

Differential Perceptions of Noninvasive Ventilation in Intensive Care among Medical Caregivers, Patients, and Their Relatives

A Multicenter Prospective Study—The PARVENIR Study

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ABSTRACT

Background: Noninvasive ventilation (NIV) requires a close “partnership” between a conscious patient and the patient’s caregivers. Specific perceptions of NIV stakeholders and their impact have been poorly described to date. The objectives of this study were to compare the perceptions of NIV by intensive care unit (ICU) physicians, nurses, patients, and their relatives and to explore factors associated with caregivers’ willingness to administer NIV and patients’ and relatives’ anxiety in relation to NIV.

Methods: This is a prospective, multicenter questionnaire-based study.

Results: Three hundred and eleven ICU physicians, 752 nurses, 396 patients, and 145 relatives from 32 ICUs answered the questionnaire. Nurses generally reported more negative feelings and more frequent regrets about providing NIV (median score, 3; interquartile range, [1 to 5] *vs.* 1 [1 to 5]; $P < 0.0001$) compared to ICU physicians. Sixty-four percent of ICU physicians and only 32% of nurses reported a high level of willingness to administer NIV, which was independently associated with NIV case-volume and workload. A high NIV session-related level of anxiety was observed in 37% of patients and 45% of relatives. “Dyspnea during NIV,” “long NIV session,” and “the need to have someone at the bedside” were identified as independent risk factors of high anxiety in patients.

Conclusions: Lack of willingness of caregivers to administer NIV and a high level of anxiety of patients and relatives in relation to NIV are frequent in the ICU. Most factors associated with low willingness to administer NIV by nurses or anxiety in patients and relatives may be amenable to change. Interventional studies are now warranted to evaluate how to reduce these risk factors and therefore contribute to better management of a potentially traumatic experience.

(*ANESTHESIOLOGY* 2016; 124:1347-59)

SINCE the 1980s, noninvasive ventilation (NIV) has become a cornerstone therapy for acute respiratory failure. A large number of positive randomized trials¹⁻⁶ have led to a marked increase in the use of NIV,⁷⁻⁹ even in extreme situations such as hypoxemic respiratory failure, elderly patients, immunocompromised patients, or palliative care.^{6,10,11} Because it requires a close “partnership” between a conscious patient and the patient’s caregivers,¹² namely intensive care unit (ICU) physicians and nurses, NIV is a distinctive treatment in the ICU. For nurses, NIV requires frequent interventions and may be time-consuming.¹³ It implies intense involvement, which is dependent on

What We Already Know about This Topic

- Noninvasive ventilation is common in critical care; it requires considerable engagement among patients, physicians, nurses, and families, but stakeholder perceptions are poorly understood.

What This Article Tells Us That Is New

- A large-sample questionnaire (396 patients, 1,063 clinicians, and 145 relatives) from 32 intensive care units revealed that concerns about noninvasive ventilation were greatest among nurses (workload) and patients (dyspnea, anxiety). Future research may reveal how to improve the effectiveness and acceptance of noninvasive ventilation.

Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are available in both the HTML and PDF versions of this article. Links to the digital files are provided in the HTML text of this article on the Journal’s Web site (www.anesthesiology.org).

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predisposing factors such as knowledge,¹⁴ perceptions,¹⁵ and beliefs.^{16,17} Conflicts between caregivers' personal beliefs and their own perception of care may impact the patient's adhesion to care recommendations, communication, and empathy¹⁸ and, ultimately, jeopardize the patient's quality of care (fig. 1).¹⁹ Patient cooperation is another cornerstone of NIV success. Pain,^{20,21} dyspnea,²² and discomfort generate suffering, which, in a life-threatening context, may challenge this cooperation. In addition, in an age when the patient's family and next of kin are often present at the bedside to provide essential psychological support,^{23–25} patient suffering and treatment may generate psychological distress.^{26,27}

The perceptions of NIV stakeholders, especially nurses, have been poorly described to date.²⁸ Note that the term “noninvasive” was originally used to refer to positive pressure mask ventilation in contrast to “invasive” ventilation (use of an endotracheal tube), the complications, discomfort, and psychological burden of which have been extensively described.

Our general hypothesis was that the term “noninvasive,” its indisputable clinical benefits, and its related sensations may not be perceived in exactly the same way by patients, relatives, physicians, and nurses. The use of NIV may therefore be associated with adverse perceptions by patients and

relatives, and adverse experiences for caregivers. We therefore conducted a survey among ICU physicians and nurses, patients, and their relatives with three main specific objectives: (1) to compare the perceptions of NIV by ICU physicians and nurses, in parallel to description of these same elements in patients and their relatives; (2) to explore factors associated with caregivers' willingness to administer NIV; and (3) to focus on NIV-related patient and relative anxiety by identifying its main risk factors and potential ways of improvement.

Materials and Methods

Study Design and Procedure

We conducted a prospective multicenter study in French and Belgian adult ICUs during a 6-month period (December 2012 to June 2013), including junior and senior ICU physicians, nurses, patients, and their relatives. This study was approved by the appropriate legal and ethical institutions (*Comité de protection des personnes Ile de France 6* and “*Comité consultatif pour le traitement de l'information en matière de recherche dans le domaine de la santé*,” Paris, France, A00104-37). Written informed consent to participate in the study was obtained from patients and relatives, whereas completion of the questionnaire was considered to indicate consent to participate for nurses and physicians.

Instruments and Measurements

Three specific questionnaires intended for ICU caregivers (*i.e.*, physicians and nurses), patients, and their relatives, respectively, were designed. Questionnaire development followed three steps.

Step 1: Questionnaire Design. Questionnaire content was defined by a panel from two ICUs, including three senior ICU physicians experienced in NIV, research methodology, and qualitative research, one junior ICU physician, two psychologists, one head nurse, and four nurses.

For the questionnaire intended for ICU caregivers, the panel selected three domains deemed to represent the caregivers' global perception of NIV in the ICU: (1) personal experience of management of a NIV session (including patient care, family care, doctor–nurse collaboration, and ICU environment), (2) ICU caregivers' perception of the patient's emotional experience during NIV, and (3) their own opinion/belief/perception and emotional experience of this treatment.

Similarly, the panel also created a patient questionnaire. As no data on the patient's perception of NIV are currently available, patient questions were based on studies performed on invasive ventilation.^{29–34} Questions regarding their perception of the devices, their environment, management of a NIV session, and their overall perception of care during their ICU stay were developed. Lastly, the relative questionnaire assessed their perception of the next-of-kin emotional experience during NIV.

Submitted for publication September 11, 2015. Accepted for publication March 3, 2016. From the Sorbonne Universités, UPMC Univ Paris 06, UMR_S 1158 “*Neurophysiologie Respiratoire Expérimentale et Clinique*,” Paris, France (M.S., T.S.); INSERM, UMR_S 1158 “*Neurophysiologie Respiratoire Expérimentale et Clinique*,” Paris, France (M.S., T.S.); AP-HP, Groupe Hospitalier Pitié-Salpêtrière Charles Foix, Service de Pneumologie et Réanimation Médicale (*Département “R3S”*), Paris, France (M.S., M.D., T.S., A.D.); Hôpital Saint Louis, Service de Biostatistique, Paris, France (E.B.-D.); Hôpital Gabriel-Montpied, Service de Réanimation Médico-Chirurgicale, Clermont Ferrand, France (S.P.); Hôpital Cochin, Service de Réanimation Médicale, Paris, France (N.M.); Hôpital Kremlin Bicêtre, Service de Réanimation Médicale, Bicêtre, France (M.D.); Hôpitaux Universitaires Henri Mondor, DHU A-TVb, Service de Réanimation Médicale, CARMAS Research Group 51, Créteil, France (K.R.); Hôpital Européen Georges Pompidou, Service de Réanimation Médicale, Paris, France (E.G.); INSERM, U1075, and Université de Caen, and CHRU Caen, Service de Réanimation Médicale, and CHU Caen, Service de Réanimation Médicale, Caen, France (N.T.); Hôpital de Bligny, Service de Réanimation, Bligny, France (P.A.); Hôpital Saint Antoine, Service de Réanimation Médicale, Paris, France (M.A.); Hôpital Bichat–Claude-Bernard, Service de Réanimation Médicale et des Maladies Infectieuses, Paris, France (R.S.); Hôpital d'Angoulême, Service de Réanimation Polyvalente, Angoulême, France (C.C.); Hôpital Percy, Service de Réanimation Médico-Chirurgicale, Clamart, France (V.P.); Hôpital de Saint Malo, Service de Réanimation Polyvalente, Saint Malo, France (F.C.); Hôpital Antoine Bécclère, Service de Réanimation Médicale, Clamart, France (B.S.); Hôpital Louis Mourier, Service de Réanimation Médico-Chirurgicale, Colombes, France (C.R.); Hôpital Saint-Louis, Service de Réanimation Médicale, Paris, France (D.R.); Hôpital de Roanne, Service de Réanimation Médico-Chirurgicale, Roanne, France (X.F.); Hôpital Tenon, Service de Réanimation Médico-Chirurgicale, Paris, France (V.L.); Hôpital Antoine Bécclère, Service de Réanimation Chirurgicale, Clamart, France (G.T.); Hôpital Albert Michalon, Service de Réanimation Médicale, Grenoble, France (C.M.); Hôpital universitaire Saint Eloi, Service de Réanimation et d'Anesthésiologie, Montpellier, France (M.C.); Sorbonne Universités, UPMC Univ Paris 06, UMR_S 974, Paris, France (E.A.); and INSERM, UMR_S 974, F-75005, Paris, France (A.D.).

