degree to which a new approach is perceived as compatible with the existing therapy. The new evidence should address an issue that clinicians per-

ceive to be a problem. Again, for clinicians with many years of experience caring for intubated mechanically ventilated patients there may not be a perception of a problem that would be alleviated by NIV.

*Complexity* is the degree to which a new approach is perceived as difficult to use. In the case of NIV, complexity can be a major impediment to adoption, because mask fitting and application of NIV can be more complex for the naïve user.

*Trialability* is the degree to which the new approach can be tried and modified. NIV lends itself well to trialability, because success may require trials of different interfaces and ventilator settings to achieve the desired outcome.

*Observability* is the degree to which the results of the new approach are visible to others. NIV lends itself well to observability in that it is obvious if the patient can be ventilated without the need for endotracheal intubation. However, observability can be counter-productive if the first attempts to use NIV are not successful.

Rogers's diffusion-adoption model<sup>23</sup> suggests 5 steps in the process of bringing evidence to practice: the clinician acquires knowledge of the evidence; the clinician is persuaded of the advantages of the new approach; the clinician engages in activities (eg, workshops and interacting with others who have adopted the new approach) that lead to the choice to adopt the evidence; the clinician incorporates the new approach into everyday practice; the clinician seeks reinforcement of the decision to adopt the new practice, such as experiencing positive results or favorably comparing experience with that of others.

Grol and Grimshaw<sup>24</sup> suggest that a sustainable change in practice occurs at several levels: factors related to the individual clinician (knowledge, skills, attitudes, habits, personality); issues related to the social context of care (expectations of patients, colleagues, and authorities); organizational context (resources, care processes); and public policy and legislation.

Grol<sup>25,26</sup> suggested a 10-step model for inducing change in professional behavior, and this can be divided into 5 domains: orientation, insight, acceptance, change, and maintenance (Fig. 1).

Bradley et al<sup>27</sup> evaluated the dissemination of a human technology intervention, the Hospital Elder Life Program, in 9 hospitals. They examined staff experiences to determine successful strategies to overcome the challenges of implementation, and they identified 6 common challenges facing hospital staff: gaining internal support for the program from administration and clinicians; ensuring effective clinical leadership; integrating the new program with existing programs; implementing the program as designed, including all parts of the intervention; documenting and publicizing positive outcomes; maintaining momentum while changing practice and shifting the organizational culture.

## HOW TO INITIATE A NONINVASIVE VENTILATION PROGRAM

Orientation	1. Promote awareness of innovation: level of interest in reading and continuous education 2. Stimulate interest and involvement: degree of contact with colleagues, experience of need for innovation
Insight	3. Create understanding: available knowledge and skills, ability to remember information 4. Develop insight into own routines: attitude, willingness to acknowledge gaps in performance
Acceptance	5. Develop positive attitude to change: ability to perceive advantages of change, opinion of scientific merit of change, opinion of credibility of evidence source, degree of involvement in development process 6. Create positive intentions/decision to change: degree of confidence in one's skills, perception of potential problems putting change into practice
Change	7. Try out change in practice: perception of practical barriers, opportunity to try change on small scale 8. Confirm value of change: whether first experiences are positive or negative, degree of cooperation from patients and colleagues, complications and costs
Maintenance	9. Integrate new practice into routines: willingness and ability to redesign processes 10. Embed new practices into organization: procedures in place for constant reminding, availability of resources, degree of support from management

Fig. 1. Potential barriers and incentives in relation to a proposed 10-step model for inducing change in professional behavior. (Adapted from Reference 25.)

Graham et al<sup>28</sup> conducted a systematic review to examine the theoretical underpinnings of knowledge translation. Nineteen of the 31 models identified in their search have not yet been empirically tested. The common steps included in the 31 models indicated that, when intending to implement change, one needs to consider the impact of the following factors: nature of the evidence; attributes of the change; intended audience; organizational context and culture; resources to support the change; and implementation-related factors. Graham et al<sup>29</sup> derived a knowledge-to-action model from that analysis and illustrated how the steps, actions, and factors interact in an iterative fashion (Fig. 2).

Cabana et al<sup>30</sup> systematically reviewed the literature to identify barriers to adherence to clinical practice guidelines. The barriers they identified are essentially barriers to knowledge transfer. Lack of awareness and lack of familiarity affect knowledge of the evidence. Attitudes, lack of agreement, self-efficacy, outcome expectations, and the inertia of previous practice are barriers. Even if clinicians are knowledgeable and have attitudes that would support following the guideline, external barriers can affect their ability to follow the guideline (Fig. 3).

Berwick<sup>31</sup> examined the dissemination of innovations and suggested applications of that to health care. He suggested that there are 3 clusters of influence on the rate of diffusion of innovations within an organization: the perceptions of the innovation, the characteristics of the indi-

viduals who may adopt the change, and contextual and managerial factors within the organization. There are 5 perceptions of an innovation that are most influential: perceived benefit; compatibility with the values, beliefs, history, and current needs; complexity of the innovation; trialability (ability to test the innovation on a small scale); and observability (ability to watch others try the innovation first).

The characteristics of individuals also affect the adoption of change (Fig. 4).<sup>22</sup> The innovators are mavericks, who often have cutting-edge ideas but are not taken seriously. Early adopters are opinion leaders, elected leaders, or representatives of a clinical group. The early majority watches the early adopters and tries innovations that meet their immediate needs. The late majority adopts innovation when it is the new status quo (standard of practice). The laggards are slow to change and swear by the old tried-and-true methods.

