Noninvasive Ventilation for Acute Respiratory Failure: A National Survey of Veterans Affairs Hospitals

Gregory B Bierer MD and Guy W Soo Hoo MD MPH

BACKGROUND: The utilization of noninvasive ventilation (NIV) in the Veterans Affairs healthcare system is not well characterized. A survey of physicians and respiratory therapists was conducted to better understand its use. METHODS: Three hospitals in each of 21 Veterans Affairs networks were selected based on severity of patient mix, level of staffing and workload. A request was sent via e-mail to Veterans Affairs respiratory therapists and critical care physicians at these hospitals to complete a 41-question survey using an Internet-based survey site. RESULTS: A total of 192/882 (22%) responses were received from a survey of about half (63/128) of the Veterans Affairs intensive care units (ICUs). Previous experience and training in NIV was limited. NIV is reported to be widely available and applied in both monitored (ICU, step-down, emergency department) and unmonitored (ward) settings. NIV was identified as a first-line option for COPD and CHF, but perceived use was less. Sixty-four percent of respiratory therapists felt NIV was used < 50% of the time when indicated, compared to 29% of physicians ($P < .001$). Reported NIV use varied, with 45% treating 0–4 patients a month and 23% with > 10 patients a month. Larger ICUs reported more frequent use of NIV (> 10 patients a month) than smaller ICUs ($P = .02$). Written guidelines were noted by 65%, but only 27% had titration guidelines. The perceived efficacy of NIV was low, with a success rate of > 50% noted by only 29% of respondents. CONCLUSIONS: The perception of NIV use in the Veterans Affairs hospitals varies significantly. This survey revealed a wide range of training and experience, location of use, presence of written guidelines, and methods of delivery. Notable perceptual differences exist between respiratory therapists and physicians. Underutilization of NIV and low rates of perceived efficacy are major findings. *Key words: noninvasive ventilation, respiratory failure, hypercapnia, respiratory therapists.* [Respir Care 2009;54(10): 1313–1320. © 2009 Daedalus Enterprises]

Introduction

Noninvasive ventilation (NIV) has been increasingly utilized for patients with respiratory distress. Consensus conferences, guidelines, and meta-analyses have endorsed and supported the use of NIV, especially in patients with exacerbations of chronic obstructive pulmonary disease (COPD) and congestive heart failure (CHF).[1-6] Utilization of NIV has continued to increase, more than doubling from 1998 to 2004 in one international survey.[7]

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However, there remains great variation in the actual use of NIV. One study reported utilization rates of NIV ranging from zero to > 50% in those requiring ventilatory assistance.[8] A survey of 268 United Kingdom hospitals reported NIV to be available in 17–78% of hospitals, and 68% of respondents treated < 20 patients yearly, with only

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9% treating more than 60 patients per year.[9] A Canadian survey showed significant variation between groups of physicians in usage patterns, experience with NIV, and perceptions of efficacy.[10]

Even in countries with extensive NIV use, an observational French survey noted only a modest increase over 5 years of use, from 16% to 23% of all patients receiving ventilatory support.[11] The utilization was greater, increasing from 35% to 52%, for those not intubated prior to intensive care unit (ICU) admission. On the other hand, in another French ICU, NIV utilization exceeded 80% of their COPD and CHF admissions.[12] The most recent report of international NIV use noted an increase in NIV use, from 4.4% to 11.1% of critically ill patients, or just 186 of 1,675 patients.[7] The limited use of NIV in the United States has been attributed to a host of factors, including lack of physician (MD) knowledge, insufficient respiratory therapist (RT) training, expense of treatment, doubt of benefit, and lack of equipment.

Despite multiple concerns limiting NIV use, there appears to be increasing use for acute respiratory distress in ward settings with limited cardiac and respiratory monitoring.[13-15] One Canadian hospital reported 41% treated with NIV in a ward setting.[16] Indications for NIV are expanding and include many types of disorders.[17-20] Written practice guidelines have improved the utilization of NIV with respect to patient selection and monitoring, but have not affected intubation rate or mortality.[21,22]

Surveys of NIV use in the United States have been limited.[8] Little is known of its use in the Department of Veterans Affairs health-care system. Veterans Affairs operates 163 hospitals, and over 125,000 patients are discharged with a primary or secondary diagnosis of COPD, annually accounting for about 33% of admissions to the medical service and 16% of all hospital admissions.[23] This represents a very large number of potential NIV candidates. Therefore, a survey of Veterans Affairs MDs and RTs was conducted to better understand the current use of NIV and to identify areas that may improve its utilization and efficacy.