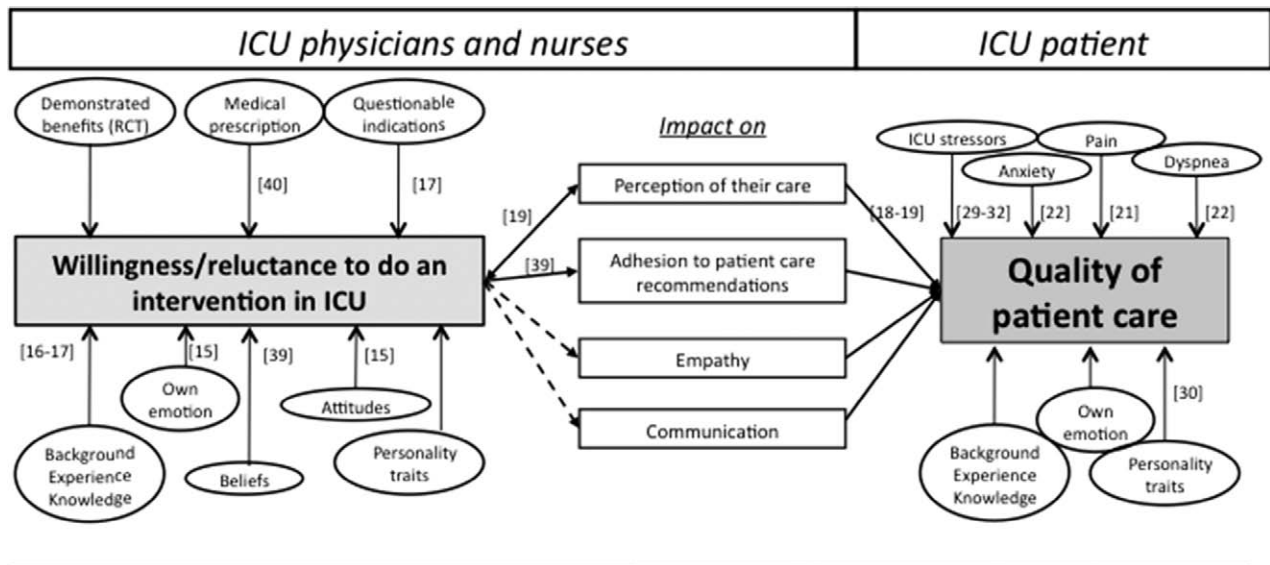


Fig. 1. Theoretical framework of intensive care unit (ICU) caregivers' willingness or reluctance to perform a specific intervention in ICU. RCT = randomized controlled trial.

Step 2: External Approval. The style and content of the physicians' and nurses' questionnaires were evaluated by four external ICU physicians and four external ICU nurses, respectively. Ten patients who had received NIV (but not only), and their relatives also accepted to evaluate the style and content of the respective questionnaires. Patients' and relatives' evaluations focused on the style and ease of understanding of the questionnaire. They were also specifically debriefed about the completeness of the questionnaire regarding NIV-associated management, NIV-associated perceptions, and NIV-associated feelings. If a NIV-associated perception or part of the NIV management was not addressed by the questionnaire and was reported by at least two patients or relatives, the missing item was then added to the questionnaire.

Step 3: Feasibility of the Questionnaire. The final version of the nurses' and physicians' questionnaire was tested with 10 nurses and 6 physicians from two different ICUs. External approval by 10 patients and relatives showed overlapping memories between NIV and invasive ventilation with endotracheal tube. In order to maintain focus on NIV-associated perceptions and to avoid any overlap memories with other forms of ICU therapy, especially invasive mechanical ventilation, the steering committee decided to only include patients who had exclusively received NIV (*i.e.*, who had not received invasive mechanical ventilation). Lastly, the final versions of the patient and the relative questionnaires were then approved by six patients who had only received NIV and six relatives, respectively.

Based on this process, a 45-item questionnaire assessing both the clinicians' and nurses' experiences and perceptions regarding overall NIV management was created (see detailed questionnaire in Supplemental Digital Content 1, <http://links.lww.com/ALN/B272>). This report describes the responses to a specific vignette as follows: "A 60-year-old male is admitted to your ICU with acute respiratory failure. At ICU admission,

he is polypneic, sweating with cyanosis and tachycardia. Given the initial severity, noninvasive ventilation is started. You are the nurse/physician in charge of this patient." The patient questionnaire comprised 30 items, while the next-of-kin perception of emotional experiences was investigated by 27 specific items concerning the ongoing ICU stay (see Supplemental Digital Content 1, <http://links.lww.com/ALN/B272>).

Whenever possible, similar items were used in the three respondent categories (*i.e.*, caregivers, patients, and relatives). Each item relative to NIV perception was scored from 1 to 10 (with "1" corresponding to "not at all" or "never" and "10" corresponding to "certainly" or "always").

Other Measurements

A panel of 50 French and Belgian ICUs was selected. All ICUs either were members of the European network on mechanical ventilation (Réseau européen de recherche en ventilation artificielle) or had previously participated in a multicenter study on NIV.^{7,35} Thirty-two ICUs (64%) agreed to participate in this study. Their characteristics (type of ICU, number of beds, number of ICU physicians, patient–nurse ratio, regular nurse–physician meetings, written NIV procedure, and nurse work shift durations) and their activities (number of ICU admissions, number of intubated patients, and number of NIV patients per year) were collected. In addition, physician and nurse personal characteristics (including age, sex, number of years working in ICU) were collected. Lastly, the main patient demographic characteristics, severity at ICU admission scores, smoking status, length of ICU stay, duration of NIV, and reason for NIV were recorded.

Questionnaire Administration

All ICU nurses and physicians (including juniors) working in each participating ICU were invited to fill in a

questionnaire, regardless of the type of patient they were managing at the time they received the questionnaire. In each participating ICU, a designated local medical investigator targeted physicians, whereas the head nurse was in charge of collecting questionnaires from the nursing staff. Physicians' and nurses' questionnaires were collected over a 2-month period. Patients and their relatives were screened for inclusion at ICU discharge. Patients were included when they were more than 18 yr of age, had received NIV for more than 4 h during their ICU stay, and had not been intubated before or after NIV. To minimize the effect of specific medical conditions and to enhance the quality of responses, patients were excluded when they were unable to read or understand French, had received home mechanical ventilation before ICU admission, or presented delirium, as assessed by the Confusion Assessment Method for the ICU (CAM-ICU).^{36,37} Relatives (*e.g.*, family members, partners, or close friends) of included patients were recruited when they were able to read and understand French, had visited their relatives at least once during a NIV session, and were more than 18 yr of age. Only one relative per patient was recruited to avoid overrepresentation of a single family.

Questionnaire Analysis

Perceptions of NIV among ICU physicians, ICU nurses, patients, and their relatives were compared. This analysis focused on identifying predictive factors of willingness of caregivers to administer NIV and patients' and relatives' anxiety in relation to NIV, as these factors are clinically relevant and may be amenable to improvement. To achieve these goals, "willingness to use NIV" was defined as a respondent score of greater than or equal to 6/10 to the specific item "*are you willing to care for the patient depicted in the vignette?*" Similarly, an anxious perception of NIV was defined as a score of greater than or equal to 6/10 on the item "*did you feel anxious during NIV?*" (patient questionnaire) or "*did you feel that your relative was anxious during NIV?*" (relative questionnaire).

Statistical Analysis

Data were initially assessed for normality. Continuous normally distributed variables were compared using Student's *t* tests or ANOVA, while nonnormally distributed variables were compared using Wilcoxon rank sum tests or Kruskal-Wallis tests. Data were expressed as median (interquartile range) or mean \pm SD. Categorical variables were compared using chi-square test for equal proportions or Fisher exact tests and were reported as numbers (percentages). A Bonferroni adjustment for multiple comparisons was used for pairwise comparisons of perception of NIV by caregivers, patients, and relatives.