Implementation of change should focus on the early adopters and the early majority. Contextual and managerial factors relate to how well the organization supports innovation. Organizations may be nurturing environments for innovators, offering praise and resources, or they may discourage innovators by regarding those who propose change as troublemakers. Berwick suggests 7 recommendations to accelerate the rate of diffusion of innovations within their organizations: find sound innovations; find and support innovators; invest in early adopters; make

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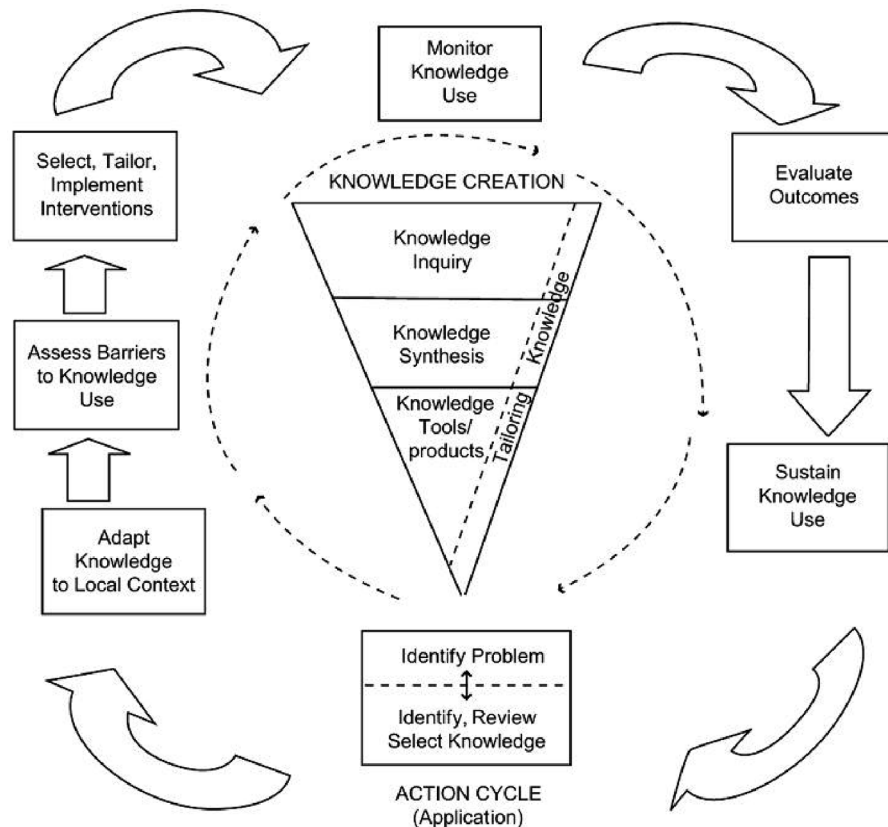


Fig. 2. Knowledge-to-action process. (From Reference 29, with permission.)

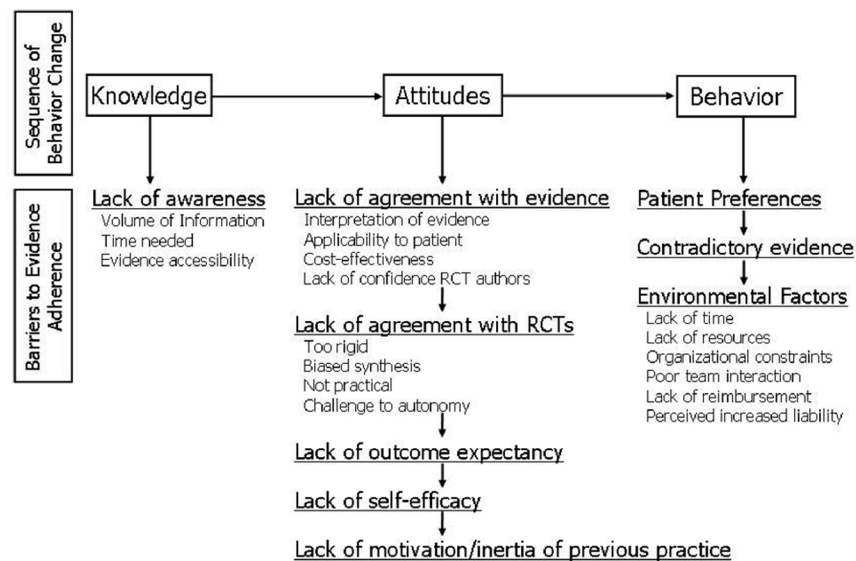


Fig. 3. Barriers to clinician incorporation of new evidence into practice. RCT = randomized controlled trial. (Adapted from Reference 30.)

early-adopter activity observable; trust and enable re-invention; create “slack” for change; and lead by example.

From this background I suggest that 7 factors are primarily important to consider when initiating an NIV pro-

gram in an acute-care hospital: identification of a clinical champion, knowledge and training, resources, clinical guidelines, self-efficacy, cost-effectiveness, and multidisciplinary communication.