Methods

An Internet-based survey (available from the authors upon request) using a 41-question, self-administered questionnaire was developed by the authors. The questionnaire content addressed areas and issues identified by the authors and local RTs, as well as more global issues. The questionnaire was constructed by the authors, based on review of previously published surveys regarding NIV, feedback from RTs about NIV, and personal experiences. The questionnaire underwent 2 rounds of testing and retesting, with feedback sessions, to evaluate question clarity and reliability. Four RTs underwent pilot testing of a paper version of the questionnaire, with at least 2 weeks between test versions. The final version posted for the survey had undergone 2 revisions and 2 rounds of pilot testing. The questionnaire and an introductory letter outlining the purpose of the survey to better characterize the use of NIV in critically ill patients in the Veterans Affairs were posted at http://www.SurveyMonkey.com (Survey Monkey, Seattle, Washington).

Three hospitals were identified from each of 21 regional Veterans Integrated Service Networks. Hospital ICUs were characterized by a 2004 survey of ICUs in Veterans Affairs hospitals conducted by the Healthcare Analysis and Information Group.[24] Results from 213 ICUs located in 128 Veterans Affairs hospitals were divided into categories designated by complexity of treated patients, availability of complex services and subspecialties, and level of physician staffing. The ICU characteristics of these hospitals are used by the Veterans Affairs Department to define their level. A brief summary is as follows:

- Level 1: complex patient mix with full-time intensivist
- Level 2: complex patient mix with consultative intensivist
- Level 3: moderate patient mix without a dedicated ICU MD, but some subspecialty services
- Level 4: similar to level 3, but without subspecialty services

Three hospitals from each Veterans Integrated Service Network, and one from each level (1, 2, or 3 and 4) were selected for the survey, to ensure representation of ICUs from each level within the Veterans Affairs health-care system. In Veterans Integrated Service Networks with multiple hospitals fulfilling criteria, the hospital with the highest number of admissions was selected. In Veterans Integrated Service Networks without a hospital in the designated category, another hospital was selected from the next highest or same level. For example, in a Veterans Integrated Service Network without a Level 2 ICU, 2 Level 1 ICUs were selected for the survey. There are a total of 57 Level 1, 20 Level 2, and 51 Level 3 and 4 hospitals with ICUs in the Veterans Affairs health-care system. Therefore, about half (63 of 128) of the Veterans Affairs hospitals with ICUs were surveyed on their use of NIV.

Using the Veterans Affairs global address book for these 63 hospitals, e-mail requests for participation were sent to listed pulmonary and critical care MDs and RTs. The e-mail letter included the purpose of the survey and provided a link to the questionnaire. The questionnaire was completely anonymous, and no personal identifying information was collected. A repeat e-mail was sent about a month later, as a reminder. After completion of the questionnaire, voluntary submission to a drawing was offered. The in-

Table 1. Demographics of Respondents (n = 192)

Respondents	n (%)
Physicians	42 (22)
Respiratory therapists	148 (77)
Other (respiratory technician)	2 (1)
Hospital size	
Bed size	
< 100	46 (24)
101–499	126 (66)
≥ 500	19 (10)
ICU size	
Beds	
< 10	30 (20)
11–24	73 (38)
25–49	64 (33)
≥ 50	17 (10)
House staff	
Yes	179 (93)
No	13 (7)

ICU = intensive care unit

Table 2. Experience and Availability of Noninvasive Ventilation Use (n = 192)

Overall experience	n (%)
Years since training	
0–5	9 (5)
6–10	23 (12)
11–19	57 (30)
≥ 20	103 (54)
NIV experience during training (patients per year)	
Zero	58 (31)
1–2	32 (17)
3–9	48 (25)
> 9	52 (27)
Location of NIV use	
ICU	190 (99)
Step-down or telemetry unit	140 (73)
Emergency department	121 (63)
Ward	75 (39)
NIV available 24 h a day/7 d a week	
Yes	186 (97)
No	6 (3)

NIV = noninvasive ventilation
ICU = intensive care unit

centive was a video iPod. Study costs were covered by departmental research funds.

The study was approved by the Veterans Affairs Greater Los Angeles Healthcare System institutional review board. The committee waived the need for informed consent, since this was an anonymous questionnaire survey with no personally identifiable information collected.