Multivariate logistic regression was used to identify factors independently associated with the caregivers' willingness to use NIV in the ICU and major anxiety induced by NIV as perceived by patients and relatives, with results expressed as

odds ratios (95% CI). Multivariate models were constructed using both stepwise selection and backwards elimination techniques. All variables with a univariate *P* value less than 0.05 were considered for model inclusion. The area under the receiver operating characteristic curve (AUC) and its standard error (SE) were used to examine the ability of the model to discriminate between (1) caregivers who reported willingness to administer NIV and those who did not, and (2) patients and relatives who reported major anxiety during NIV and those who did not. To correct for optimism and to internally validate the model, the model was repeatedly fitted with 1,000 bootstrap samples to calculate the mean AUC.

Analyses were performed using SAS version 9.3 software (SAS Institute Inc., USA), and a two-sided *P* value of 0.05 was considered to be statistically significant.

Results

Study Population

Completed questionnaires were received from 311 ICU physicians (response rate 91%) and 752 ICU nurses (response rate 62%) working in 32 ICUs (response rate 64%) (fig. 2). Details of participating ICUs are given in table 1, and table 2 reports physician and nurse characteristics. Fourteen (45%) centers reported having a written NIV procedure (table 1).

Twenty ICUs returned completed questionnaires for 396 patients (simplified acute physiology score II 36 [28 to 42]) and 145 relatives (fig. 2). Main patient and relative characteristics are described in table 3. Briefly, 57% of patients who survived NIV were male and received NIV for a median of 2 (1 to 5) days for acute on chronic respiratory failure (67%) or *de novo* acute respiratory failure (33%). NIV was provided without sedation or opioid infusion in all centers. Thirty-two percent had previously experienced NIV, and 22% had been intubated before this ICU stay.

Perception of NIV in Caregivers, Patients, and Relatives

Noninvasive ventilation perceptions among ICU physicians, nurses, patients, and their relatives are reported in figure 3 (also see Supplemental Digital Content, table 1, <http://links.lww.com/ALN/B272>), which shows major discrepancies between categories, as nurses generally reported more negative feelings and more frequently regretted providing NIV than other categories ($P < 0.05$), despite strong recognition of its efficacy (fig. 3). By contrast, relatives were poorly convinced about the efficacy of NIV ("*NIV is an effective treatment*"). Although only 56% of physicians and 32% of nurses had ever tried NIV on themselves, NIV was more frequently considered to be a stressful treatment ("*do you think NIV is a stressful treatment?*") or a traumatic experience ("*do you think NIV is traumatic experience?*") by caregivers than by patients and relatives ($P < 0.05$). Although all included patients were discharged from the ICU after receiving NIV (*i.e.*, study design), 34% of patients and 25% of their relatives reported regrets about having received NIV *versus* having received

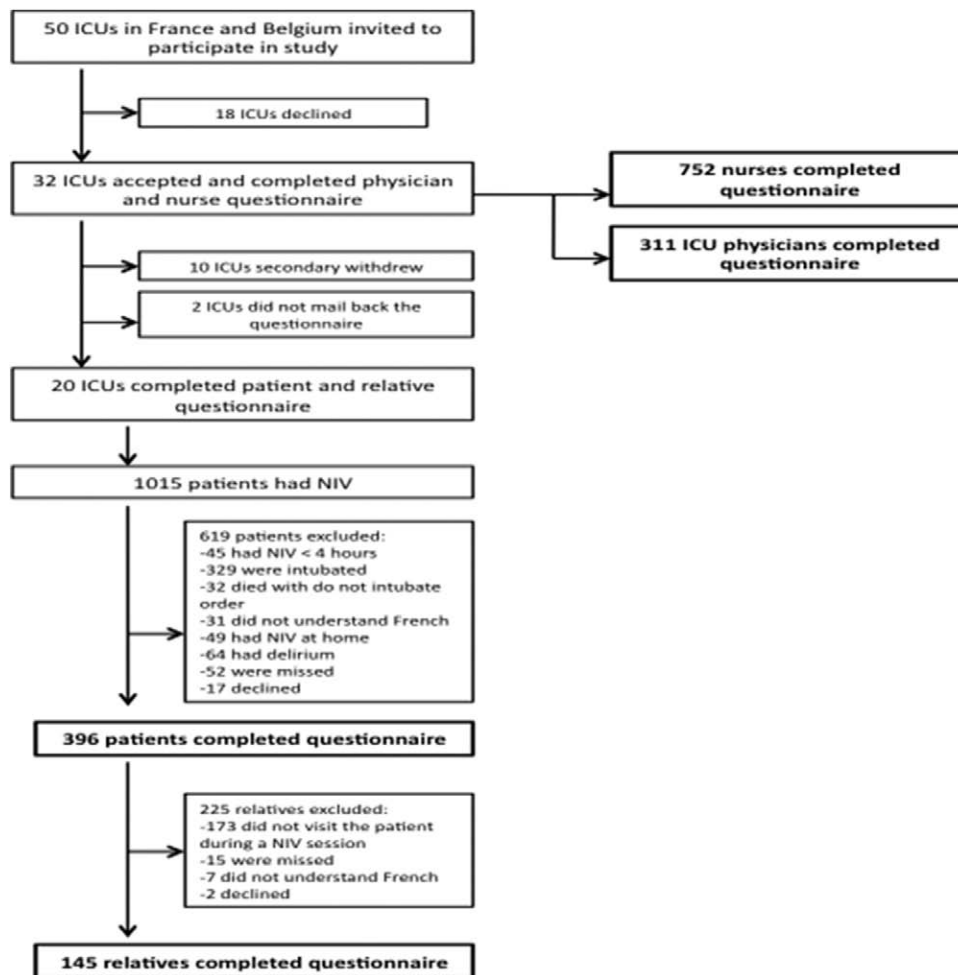


Fig. 2. Flow of questionnaire responses for all participating centers. ICU = intensive care unit; NIV = noninvasive ventilation.

simple oxygen therapy or having been intubated (*i.e.*, score greater than 1).

Caregivers' Willingness to Administer NIV

One hundred and eight (64%) ICU physicians and only 241 (32%) ICU nurses reported high willingness to administer NIV (see Supplemental Digital Content, figs. 1 and 2, <http://links.lww.com/ALN/B272>). Physician and nurse characteristics according to their willingness to administer NIV are reported in table 4. Independent factors associated with willingness to administer NIV among physicians were NIV case-volume, the belief that NIV is an effective treatment, and the feeling of being competent to provide NIV (table 4). In nurses, "feeling competent to provide NIV" and "feeling valuable or proud in providing NIV" were facilitating factors, while "working 12-h shifts," "feeling that care of a NIV patient is excessively time-consuming," and a negative perception of this therapy (*e.g.*, "it is an aggressive device," "it makes patients suffer," "feelings of regret in relation to NIV") were barriers to willingness to administer NIV. The AUC for the model was 0.72 (SE, 0.3) and 0.74 (SE, 0.2) for physicians

and nurses, respectively. The mean AUC after bootstrap resampling increased marginally to 0.75 ± 0.03 and 0.77 ± 0.02 (table 4).

Source of Major Anxiety for Patients and Their Relatives during NIV

The characteristics of patients and their relatives according to major NIV-induced anxiety are shown in the table 5. When interviewed about "the anxiety associated with a NIV session," 149 (37%) patients and 65 (45%) relatives reported a high level of anxiety (see Supplemental Digital Content, figs. 3 and 4, <http://links.lww.com/ALN/B272>). "Dyspnea during NIV," "long NIV session," and "the need to have someone at the bedside" were identified as independent risk factors of high anxiety in patients (table 5). Similarly, "seeing their next of kin experiencing difficulties to make themselves understood" was independently associated with a higher level of anxiety in relatives, whereas receiving "clear explanations" was a protective factor. None of the patient characteristics (*e.g.*, demographic, reason for NIV, past experience of NIV, etc.) were associated with anxiety during NIV session for either

Table 1. Characteristics of the 32 ICUs That Completed Physician, Nurse, Patient, and Relative Questionnaires

Characteristics	Number (%) or Median (IQR)
University hospital	21 (65)
Type of ICU	
Medical	16 (50)
Medical surgical	16 (50)
No. of hospital beds	700 (447–1,000)
No. of ICU beds	12.5 (10.0–16.0)
No. of ICU admissions per year	655 (533–900)
No. of patients with invasive ventilation per year	410 (299–501)
% patients with invasive ventilation per year	58 (47–70)
No. of patients with NIV per year	120 (71–175)
% of patients with NIV per year	16 (10–25)
% of NIV among mechanically ventilated patients	25 (17–31)
No. of ICU physicians (including juniors)	10.5 (8.0–14.0)
> 1 physicians on night shift (including juniors)	24 (75)
Patient-to-nurse ratio	2.5 (2.5–3.0)
Nurses working 12-h shifts	25 (78)
Regular nurse–physician meetings	24 (75)
NIV procedure	14 (45)

ICU = intensive care unit; IQR = interquartile range; NIV = noninvasive ventilation.