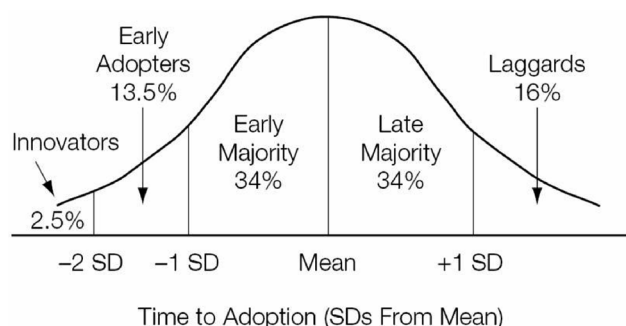


Fig. 4. Adopter categorization on the basis of innovativeness. (From Reference 22, with permission.)

## Initiating an Noninvasive Ventilation Program

### Clinical Champion

A clinical champion is an early adopter, incorporates NIV into his or her practice, encourages others to use NIV in their practice, and works with organizational leaders to remove impediments to the use of NIV. An effective champion is a good clinician, understands the institutional infrastructure, and is respected by his or her peers. The champion is enthusiastic without being obnoxious, and has good teaching skills. Writing skills are important to develop policies, procedures, and clinical algorithms. The champion should be flexible, tireless, and remain optimistic despite setbacks. The champion becomes the go-to person when problems arise with the clinical use of NIV or with the program. Given the technical aspects of NIV, it may be most effective to have a physician and a respiratory therapist (RT) serve as co-champions. Given the multidisciplinary nature of NIV, the ideal team of champions might be an RT, physician, and nurse. In countries that do not have RTs, respiratory physiotherapists often serve the role of NIV champion.

Potential champions, who have the motivation but lack the experience or technical skills needed to implement the program, can attend NIV conferences and workshops, but perhaps more important is that he or she visit an institution with a successful NIV program and observe NIV initiation, adjustment, and monitoring side-by-side with NIV-experienced clinicians. This can also establish contacts with potential expert resource persons who may be able to answer questions that arise while implementing the new NIV program.

When initiating an NIV program, it may be helpful to bring in champions from other centers to provide lectures and workshops for interested staff. External experts may also be helpful in drafting policies and procedures, and can provide continuing consultation via telephone or e-mail.



Fig. 5. Frequency of the most important reasons for low utilization of noninvasive ventilation at individual hospitals, as assessed by their directors of respiratory care. (Adapted from Reference 21.)

### Knowledge and Training

Low utilization of NIV is associated with lack of physician NIV knowledge. In the survey by Maheshwari et al,<sup>21</sup> directors of respiratory care at institutions with low NIV use rates identified lack of physician knowledge as the main reason (Fig. 5). If physicians lack the knowledge, NIV will probably not be used, because a physician must write the order to initiate NIV. How clinicians become knowledgeable about NIV may depend on the specific education intervention used.<sup>32,33</sup> Conferences and lectures often have little effect. Feedback on practice, local opinion leaders, and local consensus on practice has a variable effect. One-on-one training, reminders, and combinations of interventions are consistently effective. In the survey by Burns et al,<sup>34</sup> physicians more commonly reported learning about NIV from physician and RT colleagues than from hospital education sessions. Fewer than half obtained NIV information from conferences, original research articles, systematic reviews, or the Internet. RTs and nurses can be very influential in improving physicians' knowledge by reminding them about NIV at the bedsides of patients who might benefit from NIV.

Didactic sessions should include results of randomized controlled trials and lower-level evidence. This information allows clinicians to appropriately select patients for NIV and thereby use it only when indicated. Lectures should also cover technical aspects of NIV, although these may be better taught in hands-on workshops. NIV complications, and how they can be avoided, should be discussed. Practical tips for initiating NIV can be covered in both didactic and hands-on sessions (Table 1). Incorporating the model of Rogers,<sup>22</sup> the relative advantages of NIV (decreases the need for intubation and improves survival) and NIV's compatibility with the application of mechanical ventilation via endotracheal tube should be stressed.



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Table 1. Guidelines for Patient Selection and Initiation of Noninvasive Ventilation