The responses to the survey, including subgroup analysis, were automatically tabulated by the Web site. All responses were exported to an Excel (Microsoft, Redmond, Washington) worksheet for further analysis. Analysis of differences in responses was done by comparison of proportions, using a statistical software package (MedCalc, MedCalc Software, Brussels, Belgium) and reported as 95% confidence intervals (CIs).

Results

Survey responses were completed between October 2006 and January 2007. A total of 882 e-mail invitations were sent, with 192 respondents (22%). Demographics are in Table 1. The majority of respondents were RTs, mirroring the composition of the mailing list. Most hospitals were 100–500 beds, with an even distribution of small ICUs (10 or less beds) to larger ICUs (25–49 beds).

Past experience, training, and location of NIV use appear in Table 2. Overall, 48% reported using NIV in 2 or fewer patients during training, with 22% having no specific training in NIV. Far more MDs (51%) reported no specific NIV training, compared to RTs (13%) ($P < .001$, 95% CI 0.24–0.53). As might be expected, those further removed from training (≥ 20 years) were more likely to report zero experience with NIV (48%) during their training, compared to more recently trained (≤ 10 years), in whom the zero experience response was reported by only 7% ($P < .001$, 95% CI 0.22–0.60). Conversely, the recently trained had more NIV experience in the 3–9 patients range (44% vs 18%, $P = .006$, 95% CI 0.09–0.43) and ≥ 9 patients (38% vs 16%, $P = .02$, 95% CI 0.05–0.38), respectively, during training. Nearly 40% reported use of NIV on the wards. No restriction on location of use was reported by 43%, but 42% noted that NIV was restricted to a specific area (ICU) or service. NIV was reported to be available 24 hours a day 7 days a week by nearly all respondents (97%).

The most common conditions treated by NIV are listed in Table 3. NIV was used as a first-line therapy most commonly in obstructive sleep apnea, COPD, and CHF. When asked about the actual use of NIV when NIV was indicated, a majority (57%) of respondents felt that NIV was utilized less than 50% of the time (Fig. 1). Significantly more RTs (64%) felt that NIV was used less than 50% of the time when indicated, compared to 29% of MDs ($P < .001$, 95% CI 0.17–0.52). Conversely, only 18% of respondents felt that NIV was started for conditions in which it would be indicated ≥ 75% of the time. Only 13% of RTs held this view, as opposed to 34% of physicians ($P < .001$, 95% CI 0.08–0.34).

Regarding the use of NIV, > 95% of respondents reported the use of NIV on at least one patient per month.

Table 3. Conditions Treated With Noninvasive Ventilation

Condition	NIV Use *n* (%)	NIV a First-Line Option *n* (%)
COPD	174 (93)	142 (76)
Obstructive sleep apnea	173 (92)	145 (77)
DNR or DNI patients	156 (83)	94 (50)
Congestive heart failure	154 (82)	116 (62)
Post-extubation	150 (80)	81 (43)
Neuromuscular respiratoryfailure	115 (61)	69 (37)
Pneumonia	94 (50)	41 (22)
Facilitate weaning	58 (31)	22 (12)
Asthma	55 (29)	28 (15)
ARDS	52 (28)	18 (10)
Other	19 (10)	16 (8)

NIV = noninvasive ventilation
COPD = chronic obstructive pulmonary disease
DNR = do not resuscitate
DNI = do no intubate
ARDS = acute respiratory distress syndrome

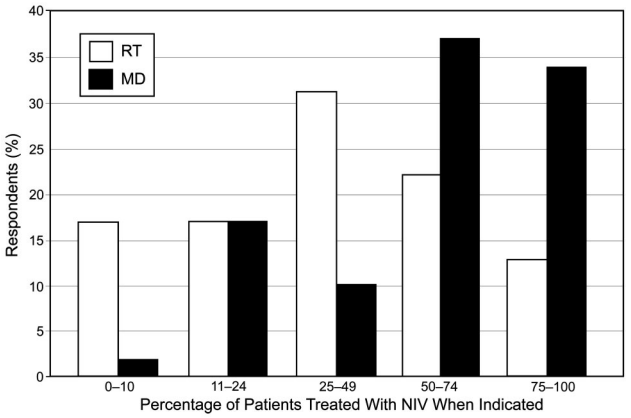

Fig. 1. Percentage of patients treated with noninvasive ventilation (NIV) when NIV indicated. Responses of respiratory therapists (RT) and physicians (MD).