Table 2. Characteristics of ICU Physicians and Nurses

Characteristics	ICU Physician (n = 311)	Nurse (n = 752)	P Value
Age	32 (28–39)	29 (25–35)	
Male sex	197 (64)	139 (19)	< 0.001
Senior physician*	186 (61)	—	
Working in the participating unit for ≥ 2 yr	124 (40)	446 (60)	< 0.001
Working in ICU for ≥ 3 yr	143 (48)	410 (56)	0.023
Experienced NIV on themselves	173 (56)	236 (32)	< 0.001

Data are expressed as number (%) or median (interquartile range).

*Senior physician designates a physician who has achieved intensive care unit (ICU) residency, who is certified in intensive care, and who is no longer a registrar or fellow.

NIV = noninvasive ventilation.

patients or relatives. Lastly, the mean AUC of the model after bootstrap resampling was 0.87 ± 0.02 and 0.75 ± 0.05 for patients and their relatives, respectively.

Discussion

The main results of this study can be summarized as follows: (1) overall perceptions of NIV were significantly different among ICU nurses, ICU physicians, patients, and their relatives; (2) two out of three ICU nurses described low willingness to perform NIV, which is associated with working 12-h shifts in ICU and a negative perception of NIV;

Table 3. Characteristics of Patients and Their Relatives

Characteristics	Number (%) or Median (IQR)
Patients (n = 396)	
Age	69 (60–80)
Male sex	226 (57)
SAPS II	36 (28–42)
Smoking status	
Nonsmoker	120 (30)
Active smoker	98 (25)
Former smoker	175 (45)
Previous use of NIV before this ICU stay	128 (69)
Previous invasive ventilation before this ICU stay	87 (22)
Length of ICU stay	4 (3–7)
No. of days with NIV	2 (1–5)
Cumulative duration of NIV during ICU stay > 12 h	197 (55)
Do not intubate order	44 (11)
Contention during NIV	28 (7)
Reason for NIV	
Decompensation of chronic respiratory disease	260 (67)
De novo acute respiratory failure	136 (33)
Relatives (n = 145)	
Age	59 (47–69)
Male sex	54 (38)
Relationship	
Spouse/partner/friend	75 (54)
Adult child/sibling/parent	65 (46)
Smoking status	
Nonsmoker	73 (52)
Active smoker	33 (23)
Former smoker	34 (25)
Previously used NIV	8 (6)

ICU = intensive care unit; IQR = interquartile range; NIV = noninvasive ventilation; SAPS II = simplified acute physiology score.

(3) one out of three ICU patients and one out of two relatives perceived NIV as a very stressful experience that generates anxiety; and (4) most factors associated with low willingness to administer NIV by nurses or anxiety in patients and relatives may be amenable to change and therefore constitute potential targets of improvement. To our knowledge, this is the first large-scale study to describe the perceptions of caregivers, patients, and relatives regarding NIV as a specific treatment modality in the ICU.

Caregiver Perceptions of NIV

Only 64% of physicians and 32% of nurses reported willingness to administer NIV. This contrasts with the numerous studies that have demonstrated the benefit of NIV in various causes of acute respiratory failure over the last 2 decades,^{1–6} and with the fact that both nurses and physician were very convinced that NIV was “an effective therapy.” This finding is also surprising in view of the various surveys that have observed a growing use of NIV in the ICU, especially in France, where the current study was mainly performed.^{7,8} It

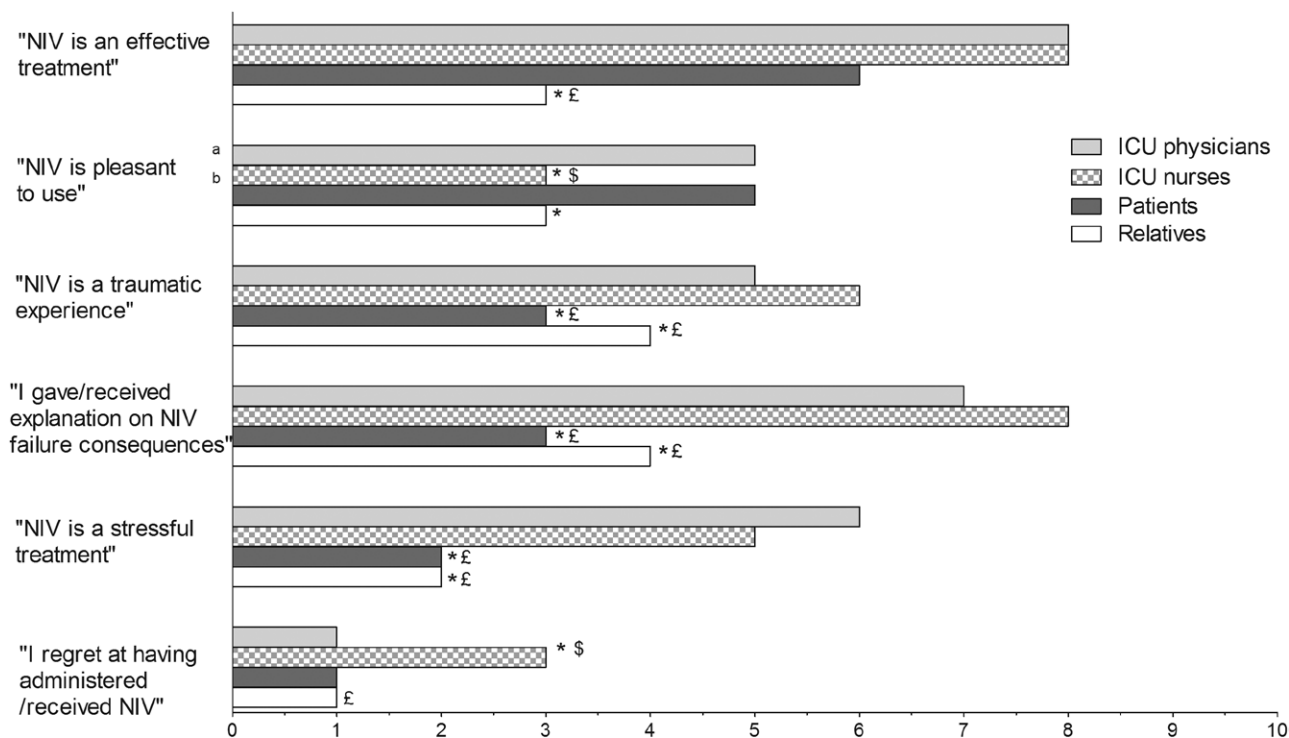


Fig. 3. Discrepancies of noninvasive ventilation (NIV) perceptions among intensive care unit (ICU) physicians, ICU nurses, patients, and their relatives. All items were scored on a scale from 1 to 10 (with "1" corresponding to "not at all" and "10" corresponding to "yes extremely"). * $P < 0.05$ with ICU physicians; £ $P < 0.05$ with nurses; \$ $P < 0.05$ with patients. ^aData were obtained on 172 (56%) ICU physicians who have previously tried NIV. ^bData were obtained on 236 (32%) nurses who have previously tried NIV.

is noteworthy that the willingness of physicians to administer NIV was associated with NIV case-volume.³⁸ Not only is case-volume associated with a better prognosis in invasively and noninvasively mechanically ventilated patients,^{38,39} but it also reinforces the caregiver's personal experience, which makes them more comfortable and confident with the technique. In addition, mastering NIV management takes time, but eventually allows the treatment of more severely ill patients, resulting in an expected improvement of the success rates.^{40,41} Improving caregivers' feelings of being competent involves various interventions, such as educational programs and local guidelines, including written procedures.^{42,43} It is noteworthy that written procedures were available in less than half of centers, a lower rate than previously reported.^{28,44}

Two determinants of low willingness of nurses to administer NIV were related to ICU structural characteristics, excessive NIV-related workload, and working 12-h shifts. Workload is directly related to the patient-to-nurse ratio, which was 2.5 in our study, a relatively higher level than those commonly observed in other Western European countries, Northern Europe, and North America.^{45,46} A low patient-to-nurse ratio improves patient safety^{45,47,48} and quality of care^{49–52} and increases time available to communicate with the patient and his/her family,⁵³ which results in higher levels of family satisfaction in ICU.⁵⁴ It should also

be noted that NIV-related workload is higher for nurses than for physicians, which may explain why willingness to administer NIV was lower among nurses. In addition, when not rewarded by improvement of the patient's condition, this gap between intense involvement requiring a high workload and failure of treatment¹⁹ may lead to "loss of belief in the efficacy of NIV" and result in "regrets." This is particularly true since nurses are more likely to perceive inappropriateness of care¹⁹ and are consequently more acutely aware of the suffering of their patients than physicians.^{55–57}

Most determinants of low willingness to administer NIV are amenable to change, allowing willingness improvement strategies. For instance, showing nurses that their patients' experience of NIV is less traumatic and less stressful than they imagine and that patients are less likely to regret NIV than nurses may help to improve the nurses' willingness to administer NIV.