1. Select appropriate patient. Patients with chronic obstructive pulmonary disease (COPD) or acute cardiogenic pulmonary edema are most likely to benefit. Noninvasive ventilation (NIV) should not be used in patients who require urgent intubation (respiratory arrest, severely depressed consciousness), who require an endotracheal tube for airway protection, or who wish not to receive NIV.
2. Choose a ventilator that meets the patient's needs. Bi-level ventilators are commonly used, but any ventilator can be used. The most common mode is pressure-support ventilation.
3. Choose the correct interface. For acute respiratory failure, an oronasal mask is commonly used. Avoid too large a mask. If the patient is intolerant of oronasal mask, try nasal mask, nasal pillows, or total face mask.
4. Explain NIV to the patient. It can be extremely frightening for a patient in acute respiratory failure to have a mask strapped over the face. Explain the goals of NIV and the alternatives. For patients who remain anxious, a small dose of anxiolytic may be appropriate.
5. Silence alarms and begin with low settings, even if the settings are sub-therapeutic. This helps the patient acclimate to the mask and the pressure.
6. Initiate NIV while holding the mask in place; do not apply the straps yet. This helps the patient acclimate to the mask without the fear that can be caused by having the mask strapped on.
7. Secure the mask but avoid a too-tight fit. A common mistake is to strap the mask too tightly. Small leak is acceptable, and a bi-level ventilator compensates for leak. Strapping the mask too tightly decreases patient tolerance and increases the risk of facial skin breakdown. It should be possible to pass 1 or 2 fingers underneath the straps.
8. Titrate the pressure support to patient comfort. With a bi-level ventilator the difference between the inspiratory pressure and expiratory positive determines the level of pressure support. Gradually increase the inspiratory pressure while observing accessory muscle use and respiratory rate, and ask the patient if breathing is becoming more comfortable. Initially, the inspiratory pressure setting may be a compromise between the therapeutic target and patient tolerance.
9. Titrate the fraction of inspired oxygen to achieve an oxyhemoglobin saturation ( $S_{pO_2}$ ) > 90%.
10. Avoid inspiratory pressure > 20 cmH<sub>2</sub>O, which decreases patient comfort and increases the risk of gastric insufflation.
11. Titrate expiratory pressure per trigger effort and  $S_{pO_2}$ . For patients with COPD, expiratory pressure (to 10 cmH<sub>2</sub>O) may counterbalance intrinsic positive end-expiratory pressure and improve the patient's ability to trigger the ventilator. For patients with acute cardiogenic pulmonary edema, expiratory pressure (to 10 cmH<sub>2</sub>O) increases intrathoracic pressure, decreases pre-load and after-load, and improves  $S_{pO_2}$ . Remember that an increase in expiratory pressure requires an equivalent increase in inspiratory pressure to maintain the same level of pressure support.
12. Continue to coach and reassure the patient. Make adjustments per patient comfort and adherence to therapy. It is acceptable to give the patient a break from NIV if the patient does not acutely decompensate when the mask is removed.
13. Evaluate NIV success. If signs of improvement are absent 1–2 h after initiation of NIV, consider alternative therapies (eg, intubation).

For the naïve user, NIV can appear technically complex. The technical aspects of NIV should be addressed in hands-on workshops to reduce concerns about complexity. The workshop should cover interface selection, interface sizing, ventilator selection, issues related to the circuit (eg, humidification and aerosol delivery), selection of ventilator settings, and troubleshooting. This training is particularly important for RTs, and less important for nurses and physicians. Hands-on training often involves clinicians setting up the equipment on themselves and others. Use of a medical simulator would seem ideal for this training. To sustain the program, hands-on NIV training should be part of the orientation for all staff brought into the department.<sup>35</sup>

Following didactic and hands-on training, NIV instruction should continue at the bedside. When initiating an NIV program, trialability may be important. This means that initially NIV would only be used in a selected clinical setting, such as the ICU, and in a population of patients in whom success is most likely, such as those with COPD exacerbation. During the trial, initiation of NIV may be limited to specific times when champions and others with experience are available to support the therapy. Persons with little NIV experience should observe the practice of

NIV-experienced clinicians, which provides the observability recommended by Rogers.<sup>22</sup>

### Resources

Additional resources are necessary to initiate an effective NIV program. Inadequate equipment has been reported as a barrier to NIV use (see Fig. 5).<sup>21</sup> More frequent NIV use is associated with a greater number of ventilators for NIV.<sup>34</sup> It is important to recognize this from the outset and establish a reasonable budget for the program. This will require buy-in from the hospital administration. Physician and RT champions will need to convince the hospital leadership of the value of NIV in patient care (fewer intubations, improved survival). Resources will be needed for training, to develop policies and protocols, to purchase equipment for NIV, and for the additional time required to initiate NIV. Initiating an NIV program should be part of a quality-improvement initiative. Program successes and failures should be monitored, discussed, and responded to quickly.

Although NIV can be successfully delivered with any ventilator and the mask from a bag-valve resuscitator, this is technically challenging and is not acceptable in current



Fig. 6. Interfaces for noninvasive ventilation. (Adapted from Reference 36.)

practice in North America. Ventilators designed for use with an endotracheal tube are not leak tolerant, which creates issues of patient-ventilator dyssynchrony. Masks designed for resuscitation or anesthesia applications are typically uncomfortable and may promote complications, such as facial skin breakdown. Ventilators designed specifically for NIV are leak tolerant and incorporate features to enhance patient-ventilator synchrony.<sup>36</sup> Many current-generation critical care ventilators have modes for invasive and noninvasive ventilation.<sup>37</sup> Modern NIV interfaces are designed to reduce leaks and, most important, improve patient comfort and decrease the risk of facial skin injury.<sup>36</sup>

The interface is commonly regarded as the weak link in the success of NIV (Fig. 6).<sup>36,38</sup> Having a variety of interfaces of various sizes is necessary for a successful NIV program. There are advantages and disadvantages to each type of interface (Table 2).<sup>36</sup> Particularly when the NIV program is in its infancy, it is likely that multiple inter-

faces will be necessary as clinicians gain experience selecting interface type and size. The program is less likely to succeed if only a single size and style of interface is available.