NIV was used in 0–4 patients/mo according to 45% of respondents, while 31% treated 5–10 patients/mo and 23% treated more than ten patients per month. As would be anticipated, the pattern of use significantly differed based on ICU size (Fig. 2). In small ICU hospitals, 68% reported use of NIV in 0–4 patients, compared to 40% reported from hospitals with larger (> 10 beds) ICUs ($P < .001$, 95% CI 0.11–0.46). More frequent use of NIV (> 10 patients/mo) occurred in larger ICUs (27%), compared to smaller ICUs (8%) ($P = .02$, 95% CI 0.04–0.34). Of note, NIV use on the ward in hospitals with small ICUs was reported by nearly 60% of respondents, compared to 35% from those with more ICU beds ($P = .01$, 95% CI 0.07–0.42).

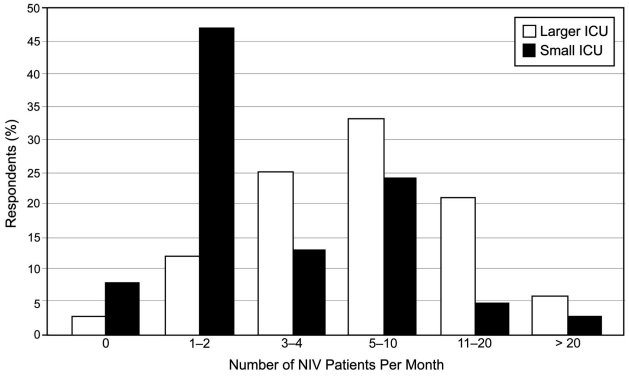

Fig. 2. Monthly experience with noninvasive ventilation (NIV). Responses of small intensive care units (ICUs) (≤ 10 beds) and large ICUs (> 10 beds).

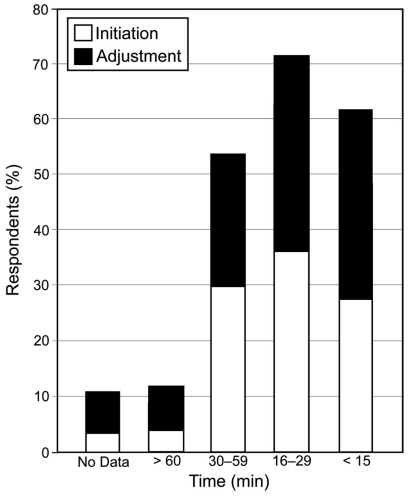

Fig. 3. Time spent in implementation of noninvasive ventilation. Initial time and time spent in adjusting the mask and ventilator settings.

The most common interface reported was a face mask (56%), followed by either a face mask or nasal mask (29%). A nasal mask was started 11% of the time. Initiation of NIV occurred in < 30 min according to 62%, and < 60 min according to 90% (Fig. 3). The majority (71%) reported < 30 min of adjustment time in the first 8 hours.

The most common ventilators used were from Respironics and Puritan Bennett. Over 70% were made by Respironics (STD, Esprit, and Vision). A bedside critical care ventilator with a noninvasive ventilation option was used exclusively by few (18%), with most (55%) reporting the use of a specialty noninvasive ventilator for NIV. Bi-level positive airway pressure was the most common initial mode (85%), followed by pressure support. Initial settings for bi-level positive airway pressure were usually inspiratory positive airway pressure of 11–14 cm H_2O and expiratory positive airway pressure of 5–6 cm H_2O.

Table 4. Variables Used to Adjust Noninvasive Ventilation

Variable	*n* (%)
Changes in blood gases (O_2 or CO_2)	170 (91)
Changes in pulse oximetry	143 (77)
Changes in respiratory rate	120 (64)
Changes in tidal volume	115 (62)
Patient comfort and/or accessory muscle use	9 (5)
Other	8 (4)

Although 65% of respondents reported written guidelines for initiation of NIV, only 27% reported written guidelines for the titration of NIV. The vast majority (84%) reported no predetermined duration of an NIV trial. Adjustments to NIV settings were based on several factors, including respiratory rate, tidal volume, pulse oximetry and arterial blood gas values, as outlined in Table 4.