NIV-related Anxiety among Patients and Their Relatives

Patients receiving invasive ventilation are subject to numerous stressful experiences, which are associated with spells of terror, feeling nervous when left alone, and poor sleeping pattern.⁵⁸ In addition, pain, feeling tense, anxiety, inability to speak/communicate, lack of control, and nightmares have been constantly reported as important patient complaints on invasive mechanical ventilation.^{22,30–33} However, patients' recollections of their NIV experience in ICU have been

Table 4. Baseline Characteristics of Physicians and Nurses and Independent Factors (Multivariate Analysis) Associated with Caregivers' Willingness to Deliver NIV

Variables	Unwillingness to Provide NIV	Willingness to Provide NIV	P Value	OR (95% CI)	P Value
Physicians	n = 111	n = 198			
University hospital	72 (65)	137 (69)	0.45		
No. of ICU beds	13 (12–16)	14 (12–18)	0.27		
No. of patients receiving NIV per year	122 (75–158)	134 (75–275)	0.023	1.43 (1.12–1.83)	0.004
No. of daytime physicians	13 (9–15)	12 (9–15)	0.90		
More than one doctor working night shifts	94 (84)	168 (84)	1		
Feels competent to care for this patient*	7 (5–8)	8 (7–9)	< 0.0001	1.23 (1.07–1.40)	0.003
Feels anxious about caring for this patient*	3 (1–5)	2 (1–4)	0.049		
Thinks that NIV is effective*	6 (5–7)	7 (6–8)	< 0.0001	1.57 (0.33–1.86)	< 0.0001
Thinks that NIV makes the patient feel anxious*	7 (5–8)	6 (5–7)	0.0002		
Thinks that NIV is an aggressive therapy*	5 (3–7)	5 (3–6)	0.32		
Thinks that NIV induces patient suffering*	3 (2–5)	3 (2–5)	0.028		
Regrets providing NIV*	1 (1–3)	1 (1–2)	0.13		
Nurses	n = 508	n = 241			
University hospital	360 (71)	180 (75)	0.30		
No. of ICU beds	14 (12–18)	13 (12–18)	0.38		
No. of patients receiving NIV per year	122 (75–181)	134 (75–250)	0.62		
No. of doctors at daytime	12.5 (8.7–15.0)	11 (8–14)	0.042		
More than one doctor working night shifts	436 (86)	201 (83)	0.45		
Nurses working 12-h shifts (vs. 8-h shifts)	404 (79)	155 (64)	< 0.0001	0.68 (0.56–0.84)	< 0.0001
Feels competent to care for this patient*	8 (7–8)	8 (7–9)	< 0.0001	1.19 (1.07–1.32)	0.001
Feels anxious about caring for this patient*	2 (1–5)	2 (1–3)	0.0002		
Feels valuable or proud to provide NIV to this patient*	5 (3–7)	7 (5–8)	< 0.0001	1.16 (1.08–1.24)	< 0.0001
It will be excessively time-consuming*	6 (5–8)	5 (3–7)	< 0.0001	0.83 (0.77–0.90)	< 0.0001
Thinks that NIV is effective*	7 (5–8)	8 (6–9)	< 0.0001		
Thinks that NIV makes the patient feel anxious*	8 (7–9)	7 (6–8)	0.0001		
Thinks that NIV is an aggressive therapy*	7 (5–8)	5 (3–7)	< 0.0001	0.88 (0.81–0.96)	0.003
Thinks that NIV induces patient suffering*	5 (3–6)	3 (2–5)	< 0.0001	0.86 (0.78–0.95)	0.003
Regrets providing NIV*	2 (1–5)	2 (1–3)	< 0.0001	0.87 (0.79–0.95)	0.002

"Willingness to administer noninvasive ventilation (NIV)" was defined as a respondent score of $\geq 6/10$ to the specific item "are you willing to care for the patient depicted in the vignette?" Area under receiver operating characteristic curve (AUC): 0.72 for the physicians and 0.74 for the nurses. The average AUC after bootstrap were 0.75 ± 0.02 for the physicians and 0.77 ± 0.02 for the nurses.

*Items scored on a scale from 1 to 10 (with "1" corresponding to "not at all" and "10" corresponding to "yes extremely").

ICU = intensive care unit; OR = odds ratio.

poorly studied. Because anxiety has been frequently reported in relation to mechanical ventilation^{22,30–33} and could be a major goal of improvement,²² we focused our analysis on NIV-induced anxiety in patients and their relatives. Again, we found that most of these risk factors were amenable to change and could therefore constitute potential targets for improvement.^{11,12}

Some factors, such as dyspnea and length of NIV sessions, are influenced by the physician's prescriptions. Dyspnea associated with invasive mechanical ventilation may be related to inadequate ventilator settings and may be dramatically reduced by improving ventilator settings.²² Reduction of identified ICU stressors is warranted to decrease NIV-induced anxiety, and new tools such as medical hypnosis or sophrology might help to achieve this goal.^{59,60} Similarly, NIV sessions should not be longer than needed and should be reduced as soon as the patient's condition improves. Lastly, target-controlled infusion of propofol or remifentanyl

during NIV in patients with NIV failure due to poor tolerance may facilitate acceptance of NIV and could therefore decrease NIV-related anxiety.^{61,62}

Patients with NIV-induced anxiety expressed the need to have beside support and to share their experience with their relatives. An open visiting policy could meet this expressed need.^{23–25} Such a policy may be part of a larger family-centered care policy,^{63–65} which must include the quality of information given to the relatives of a patient receiving NIV, as poor-quality information is a source of anxiety. In addition, as demonstrated in patients dying in ICU,⁶⁶ simple, standardized written information on NIV could also improve communication with relatives.⁶⁷ Trying NIV themselves might be a simple first measure for caregivers to experience this therapy and to therefore provide more objective information to patients and relatives regarding the disadvantages and the sensations to be expected with NIV.

Table 5. Characteristics of Patients and Their Relatives and Independent Factors (Multivariate Analysis) Associated According to NIV-induced Anxiety

Variables	No or Low Level of Anxiety during NIV	High Level of Anxiety during NIV	P Value	OR (95% CI)	P Value
Patients	n = 239	n = 149			
University hospital	201 (84)	129 (87)	0.56		
Regular nurse–physician meetings	138 (58)	72 (48)	0.076		
Age, yr	71 (61–80)	68 (59–79)	0.18		
Male (vs. female)	153 (64)	70 (47)	0.051		
SAPS II	36 (27–42)	36 (28–41)	0.68		
Chronic disease (vs. acute)	162 (70)	93 (64)	0.22		
Explanations about NIV were clear*	8 (4–10)	7 (3–10)	0.027		
Understood the consequences of NIV failure*	2 (1–7)	4.5 (1–10)	0.023		
Felt dyspneic during NIV*	3 (1–7)	8 (5–10)	< 0.0001	1.16 (1.06–1.26)	0.0010
Experienced face pain*	2 (1–5)	6 (2–10)	< 0.0001		
Was disturbed by mask leaks*	3 (1–5)	4 (1–8)	0.005		
Was disturbed by ventilator noise*	2 (1–4)	5 (1–8)	< 0.0001		
Felt thirsty*	6 (2–9)	8 (5–10)	0.0003		
Could not be correctly understood*	5 (1–8)	8 (5.7–10)	< 0.0001		
NIV sessions were too long*	5 (2–8)	8 (6–10)	< 0.0001	1.22 (1.10–1.35)	0.0002
Was forced to receive NIV*	1 (1–5)	6 (1–10)	< 0.0001		
Needed to have someone at the bedside*	1 (1–5)	7 (3–10)	< 0.0001	1.25 (1.15–1.36)	< 0.0001
Thinks that NIV was a traumatic experience*	1 (1–3)	7 (4–9)	< 0.0001		
Thinks that NIV was an effective therapy*	8 (6–10)	8 (5–9)	0.006		
Has spoken about this experience with next of kin *	2 (1–8)	5 (1–10)	0.008	1.12 (1.04–1.21)	0.0018
Would accept to have NIV again (vs. would not)	211 (89)	100 (68)	< 0.0001		
Regrets having received NIV*	1 (1)	2 (1–7)	< 0.0001	1.30 (1.17–1.45)	< 0.0001
Relatives	n = 77	n = 65			
University hospital	65 (84)	57 (88)	0.63		
Regular nurse–physician meetings	43 (56)	35 (54)	0.87		
Patient's age, yr	73 (63–83)	69 (63–81)	0.49		
Relative's age	59 (50–68)	59 (42–70)	0.88		
Male relative (vs. female)	26 (34)	26 (41)	0.38		
Explanations about NIV were clear	10 (7–10)	7 (5–10)	0.009	0.81 (0.69–0.96)	0.0140
Understood the consequences of NIV failure	8 (1–10)	7 (1–9)	0.57		
Felt that the patient suffered during NIV	4 (1–6)	7 (4–9)	< 0.0001		
Felt that the patient was dyspneic during NIV	2 (1–5)	5 (2–8)	0.002		
Felt that the patient experienced pain	2 (1–5)	4 (2–7)	0.003		
Felt that the patient was worried about not being correctly understood	6 (4–9)	9 (7–10)	0.0007	1.25 (1.08–1.45)	0.0033
Felt that NIV sessions were too long	3 (1–5)	5 (4–8)	0.002		
Felt that the patient needed to have someone at the bedside	7 (1–10)	9 (7–10)	0.002		
Felt that NIV was a traumatic experience	2 (1–4)	8 (5–9)	< 0.0001		
Felt that NIV was an effective therapy	10 (8–10)	9 (7–10)	0.12		
Your relative talked about his/her NIV experience	5 (1–9)	8 (4–10)	0.071		