Initiating NIV is time-consuming. Although the time required is worthwhile in terms of avoiding intubation and saving lives, it is nonetheless a consideration when establishing an NIV program. It may require nearly an additional hour of RT time during the first 8 hours to initiate NIV, but this time requirement significantly decreases over the second 8 hours of therapy (Fig. 7).<sup>39</sup> In countries where nurses have a greater responsibility for initiating NIV than they do in North America, an additional hour of nursing time may be required for the first 24 hours of therapy. To establish realistic expectations when initiating an NIV program, this additional time should be considered.<sup>40</sup>

To improve the convenience of NIV initiation, and to prevent delays in initiation, it is important that the equipment (both masks and ventilators) is readily available in

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Table 2. Advantages and Disadvantages of the Interfaces for Noninvasive Ventilation

Interface	Advantages	Disadvantages
Nasal mask	Less risk of aspiration Easier secretion clearance Less claustrophobia Easier speech Patient may be able to eat Easy to fit and secure Less dead space	Mouth leak Higher resistance through nasal passages Less effective with nasal obstruction Nasal irritation and rhinorrhea Mouth dryness
Oronasal mask	Better oral leak control More effective in mouth-breathers	Greater dead space Claustrophobia Greater aspiration risk Greater difficulty speaking and eating Asphyxiation risk with ventilator malfunction
Mouthpiece	Less interference with speech Very little dead space May not require headgear	Less effective if patient cannot maintain mouth seal Usually requires nasal or oronasal mask at night Nasal leak Potential for orthodontic injury
Total face mask	May be more comfortable for some patients Easier to fit (one size fits all) Less risk of facial skin breakdown	Potentially more dead space Potential for drying of the eyes Cannot deliver aerosol medications
Helmet	More comfortable for some patients Easier to fit (one size fits all) Less risk of facial skin breakdown	Rebreathing Poorer patient-ventilator synchrony Less respiratory-muscle unloading Asphyxiation risk with ventilator malfunction Cannot deliver aerosol medications

(Adapted from Reference 36.)

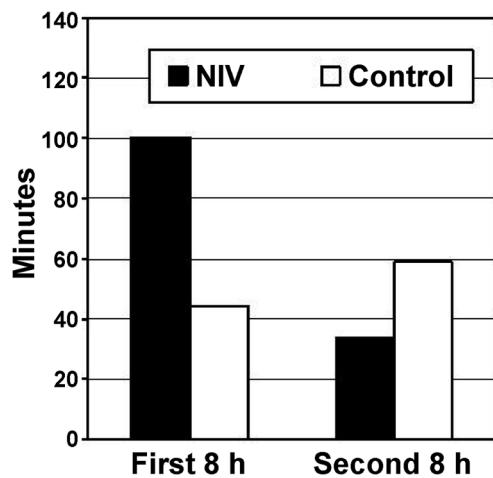


Fig. 7. Respiratory therapist time requirement for initiating noninvasive ventilation (NIV). (Data from Reference 39.)

high-use areas such as the ICU and the emergency department. Ventilators should be set up with circuits in place and pre-use procedures completed. Having to search for equipment or deal with malfunctioning equipment can be an important impediment to NIV initiation, and can frus-

trate clinicians and reduce their confidence in the NIV program.

### Practice Guidelines

Clinical practice guidelines are designed to change practitioner performance and to improve the process and outcomes of care. Guidelines and protocols have been used as a link between evidence and practice, to promote best practice, to improve uniformity of care, to reduce error rates, and to promote collaboration and a multidisciplinary approach to care.<sup>41-43</sup>

Sinuff et al<sup>44</sup> conducted a survey of Canadian clinicians' attitudes toward clinical practice guidelines in the ICU. They found that many Canadian institutions locally develop guidelines, and many ICU physicians and nurses reported using them. Clinicians preferred simple formats such as pre-printed orders, algorithms, and electronic methods to access guidelines. Physicians considered endorsement of guidelines by a colleague to be more relevant than did nurses, whereas nurses considered the guideline's perceived risk as more relevant to guideline uptake than did physicians. Lack of agreement with recommendations was a more important barrier to use of guidelines for physicians than for nurses.