According to 70% of respondents, "failure" of an NIV trial was based on clinical judgment. Written guides defining failure were used by the rest, and only 18% utilized arterial blood gas values. The most frequent perceived causes of NIV failure were patient intolerance (89%), progressive respiratory failure (87%), mask leaks (42%), inability to clear secretions (33%), and aspiration (19%). Comments offered regarding factors in failure included late initiation of therapy and lack of patient education. NIV failure occurred within one hour according to 27%, and 54% felt that failure would be evident within 2 hours. Most estimated the success rate of NIV to be in a middle range (26–50%), and < 10% felt it was successful > 75% of the time.

Most RTs (69%) felt patients failed NIV within 2 hours, a view held by only 44% of MDs ($P < .001$, 95% CI 0.08–0.41). More MDs (34%) than RTs (26%) reported that NIV has a success rate > 50%, although this was not statistically significant.

Of respondents with low use of NIV (0–4 patients/mo), only 50% felt NIV had a > 25% success rate, compared to those with higher NIV use (> 10 patients/mo), where 77% felt NIV had a > 25% success rate ($P < .001$, 95% CI 0.08–0.45) (Fig. 4). No difference in higher levels of expected success rates was noted between low and high users of NIV.

At the end of the survey, 36% reported a greater likelihood of implementing NIV in the future.

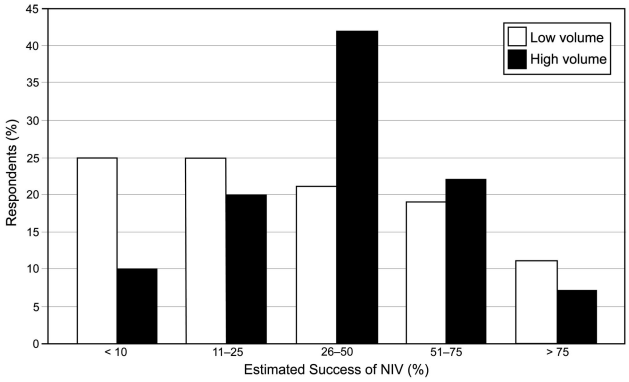

Fig. 4. Estimated success rate of noninvasive ventilation (NIV). Responses of those with low (0–4 patients/mo) and high (> 10 patients/mo) volume NIV use.

Discussion

NIV is an accepted and recommended first-line option in respiratory distress related to COPD and CHF. However, utilization in the United States is not well characterized. A large survey conducted in 1998 reported the use of NIV to be < 5%,[25] and surveys document great variability in its use,[8] from 0–20% for all those requiring ventilatory assistance. More recent surveys reported in abstract form suggest further increase in its use.[26,27]

This report outlines NIV use in the Veterans Affairs health-care system, which represents one of the largest health-care providers in the United States. The target group of the survey included front-line providers of NIV, specifically RTs and critical care MDs. Hospitals included in the survey were selected based on varying levels of patient mix, ICU staffing, and region of the country. The extent to which the results of this survey represent the use of NIV in the remainder of United States non-Veterans-Affairs facilities will require further investigation.

The most notable findings of this survey are the wide range of training, experience, location of use, presence of written guidelines, methods of delivery, and perception of efficacy of NIV among respondents.

NIV is a relatively new treatment modality, with key trials published within the past 10–12 years.[15,18,28-31] Its widespread implementation may be limited by time required for acquisition of technology and training of key personnel. NIV was not an accepted treatment modality for acute respiratory distress until after many of our respondents completed training. Therefore, it is not surprising that many respondents reported no previous training in NIV.

NIV for acute respiratory distress was once exclusively provided in the ICU, and use in settings without continuous cardiac or respiratory monitoring has primarily been reported outside the United States.[15,16,32] In our survey the 39% who reported NIV use in a ward setting is substantial. NIV use on wards was greater in those with small ICUs, as opposed to larger ICUs, which probably reflects a pragmatic approach to treatment, given the obvious limitation of beds. Nevertheless, 42% of respondents noted that NIV was restricted to a service or location (ICU), which illustrates the dichotomy of its implementation.

While respondents acknowledged NIV as a reasonable therapy, the results suggest that it is underutilized. COPD and CHF are considered conditions most amenable to NIV; however, only 76% and 62% of respondents reported using it as a first-line option for these conditions. Indeed, 57% of respondents believe that NIV was employed less than half of the time that an indication existed. There was a statistically significant difference between RTs and MDs in this regard. RTs not only feel that NIV is underutilized, compared to physicians, but also have lower expectations for its success, as will be discussed. Only 18% of all respondents felt that NIV was usually started > 75% of the time in patients with an indication for NIV.