An anxious perception of noninvasive ventilation (NIV) was defined as a score of $\geq 6/10$ on the item "did you feel anxious during NIV?" (patient questionnaire) or "did you feel that your relative was anxious during NIV?" (relative questionnaire). Area under receiver operating characteristic curve (AUC): 0.85 for the patients and 0.74 for their relatives. The average AUC after bootstrap were 0.87 ± 0.02 for the patients and 0.75 ± 0.05 for the relatives.

*Items scored on a scale from 1 to 10 (with "1" corresponding to "not at all" and "10" corresponding to "yes extremely").

OR = odds ratio; SAPS II = simplified acute physiology score.

It is noteworthy that 34% of patients reported regrets at having NIV, which were independent predictors of high anxiety. This finding highlights the negative impact of NIV-induced anxiety, which makes patients paradoxically regret having received a treatment that was potentially beneficial. This result is all the more surprising in that 32% of patients had a previous experience of NIV,

and should therefore have been better prepared for these sensations.

Limitations of the Study

This study presents several limitations. First, we defined a high level of willingness and a high level of anxiety based on suggestions from a panel of practicing ICU physicians and

nurses. The subjective threshold of high willingness and high anxiety used in our study may therefore be open to criticism. In addition, the 10-point scale used in the questionnaire with, consequently, no “neutral answer” may also have influenced the results. Second, because of intercultural differences, discrepancies between ICU organizations,^{68–70} and a wide range of NIV use reported worldwide,²⁸ our findings may not be relevant to every ICU around the world. As an example, NIV is a medical prescription applied by nurses in many European countries, whereas a team including respiratory therapists, physicians, and nurses manage NIV in the United States and Canada. However, the study was performed in university- and non-university-affiliated hospitals in France (and Belgium), suggesting that this may reflect real-life practices in French-speaking countries. Third, because CAM-ICU assessment was performed at study inclusion and not daily during the ICU stay, we can only rule out patients who did not exhibit delirium at the time they were asked to answer the questionnaire. However, patients who had a normal CAM-ICU at inclusion could have exhibited delirium during previous NIV sessions. Fourth, we cannot rule out that education level and social status of the patients, which were not collected, might have influenced NIV perceptions. Fifth, our inclusion criteria were restricted to patients with successful NIV in order to avoid overlapping memories between invasive ventilation and NIV. Previous studies have suggested the existence of overlapping memories in intubated patients after NIV failure. We could therefore speculate that the perception of NIV would have been even poorer if patients who failed NIV had also been included. However, we do not know how this factor would have influenced the discrepancies between the various categories. In addition, less than half of the relatives answered the questionnaire, as most of them did not visit their relatives during a NIV session (fig. 2). Finally, NIV-related perceptions were not compared to perceptions related to another ICU therapy, such as invasive mechanical ventilation, oxygen therapy, or renal replacement therapy.

Conclusions, Clinical Implications, and Future Developments

Although promising results of the use of high-flow oxygen for the treatment of acute respiratory failure have recently been published,⁷¹ NIV is still the leading treatment option for acute on chronic respiratory disease and cardiogenic pulmonary edema. Most of the factors related to a lack of willingness for caregivers and high anxiety for patients and relatives are amenable to change. Better management of these risk factors could therefore help to improve the management of a potentially traumatic experience. Based on these findings, there is a strong rationale to encourage ICU nurses and physicians to improve their knowledge of NIV by means of specific training programs. These training programs could focus on (1) improving the technical aspects of NIV management (improve the skills of ICU physicians and nurses), (2) early detection and management of patient discomfort, and (3) providing better

information concerning the risks, benefits, and expected sensations of NIV.

Acknowledgments

The authors are indebted to all intensive care unit physicians and intensive care unit nurses of the PARVENIR study group who participated in the study (see list in the appendix). The authors also thank Christian Delafosse, M.D., Department of Respiratory and Intensive Care Medicine, Groupement Hospitalier Eaubonne, Montmorency Hôpital Simone Veil, Eaubonne, France, for his humor column on noninvasive ventilation, which was the source of this work.

Dr. Schmidt was supported by the French Intensive Care Society (SRLF), the “Fonds de dotation Recherche en Santé Respiratoire, 2012,” the “Collège des Enseignants de Réanimation Médicale,” and the “Fonds d’Etude et de Recherche du Corps Médical des Hôpitaux de Paris.”

Competing Interests

Dr. Dres has a conflict of interest with Pulsion Medical System (Feldkircher, Germany). Dr. Azoulay has conflicts of interest with Gilead (Foster City, California), Alexion (Zurich, Switzerland), Astellas (Levallois Perret, France), Pfizer (Paris, France), and Fisher & Payckle (Villebon-sur-Yvette, France). Dr. Demoule has conflicts of interest with Covidien (Dublin, Ireland), Maquet (Solna, Sweden), and Philips (Andover, Massachusetts). The other authors declare no competing interests.

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References

1. Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Rauss A, Simonneau G, Benito S, Gasparetto A, Lemaire F: Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. *N Engl J Med* 1995; 333:817–22
2. Esteban A, Frutos-Vivar F, Ferguson ND, Arabi Y, Apezteguia C, González M, Epstein SK, Hill NS, Nava S, Soares MA, D’Empaire G, Alía I, Anzueto A: Noninvasive positive-pressure ventilation for respiratory failure after extubation. *N Engl J Med* 2004; 350:2452–60
3. Ferrer M, Esquinas A, Leon M, Gonzalez G, 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
4. Nava S, Ambrosino N, Clini E, Prato M, Orlando G, Vitacca M, Brigada P, Fracchia C, Rubini F: Noninvasive mechanical ventilation in the weaning of patients with respiratory failure due to chronic obstructive pulmonary disease. A randomized, controlled trial. *Ann Intern Med* 1998; 128:721–8
5. Nava S, Carbone G, DiBattista N, Bellone A, Baiardi P, Cosentini R, Marengo M, Giostra F, Borasi G, Groff P: Noninvasive ventilation in cardiogenic pulmonary edema: A multicenter randomized trial. *Am J Respir Crit Care Med* 2003; 168:1432–7