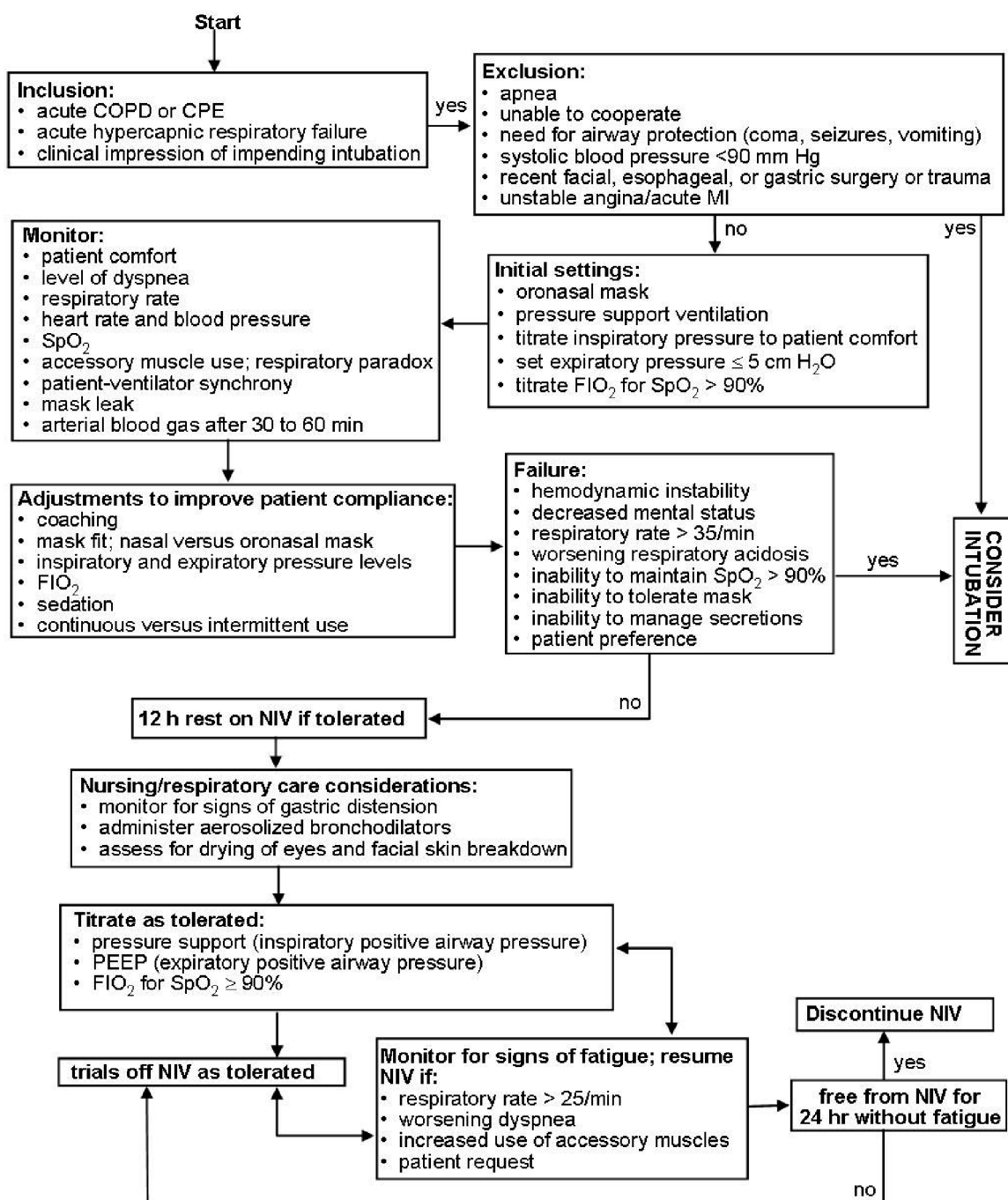


Fig. 8. An algorithm for initiating noninvasive ventilation (NIV) in patients with acute respiratory failure. COPD = chronic obstructive pulmonary disease. CPE = cardiogenic pulmonary edema. MI = myocardial infarction.  $S_{pO_2}$  = oxygen saturation measured via pulse oximetry.  $F_{IO_2}$  = fraction of inspired oxygen. PEEP = positive end-expiratory pressure.

Guidelines and algorithms may be useful when initiating an NIV program (Table 2 and Fig. 8). Sinuff et al<sup>45</sup> reported that an NIV guideline was associated with changes in the process of care, with greater NIV utilization in the ICU, and with increased pulmonary consultation, but without a significant change in patient outcomes. In a study designed to evaluate attitudes toward that guideline, Sinuff

et al<sup>46</sup> found that the clinicians' perception was that the guideline defined individual clinical responsibilities, improved clinician comfort with use of technology, increased patient safety, and reduced practice variability. Barriers to guideline use included lack of awareness of the guideline, unclear guideline format and presentation, and reluctance to change practice. Clinicians reported that the guideline

did not limit clinical autonomy. Clinicians used the guideline variously as an educational resource, to access monitored beds, to avoid clinical conflict, or to leverage professional credibility.

Guidelines for initiating NIV can help adapt evidence to local culture and thus translate evidence into local practice. Guideline development should be multidisciplinary, with input from physicians, RTs, and nurses. NIV guidelines can deal with issues such as where NIV will be offered (wards, ICU, step-down unit) and the types of interfaces and ventilators that will be available. Guidelines can help consolidate authority (who does what when). They can be linked to order sets so that NIV is prescribed consistently. The guideline can also be linked to diagnosis, so the physician is prompted to consider NIV when a patient with COPD exacerbation is admitted to the ICU or emergency department. Guidelines should avoid unnecessary detail; algorithms are helpful in this regard. The guideline should allow rational deviation from the protocol rules. The guideline should be regularly assessed, updated, and modified as new evidence becomes available or protocol problems are identified. The guideline can serve as the basis for quality-assurance initiatives related to NIV. The guideline can also serve as a framework for education.

## Self-Efficacy

The application of NIV is as much an art as a science. Typically, clinician skills and confidence improve with experience. It is important to deal with contradictions and unrealistic expectations. When initiating an NIV program, it is important to have realistic expectations. NIV, even in the hands of the most skilled clinician, does not avoid intubation in all cases. Extrapolating from randomized controlled trials and observational studies, it is reasonable to expect an NIV failure rate of 20–40%, so clinicians who are naïve to NIV should not be discouraged if their initial applications are not successful.

NIV success is better with certain conditions (eg, COPD exacerbation or acute cardiogenic pulmonary edema) than with others (eg, pneumonia or acute lung injury). To improve clinician confidence while initiating the program, it is reasonable to use NIV only in cases where it is most likely to succeed, in patients with COPD exacerbation or acute cardiogenic pulmonary edema. The program can also be limited to times when staffing is best, and it can be limited to specific units where the staff are specifically trained in NIV application.