The technical aspects of applying and adjusting the mask were not deemed to be excessively time-consuming. This further supports the findings of other investigators[33,34] and markedly differs from earlier reports of an onerous workload.[35]

A surprising number of respondents (65%) reported written guidelines for NIV. Far fewer (27%) reported titration guidelines. Our survey did not query if NIV titration was done for patient comfort, as we focused on more objective measurements. Nevertheless, patient intolerance was a key finding regarding NIV failure. Clinical judgment most commonly determines the success of an NIV trial. Overall, these responses reflect a lack of standardization on the use of NIV.

The perception of efficacy can best be described as modest. RTs and MDs had discordant, though not statistically significant, views of NIV efficacy. Physicians had a more optimistic view of NIV, compared to RTs. This may reflect the closer involvement of RTs with NIV as front-line providers. As might be expected, those with high NIV use noted greater success with NIV than low-use respondents. Increased familiarity with NIV is one explanation for this finding. Greater experience with NIV may translate into more effective therapy. Alternatively, less than expected outcomes and low use further perpetuate lower success rates and mitigate against its use. It should be noted that the expected success rates are much lower than those reported by other investigators,[3] which were usually > 75%. Coding and reimbursement issues may provide some insight into differences in NIV utilization.[36,37]

There are some obvious limitations inherent in this type of survey. One limitation of the study is a lack of external validation of the questionnaire. The questionnaire underwent internal evaluation at our institution, but there was no independent review of the clarity of questions or reliability of the tool to test perceptions of respondents. However, the questionnaire was constructed based on previously available validated surveys. Reviews of the responses from the survey demonstrated internal consistency to responses. Therefore the findings should be representative of the perceptions of health-care providers on NIV use. The findings of this study should assist in designing future studies on the use of NIV. Additionally, the interpretation of the survey questions may have influenced some of the answers. Although the survey was intended to elicit responses regarding NIV in the treatment of critically ill patients, it is possible that responses included consideration of those with a lower severity of illness. Recall bias is also acknowledged.

The response rate of 22% was modest, but is comparable to similar surveys,[38] and is higher than the North American component of that survey (19%). It should be noted that about half of the Veterans Affairs hospitals with ICUs were surveyed by this questionnaire. The Web-based survey documented that over 98% of responses were from different Internet-Protocol addresses, thereby minimizing repeat respondents. The survey Web site also documented that all respondents to the questionnaire were unique. It does appear that there was a respondent from each hospital queried. The use of only a single e-mail reminder may not have been sufficient to harvest as many responses as possible, but a prize was offered as an incentive for participation. Therefore despite the modest proportional response, the survey does represent responses from a broad sample of the Veterans Affairs health-care system. No personally identifiable information could be collected, thereby precluding closer follow-up of non-respondents. The survey did require a Veterans Affairs address directory listing and is thus subject to some misclassification, but we estimated this to be > 5%, but < 10% in our own center's listings, and consists mostly of people no longer at the Veterans Affairs health-care system. This reduces the survey denominator, but of course the actual change in response rate is unknown.

Based on the methodology, groups with larger numbers (large hospitals, ICUs, larger number of RTs) may sway some of the general responses to the questions. But subgroup analysis based on the size of the hospital, ICU, or profession did not demonstrate significant differences except in areas highlighted. Response bias is always a consideration and would be expected to favor NIV proponents. Overall, the major themes of lack of education and training, underutilization, and perceived lack of efficacy mirror those of other investigators.[8-10]

Even with the limitations of a survey, it is noteworthy that 36% of the respondents felt that after completing the query they would use NIV more frequently. The survey was not designed to increase NIV use, but after reflection on some of the issues, some of the respondents did feel that NIV may have a greater role than previously thought. This finding implies that there is a need for education and training.

Summary

The findings of this questionnaire survey better characterize the current use of NIV in the Veterans Affairs healthcare system. Our survey suggests that despite widespread availability, NIV is underutilized, and that many practitioners have only a modest perception of its efficacy. Lack of training and experience in NIV may explain the lower rates of NIV implementation. The rarity of guidelines regarding initiation, adjustment, and treatment failure may contribute to underutilization. There is also significant discordance between the perceptions of RTs and MDs concerning the utilization and success of NIV. Increased education, training, and guidelines may lead to higher rates of utilization and success. Despite widespread availability of NIV, opportunities remain to improve its application and efficacy.

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Army nurse administers oxygen to a patient (1950?)
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