6. Plant PK, Owen JL, Elliott MW: Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: A multicentre randomised controlled trial. *Lancet* 2000; 355:1931–5
7. Demoule A, Girou E, Richard JC, Taillé S, Brochard L: Increased use of noninvasive ventilation in French intensive care units. *Intensive Care Med* 2006; 32:1747–55
8. Esteban A, Ferguson ND, Meade MO, Frutos-Vivar F, Apezteguia C, Brochard L, Raymondos K, Nin N, Hurtado J, Tomicic V, González M, Elizalde J, Nightingale P, Abroug F, Pelosi P, Arabi Y, Moreno R, Jibaja M, D'Empaire G, Sandi F, Matamis D, Montañez AM, Anzueto A; VENTILA Group: Evolution of mechanical ventilation in response to clinical research. *Am J Respir Crit Care Med* 2008; 177:170–7
9. Maheshwari V, Paioli D, Rothaar R, Hill NS: Utilization of noninvasive ventilation in acute care hospitals: A regional survey. *Chest* 2006; 129:1226–33
10. Paus-Jenssen ES, Reid JK, Cockcroft DW, Laframboise K, Ward HA: The use of noninvasive ventilation in acute respiratory failure at a tertiary care center. *Chest* 2004; 126:165–72
11. Vanpee D, Delaunoy L, Gillet JB: Non-invasive positive pressure ventilation for exacerbation of chronic obstructive pulmonary patients in the emergency department. *Eur J Emerg Med* 2001; 8:21–5
12. Peslin R, Sadoul P: [Exploration of ventilation mechanics]. *Rev Prat* 1965; 15(suppl):1465–81
13. Chevreton JC, Joliet P, Abajo B, Toussi A, Louis M: Nasal positive pressure ventilation in patients with acute respiratory failure. Difficult and time-consuming procedure for nurses. *Chest* 1991; 100:775–82
14. Madan AK, Raafat A, Hunt JP, Rentz D, Wahle MJ, Flint LM: Barrier precautions in trauma: Is knowledge enough? *J Trauma* 2002; 52:540–3
15. Alvaran MS, Butz A, Larson E: Opinions, knowledge, and self-reported practices related to infection control among nursing personnel in long-term care settings. *Am J Infect Control* 1994; 22:367–70
16. Pittet D: The Lowbury lecture: Behaviour in infection control. *J Hosp Infect* 2004; 58:1–13
17. Seto WH: Staff compliance with infection control practices: Application of behavioural sciences. *J Hosp Infect* 1995; 30(suppl):107–15
18. Mobley MJ, Rady MY, Verheijde JL, Patel B, Larson JS: The relationship between moral distress and perception of futile care in the critical care unit. *Intensive Crit Care Nurs* 2007; 23:256–63
19. Piers RD, Azoulay E, Ricou B, Dekeyser Ganz F, Decruyenaere J, Max A, Michalsen A, Maia PA, Owczuk R, Rubulotta F, Depuydt P, Meert AP, Reyniers AK, Aquilina A, Bekaert M, Van den Noortgate NJ, Schrauwen WJ, Benoit DD; APPROPRIUS Study Group of the Ethics Section of the ESICM: Perceptions of appropriateness of care among European and Israeli intensive care unit nurses and physicians. *JAMA* 2011; 306:2694–703
20. Payen JF, Chanques G, Mantz J, Hercule C, Auriant I, Leguillou JL, Binhas M, Genty C, Rolland C, Bosson JL: Current practices in sedation and analgesia for mechanically ventilated critically ill patients: A prospective multicenter patient-based study. *ANESTHESIOLOGY* 2007; 106:687–95; quiz 891–2
21. Chanques G, Jaber S, Barbotte E, Violet S, Sebbane M, Perrigault PF, Mann C, Lefrant JY, Eledjam JJ: Impact of systematic evaluation of pain and agitation in an intensive care unit. *Crit Care Med* 2006; 34:1691–9
22. Schmidt M, Demoule A, Polito A, Porchet R, Aboab J, Siami S, Morelot-Panzini C, Similowski T, Sharshar T: Dyspnea in mechanically ventilated critically ill patients. *Crit Care Med* 2011; 39:2059–65
23. Berwick DM, Kotagal M: Restricted visiting hours in ICUs: Time to change. *JAMA* 2004; 292:736–7
24. Kleinpell RM: Visiting hours in the intensive care unit: More evidence that open visitation is beneficial. *Crit Care Med* 2008; 36:334–5
25. Slota M, Shearn D, Potersnak K, Haas L: Perspectives on family-centered, flexible visitation in the intensive care unit setting. *Crit Care Med* 2003; 31(5 suppl):S362–6
26. Azoulay E, Pochard F, Kentish-Barnes N, Chevret S, Aboab J, Adrie C, Annane D, Bleichner G, Bollaert PE, Darmon M, Fassier T, Galliot R, Garrouste-Orgeas M, Goulenok C, Goldgran-Toledano D, Hayon J, Jourdain M, Kaidomar M, Laplace C, Larché J, Liotier J, Papazian L, Poisson C, Reignier J, Saidi F, Schlemmer B; FAMIREA Study Group: Risk of post-traumatic stress symptoms in family members of intensive care unit patients. *Am J Respir Crit Care Med* 2005; 171:987–94
27. Myhren H, Ekeberg Ø, Langen I, Stokland O: Emotional strain, communication, and satisfaction of family members in the intensive care unit compared with expectations of the medical staff: Experiences from a Norwegian University Hospital. *Intensive Care Med* 2004; 30:1791–8
28. Bierer GB, Soo Hoo GW: Noninvasive ventilation for acute respiratory failure: A national survey of Veterans Affairs hospitals. *Respir Care* 2009; 54:1313–20
29. Kalfon P, Mimoz O, Auquier P, Loundou A, Gauzit R, Lepape A, Laurens J, Garrigues B, Pottecher T, Mallédant Y: Development and validation of a questionnaire for quantitative assessment of perceived discomforts in critically ill patients. *Intensive Care Med* 2010; 36:1751–8
30. Myhren H, Tøien K, Ekeberg O, Karlsson S, Sandvik L, Stokland O: Patients' memory and psychological distress after ICU stay compared with expectations of the relatives. *Intensive Care Med* 2009; 35:2078–86
31. Novaes MA, Aronovich A, Ferraz MB, Knobel E: Stressors in ICU: Patients' evaluation. *Intensive Care Med* 1997; 23:1282–5
32. Novaes MA, Knobel E, Bork AM, Pavão OF, Nogueira-Martins LA, Ferraz MB: Stressors in ICU: Perception of the patient, relatives and health care team. *Intensive Care Med* 1999; 25:1421–6
33. Samuelson KA, Lundberg D, Fridlund B: Stressful experiences in relation to depth of sedation in mechanically ventilated patients. *Nurs Crit Care* 2007; 12:93–104
34. van de Leur JP, van der Schans CP, Loef BG, Deelman BG, Geertzen JH, Zwaveling JH: Discomfort and factual recollection in intensive care unit patients. *Crit Care* 2004; 8: R467–73
35. Azoulay E, Kouatchet A, Jaber S, Lambert J, Meziani F, Schmidt M, Schnell D, Mortaza S, Conseil M, Tchenio X, Herbecq P, Andrivet P, Guerot E, Lafabrie A, Perbet S, Camous L, Janssen-Langenstein R, Collet F, Messika J, Legriel S, Fabre X, Guisset O, Touati S, Kilani S, Alves M, Mercat A, Similowski T, Papazian L, Meert AP, Chevret S, Schlemmer B, Brochard L, Demoule A: Noninvasive mechanical ventilation in patients having declined tracheal intubation. *Intensive Care Med* 2013; 39:292–301
36. Ely EW, Inouye SK, Bernard GR, Gordon S, Francis J, May L, Truman B, Speroff T, Gautam S, Margolin R, Hart RP, Dittus R: Delirium in mechanically ventilated patients: Validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). *JAMA* 2001; 286:2703–10
37. Ely EW, Margolin R, Francis J, May L, Truman B, Dittus R, Speroff T, Gautam S, Bernard GR, Inouye SK: Evaluation of delirium in critically ill patients: Validation of the Confusion Assessment Method for the intensive care unit (CAM-ICU). *Crit Care Med* 2001; 29:1370–9
38. Dres M, Tran TC, Aegerter P, Rabbat A, Guidet B, Huchon G, Roche N; CUB-REA Group: Influence of ICU case-volume on the management and hospital outcomes of acute exacerbations of chronic obstructive pulmonary disease*. *Crit Care Med* 2013; 41:1884–92
39. Kahn JM, Goss CH, Heagerty PJ, Kramer AA, O'Brien CR, Rubenfeld GD: Hospital volume and the outcomes of mechanical ventilation. *N Engl J Med* 2006; 355:41–50