It is important to know not only when to start NIV but also when it is not succeeding and alternatives (eg, intubation) should be considered. It is not in the best interest of staff confidence or patient outcomes to struggle with NIV if the patient's condition is deteriorating despite the

clinical team's best efforts. It is important to appreciate that complications can occur despite our best efforts to avoid them. Complications should be evaluated in the context of quality-improvement and should not be seen as a reason to abandon the program.

The NIV program should be initiated as a quality-improvement initiative. Initially, it might be reasonable to critique every NIV application. Successes should be recognized. For example, if NIV decreases the intubation rate in patients with COPD exacerbation, this should be announced in in-house publications.

Observational studies have found that NIV use increases over time. Girou et al<sup>47</sup> reported a significant increase in NIV use and a concomitant decrease in mortality and ICU-acquired infection rates from January 1, 1994, through December 31, 2001. Demoule et al<sup>48</sup> reported that first-line NIV increased significantly over a 5-year period (overall from 16% to 23%), and especially in patients not intubated before ICU admission (from 35% to 52%). Esteban et al<sup>49</sup> reported that from 1998 to 2004 the NIV use increased from 17% to 44% of patients who presented with COPD exacerbation. These results suggest that NIV use increases as clinicians become more familiar with its use.

## Cost-Effectiveness

When the NIV program is being developed, its cost-effectiveness will probably be questioned. A superficial analysis might suggest that the cost of additional equipment and staff time is prohibitive, and this might be an obstacle to developing the program. However, the available evidence suggests that NIV is cost-effective. Keenan et al<sup>50</sup> constructed a decision tree, and probabilities were applied at each chance node using research evidence and a comprehensive regional database. To estimate the costs of the alternative therapies, the costs of 8 types of hospitalization days were used. Sensitivity analyses were performed, varying all assumptions made. Their economic assessment found cost savings with NIV, and they concluded that, from a hospital's perspective, NIV for severe exacerbation of COPD is more effective and less expensive than standard therapy alone. Plant et al<sup>40</sup> evaluated the cost-effectiveness of standard treatment with and without the addition NIV in patients with exacerbation of COPD. They found lower costs with NIV, mainly because of less ICU use, and they concluded that NIV is a highly cost-effective treatment that reduces costs and improves mortality.

## Multidisciplinary Interaction and Communication

For optimum success, the multidisciplinary nature of NIV application must be recognized.<sup>51</sup> It is typically the

physician's responsibility to select patients for NIV, with input from RTs and nurses. In North America, RTs usually select the NIV equipment and often tailor the ventilator settings to the individual patient's needs. RTs and nurses work together to coach the patient, adjust the interface, and assure patient adherence. In countries without RTs these responsibilities are assumed by nurses, physicians, or respiratory physiotherapists. When initiating an NIV program, it is important to identify the responsibilities of the individual team members, to stress the value of each team member, and to encourage communication among the team members.

### Certification

Hospitals may choose to develop a formal certification program as part of the NIV program. This might include written and hands-on testing of RTs, physicians, and nurses. Certification of RTs should include mask fitting, selecting appropriate ventilator settings, monitoring the response to NIV, and adjusting the interface and ventilator settings. Certification of physicians should be directed at appropriate patient selection. Certification of nurses should be directed at issues such as patient monitoring and facial skin care. The certification process should be multidisciplinary and, ideally, co-directed by a physician, RT, and nurse. It is important that the certification process is tailored to the hospital's culture and available resources. In countries that do not have RTs, respiratory physiotherapists or nurses might assume the responsibilities typical to RTs in North America.

### Summary

For NIV to become an accepted therapy, clinicians must come to view it as better than alternative therapies. NIV must be perceived as compatible with existing approaches to mechanical ventilation, it must not be too difficult to use, it must be trialable, and its results must be visible. Barriers to NIV include lack of knowledge, lack of agreement with the evidence, lack of self-efficacy, unrealistic outcome expectations, and the inertia of previous practice. A clinical champion and one-on-one, hands-on training are important, and adequate personnel and equipment resources are necessary when implementing an NIV program. Guidelines and protocols may be useful, and success with NIV improves with experience. The available evidence suggests that NIV is cost-effective. For optimum success, the multidisciplinary nature of NIV application must be recognized. Following these principles, a successful NIV program can be initiated in any acute-care setting.

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## Discussion

**Gay:** When I first started to use NIV, around 1989, I had to go find a Puritan Bennett 2800 that was always in the warehouse and basically was a home portable ventilator. We used masks made for intermittent-positive-pressure-breathing ventilators, and we were the work force. I personally did all of it for a couple years, and insti-

tuting an RT-driven protocol changed my life.

**Hess:** So you were the local champion.

**Gay:** My wife was the champion, for getting me out of the house and making sure I got the job done right. It has to be a bedside approach. Better equipment came along too. We bought

a Craftsman cart that we could wheel all over, and we made it a dedicated mask and equipment cart, in which we had an array of equipment, like a crash cart, so we could rapidly try various interfaces and equipment. It tremendously facilitated starting the program.

**Hess:** In the beginning of our NIV experience we went to Home Depot



and got a big toolbox, in which we put interfaces of various sizes and types, and when RTs went to initiate NIV, they would take the box and choose an interface. As our confidence and experience increased, we moved away from that strategy, but it was helpful initially.

**Davies:** I think it will help departments that are starting NIV programs to send their early adopters (not the innovators) to NIV-education conferences and seminars. That's how to get the most educational bang for your buck. The innovators are self-driven, but early adopters may need a "kick start," and educational programs can be just the thing.

**Hess:** They're the ones who are going to be giving the lectures.

**Davies:** Right, but some early adopters sometimes need a little push, and those education sessions might be just what they need. We were sometimes sending the wrong people; not the laggards, but some of the others.

You also mentioned celebrating therapeutic successes; that's worked well for us. Publicizing successes can make others aware of how success was achieved and open avenues for further enhancements to care.

**Hess:** I recall an RT in our department who was skeptical about NIV early on. Then one day he came to my office and was as excited as I ever saw him. A patient came to the emergency department with acute cardiogenic pulmonary edema, and they asked him to try BiPAP [bi-level positive airway pressure], which he did, and the patient got better and went home.

**Epstein:** For people starting NIV programs, what is your recommendation for specific training? Should there be a certification process?

**Hess:** Yes. We have a test and check-off. Every new employee spends about a half day with me and they watch a video of a Professor's Rounds that Dave Pierson and I did a couple of years ago, which goes over NIV. Then we go over the ventilators and various interfaces. They need to set up NIV on one another. Sometimes I make them set it up on me. Then they take a test and we go over the test together and talk about the answers. That is our check-off system.

**Epstein:** Almost like a simulation program? Does anybody use simulators or mannequins for NIV?

**Davies:** We don't use our simulator at present, but that certainly could be valuable. Case scenarios and simulations can help enforce that NIV is not merely slapping on the mask and applying pressure to the patient's face.

**Hess:** Yes, though simulator time is very expensive.

**Epstein:** I'm thinking of institutions that already have a simulation center, for teaching RTs and empowering them to do a time-out. On service in the ICU a couple of weeks ago, I saw at least 3 patients who should not have been started on NIV: house staff had started NIV in situations where it was contraindicated. I wonder about RTs stepping in and saying, "Hey guys, hold on." How do you train your RTs?

**Hess:** I think our RTs are very involved in dealing with the house staff in situations like that. They will typically bump it up pretty quickly. Bob Kacmarek or I, or others in the department leadership get calls about this. It also gets bumped up to some of our physician leadership. And on the nursing side, they will bump it up to nursing supervisors.

**Davies:** The same thing has occurred in my institution. We find patients on "TryPAP." Some physicians try NIV

when it is contraindicated, which may delay appropriate therapy and endanger the patient. One key to avoiding incorrect patient selection is timely intervention by the RT or nurse. We take the fact that NIV is enjoying much more widespread use as a good sign overall, but we must be careful of misuse.

**Hess:** Punished by our successes, in other words. We've gotten so good that we're asked to use it in places where it's inappropriate. Stefano, what has been the European experience with this?

**Nava:** We don't have formal guidelines in most centers, and those that do might not pay as much attention to them as you do in North America. We tend to be reluctant to use formal protocols, even for weaning. We do a lot of teamwork. In my unit, usually every month, we get together with the physiotherapists and the nurses to do a refresher on applying NIV.

What I *always* suggest is that everyone try NIV on himself. This is very important, especially when you simulate leaks, so you can see how the ventilator looks when it compensates for leaks. I think you need that. The only thing we have a protocol for is nose abrasion, and our nurses are pretty good with that.

What I've found very good for us is that we (a group of friends, including Antonelli, Conti, Navalesi, Gorini, Gregoretti, and myself) conduct NIV courses 3 times a year, around Italy. In these "NIV schools" so far we have trained about 3,000 people, mainly physicians but also nurses and RTs. It's quite useful, for both the attendees and us, to get ideas about real clinical NIV situations.

**Epstein:** Of the people here who have protocols and guidelines, how many include anything on discontinuing or weaning from NIV? A lot of us have protocols for initiating



NIV, but what do you do when it's failing?

**Davies:** Strict protocol guidelines are good in many instances, but I think discontinuing NIV should be a care team decision. If the patient could be liberated from NIV, the questions that need to be asked of the team are: How are the ABGs [arterial blood gas values]? Have we reached our goals? And, in terms of clinical assessment, is everybody happy with this next step?

**Doyle:**<sup>\*</sup> Regarding training at clinical simulation centers, I was at the Mayo Clinic about 8 months ago and it seemed like their whole approach

was trying to train clinicians together and use a team approach, as opposed to individual training, and it seemed like a great venue for NIV training, but is it too costly?

**Hess:** Simulator time is costly, and getting time in the simulator is really tight. We have that kind of a program for our code team. Every month the code team (including physicians, nurses, anesthesia, and RTs) gets together for several hours in the simulator, and it's all about working together as a team. It could be very helpful to do that for NIV, to get a medical resident, an RT, and a nurse together in the simulator.

**Mehta:** Do you have NIV training for the residents? I find that the residents basically leave it up to the RTs.

They sign off on initiation and basically walk out of the room thinking everything's going to be done, because the RTs know more about NIV than they do.

**Hess:** Periodically. I personally spend 3 hours every month with the residents of our medical ICU talking about mechanical ventilation. For a small part of that time we talk about NIV, but it's more about who's the right candidate and who's not.

**Mehta:** So it's not a practical approach?

**Hess:** Right: not very practical, though about every 2 years I am asked to meet with the residents and I will bring NIV ventilators and masks and they can try them.

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