40. Carlucci A, Delmastro M, Rubini F, Fracchia C, Nava S: Changes in the practice of non-invasive ventilation in treating COPD patients over 8 years. *Intensive Care Med* 2003; 29:419-25
41. 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
42. Bouadma L, Mourvillier B, Deiler V, Derennes N, Le Corre B, Lolom I, Régnier B, Wolff M, Lucet JC: Changes in knowledge, beliefs, and perceptions throughout a multifaceted behavioral program aimed at preventing ventilator-associated pneumonia. *Intensive Care Med* 2010; 36:1341-7
43. Bouadma L, Mourvillier B, Deiler V, Le Corre B, Lolom I, Régnier B, Wolff M, Lucet JC: A multifaceted program to prevent ventilator-associated pneumonia: Impact on compliance with preventive measures. *Crit Care Med* 2010; 38:789-96
44. Burns SM, Earven S, Fisher C, Lewis R, Merrell P, Schubart JR, Truitt JD, Bleck TP; University of Virginia Long Term Mechanical Ventilation Team: Implementation of an institutional program to improve clinical and financial outcomes of mechanically ventilated patients: One-year outcomes and lessons learned. *Crit Care Med* 2003; 31:2752-63
45. Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Griffiths P, Busse R, Diomidous M, Kinnunen J, Kózka M, Lesaffre E, McHugh MD, Moreno-Casbas MT, Rafferty AM, Schwendimann R, Scott PA, Tishelman C, van Achterberg T, Sermeus W; RN4CAST Consortium: Nurse staffing and education and hospital mortality in nine European countries: A retrospective observational study. *Lancet* 2014; 383:1824-30
46. McHugh MD, Brooks Carthon M, Sloane DM, Wu E, Kelly L, Aiken LH: Impact of nurse staffing mandates on safety-net hospitals: Lessons from California. *Milbank Q* 2012; 90:160-86
47. Amaravadi RK, Dimick JB, Pronovost PJ, Lipsett PA: ICU nurse-to-patient ratio is associated with complications and resource use after esophagectomy. *Intensive Care Med* 2000; 26:1857-62
48. Hugonnet S, Chevrolet JC, Pittet D: The effect of workload on infection risk in critically ill patients. *Crit Care Med* 2007; 35:76-81
49. Aiken LH, Clarke SP, Sloane DM, Sochalski J, Silber JH: Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *JAMA* 2002; 288:1987-93
50. Cohen MM, O'Brien-Pallas LL, Copplestone C, Wall R, Porter J, Rose DK: Nursing workload associated with adverse events in the postanesthesia care unit. *ANESTHESIOLOGY* 1999; 91:1882-90
51. Embriaco N, Azoulay E, Barrau K, Kentish N, Pochard F, Loundou A, Papazian L: High level of burnout in intensivists: Prevalence and associated factors. *Am J Respir Crit Care Med* 2007; 175:686-92
52. Tarnow-Mordi WO, Hau C, Warden A, Shearer AJ: Hospital mortality in relation to staff workload: A 4-year study in an adult intensive-care unit. *Lancet* 2000; 356:185-9
53. Stricker KH, Kimberger O, Schmidlin K, Zwahlen M, Mohr U, Rothen HU: Family satisfaction in the intensive care unit: What makes the difference? *Intensive Care Med* 2009; 35:2051-9
54. Azoulay E, Pochard F, Chevret S, Lemaire F, Mokhtari M, Le Gall JR, Dhainaut JF, Schlemmer B, French FAMIREA Group: Meeting the needs of intensive care unit patient families: A multicenter study. *Am J Respir Crit Care Med* 2001; 163:135-9
55. Hamric AB, Blackhall LJ: Nurse-physician perspectives on the care of dying patients in intensive care units: Collaboration, moral distress, and ethical climate. *Crit Care Med* 2007; 35:422-9
56. Ho KM, English S, Bell J: The involvement of intensive care nurses in end-of-life decisions: A nationwide survey. *Intensive Care Med* 2005; 31:668-73
57. Puntillo KA, McAdam JL: Communication between physicians and nurses as a target for improving end-of-life care in the intensive care unit: Challenges and opportunities for moving forward. *Crit Care Med* 2006; 34(11 suppl):S332-40
58. Rotondi AJ, Chelluri L, Sirio C, Mendelsohn A, Schulz R, Belle S, Im K, Donahoe M, Pinsky MR: Patients' recollections of stressful experiences while receiving prolonged mechanical ventilation in an intensive care unit. *Crit Care Med* 2002; 30:746-52
59. Constantin JM, Perbet S, Futier E, Cayot-Constantin S, Gignac V, Bannier F, Fabrègue H, Chartier C, Guerin R, Bazin JE: [Impact of sophrology on non-invasive ventilation tolerance in patients with acute respiratory failure]. *Ann Fr Anesth Reanim* 2009; 28:215-21
60. Delord V, Khirani S, Ramirez A, Joseph EL, Gambier C, Belson M, Gajan F, Fauroux B: Medical hypnosis as a tool to acclimatize children to noninvasive positive pressure ventilation: A pilot study. *Chest* 2013; 144:87-91
61. Clouzeau B, Bui HN, Vargas F, Grenouillet-Delacore M, Guilhon E, Gruson D, Hilbert G: Target-controlled infusion of propofol for sedation in patients with non-invasive ventilation failure due to low tolerance: A preliminary study. *Intensive Care Med* 2010; 36:1675-80
62. Constantin JM, Schneider E, Cayot-Constantin S, Guerin R, Bannier F, Futier E, Bazin JE: Remifentanyl-based sedation to treat noninvasive ventilation failure: A preliminary study. *Intensive Care Med* 2007; 33:82-7
63. Family presence: Visitation in the adult ICU. *Crit Care Nurse* 2012; 32:76-8
64. Davidson JE, Powers K, Hedayat KM, Tieszen M, Kon AA, Shepard E, Spuhler V, Todres ID, Levy M, Barr J, Ghandi R, Hirsch G, Armstrong D; American College of Critical Care Medicine Task Force 2004-2005, Society of Critical Care Medicine: Clinical practice guidelines for support of the family in the patient-centered intensive care unit: American College of Critical Care Medicine Task Force 2004-2005. *Crit Care Med* 2007; 35:605-22
65. Needham DM, Davidson J, Cohen H, Hopkins RO, Weinert C, Wunsch H, Zawistowski C, Bemis-Dougherty A, Berney SC, Bienvenu OJ, Brady SL, Brodsky MB, Denehy L, Elliott D, Flatley C, Harabin AL, Jones C, Louis D, Meltzer W, Muldoon SR, Palmer JB, Perme C, Robinson M, Schmidt DM, Scruth E, Spill GR, Storey CP, Render M, Votto J, Harvey MA: Improving long-term outcomes after discharge from intensive care unit: Report from a stakeholders' conference. *Crit Care Med* 2012; 40:502-9
66. Lautrette A, Darmon M, Megarbane B, Joly LM, Chevret S, Adrie C, Barnoud D, Bleichner G, Bruel C, Choukroun G, Curtis JR, Fieux F, Galliot R, Garrouste-Orgeas M, Georges H, Goldgran-Toledano D, Jourdain M, Loubert G, Reignier J, Saidi F, Souweine B, Vincent F, Barnes NK, Pochard F, Schlemmer B, Azoulay E: A communication strategy and brochure for relatives of patients dying in the ICU. *N Engl J Med* 2007; 356:469-78
67. Azoulay E, Pochard F, Chevret S, Jourdain M, Bornstain C, Wernet A, Cattaneo I, Annane D, Brun F, Bollaert PE, Zahar JR, Goldgran-Toledano D, Adrie C, Joly LM, Tayoro J, Desmettre T, Pigne E, Parrot A, Sanchez O, Poisson C, Le Gall JR, Schlemmer B, Lemaire F: Impact of a family information leaflet on effectiveness of information provided to family members of intensive care unit patients: A multicenter, prospective, randomized, controlled trial. *Am J Respir Crit Care Med* 2002; 165:438-42
68. Pronovost PJ, Angus DC, Dorman T, Robinson KA, Dremsizov TT, Young TL: Physician staffing patterns and clinical outcomes in critically ill patients: A systematic review. *JAMA* 2002; 288:2151-62
69. Evans T, Elliott MW, Ranieri M, Seeger W, Similowski T, Torres A, Roussos C: Pulmonary medicine and (adult) critical care medicine in Europe. *Eur Respir J* 2002; 19:1202-6
70. Artigas A, Pelosi P, Dellweg D, Brochard L, Ferrer M, Geiseler J, Larsson A, Nava S, Navalesi P, Noël JL, Orfanos

S, Palange P, Schoenhofer B, Vassilakopoulos T, Simonds A; ERS Educational Task Force on Respiratory Critical Care HERMES: Respiratory critical care HERMES syllabus: Defining competencies for respiratory doctors. *Eur Respir J* 2012; 39:1294–7

71. Frat JP, Thille AW, Mercat A, Girault C, Ragot S, Perbet S, Prat G, Boulain T, Morawiec E, Cottreau A, Devaquet J,

Nseir S, Razazi K, Mira JP, Argaud L, Chakarian JC, Ricard JD, Wittebole X, Chevalier S, Herbrand A, Fartoukh M, Constantin JM, Tonnelier JM, Pierrot M, Mathonnet A, Béduneau G, Deléage-Métreau C, Richard JC, Brochard L, Robert R; FLORALI Study Group; REVA Network: High-flow oxygen through nasal cannula in acute hypoxemic respiratory failure. *N Engl J Med* 2015; 372:2185–96

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