Journal of Critical Care 38 (2017) 182–189

Contents lists available at ScienceDirect

Journal of Critical Care

journal homepage: www.jccjournal.org

Sedation / Delirium

Predictors of clinicians' underuse of daily sedation interruption and sedation scales

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ARTICLE INFO

Keywords:
Daily sedation interruption
Sedation scales
Protocols
Quality improvement
Barriers
Intensive care unit

ABSTRACT

Purpose: The purpose of the study is to identify predictors of underuse of sedation scales and daily sedation interruption (DSI).
Methods: We surveyed all physicians and seven nurses in every Belgian intensive care unit (ICU), addressing practices and perceptions on guideline recommendations. *Underuse* was defined for sedation scales as use less than 3× per day and for DSI as never using it. Classification trees and logistic regressions identified predictors of underuse.
Results: Underuse of sedation scales and DSI was found for 16.6% and 32.5% of clinicians, respectively. Strongest predictors of underuse of sedation scales were agreeing that using them daily takes much time and being a physician (rather than a nurse). Further predictors were confidence in their ability to measure sedation levels without using scales, for physicians, and nurse/ICU bed ratios less than 1.98, for nurses. The strongest predictor of underuse of DSI among physicians was the perception that DSI impairs patients' comfort. Among nurses, lack of familiarity with DSI, region, and agreeing DSI should only be performed upon medical orders best predicted underuse.
Conclusions: Workload considerations hamper utilization of sedation scales. Poor familiarity, for nurses, and negative perception of impact on patients' comfort, for physicians, both reduce DSI utilization. Targeting these obstacles is essential while designing quality improvement strategies to minimize sedative use.

1. Introduction

The estimated average length of time for new knowledge to result in changes in bedside care is 17 years [1]. Over a decade's worth of research focusing on minimizing sedation in intensive care units (ICUs) has demonstrated that protocolized sedation using validated sedation scales and daily sedation interruption (DSI) may improve patient outcomes, including reduced duration of mechanical ventilation [2–5], length of stay [2–5], and mortality [5]. However, significant variation in the degree to which these strategies have been adopted by health care professionals (HCPs) leaves considerable room for improvement [6]. Studies confirm that although sedation protocols, sedation scales, and DSI are widely available, few patients actually benefit from such strategies [7–10]. Our team also recently found that protocols and sedation scales are available to 31% and 86% of Belgian clinicians, respectively [11]. However, sedation scales were used less than 3 times a day by 17% of clinicians. Similarly, DSI was never used by 31% of clinicians.

Prominent professional societies recently identified minimizing sedation as 1 of the top 5 priority recommendations to improve quality and lower costs of care in ICUs [12]. This highlights the need for research into ways of enhancing adherence to strategies minimizing sedation and identifying challenges to knowledge translation (KT). Quality improvement initiatives, tailored to previously identified local barriers, have efficiently improved practices [13–15]. Qualitative studies and surveys have tackled the challenges to utilization of sedation scales and DSI [16–23]. Factors influencing utilization of sedation scales and DSI based on patients' or organizations' characteristics were identified [10,23]. However, tailoring KT interventions (KT-Is) to suit HCPs is essential [16]. Predictors of utilization of sedation scales and DSI from the individual perspectives of HCPs have been described essentially for HCPs from organizations highly involved in KT research for analgosedation and research focused on nurses [19–22]. Furthermore, KT research regarding ICU analgosedation practices has been conducted exclusively in North

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http://dx.doi.org/10.1016/j.jcrc.2016.07.021
0883-9441/

America [10,17–23]. Its applicability to any European country is limited, as sedation scales and DSI are complex interventions, and as such, their effectiveness highly depends on contextual and clinician characteristics in different ICU environments [24–26].

Our primary objective was to identify predictors of underuse of strategies minimizing sedation, particularly sedation scales and DSI, among HCPs. Based on a previous qualitative study, we anticipated these would be related to individual characteristics of HCPs (eg, demographics, knowledge, self-efficacy, and outcome expectancy), characteristics of local analgosedation practices, and characteristics of the system within which the HCP works (eg, workload, responsibilities, and organizational characteristics, including culture) [16]. Secondary objectives were to assess predictors for physicians and nurses separately.

2. Methodology

We conducted a nationwide survey on sedation and analgesia practices and determinants of those practices in ICUs across Belgium. A central ethics committee approved our research protocol. The methodology is summarized here, as a full report has been elsewhere [11]. The target population comprised all nurses and physicians working in all 101 Belgian hospitals having an adult ICU. All physicians and a sample of 7 nurses from each hospital were contacted. The survey tool was developed by a multidisciplinary team, which also verified face and content validity. Important questionnaire items were identified using a literature review and a previous qualitative study [16]. Pretesting methods included respondent debriefings and test-retest reliability within a 2-week interval, which yielded substantial agreement [27,28]. The survey instrument was delivered, primarily in paper and electronic versions, using SurveyMonkey version 9.1 software (SurveyMonkey, Inc, Palo Alto, California), to nurses and physicians, respectively. Four reminders were sent to each group within 2 months of the first invitation (March-May 2011).

To identify system characteristics, site-level data were collected from 2 sources: (1) a preliminary survey addressed to the human resources departments (HRDs) and (2) the main survey addressed to HCPs. Variables collected through HRDs included region, academic status of the hospital, number of hospital beds, number of ICUs and ICU beds, type of ICU (medical, surgical, or medicosurgical), staffing information (no. of full-time equivalents [FTEs] working within ICU as physicians and nurses), and indicators of unit's workload (mean no. of patient days admitted to the ICU, no. of admissions, and proportion of patients requiring mechanical ventilation or elective surgery). Other site-level data collected from HCPs (main survey) included information on local management of analgosedation (type of regimens and management strategies used). Data on individual characteristics of HCPs collected through the main survey included demographic data (profession, background training, managerial position, experience, and time shift for nurses), perceived indications for using sedatives and sedation scales, perceived contraindications for using of DSI, and level of agreement with common misperceptions regarding both strategies.

2.1. Definitions of underuse of sedation scales and daily sedation interruption

We have defined underuse, using very low thresholds, which is less controversial than providing definitions for "sufficient" use, as "how many is enough?" is an unanswerable question. In addition, to design KT-Is to minimize sedation, identifying the characteristics more likely to be associated with underuse is essential to prioritize actions.

Underuse of sedation scales and DSI has not yet been defined in the literature. The optimal frequency of use of sedation scales is debatable. In studies demonstrating beneficial patient outcomes, frequency of assessments using appropriate scales ranged from 3 times a day to hourly assessments [29,30]. Recently revised recommendations by the Society of Critical Care Medicine suggested that assessments of sedation should be performed at least 4 times per shift [31]. We have defined underuse of sedation scales as utilization less than 3 times daily among HCPs who report availability of sedation scales in the ICU in which they work. Similarly, the appropriate proportion of patients in which DSI should be used is unknown. Although the "every patient, every day" rule should be applied when screening the eligibility of patients, prevalence of DSI may vary between ICUs for 2 reasons. First, applicability of DSI depends on the ICUs case mix, as varying proportions of patients may have appropriate contraindications to DSI. Second, proportion of mechanically ventilated patients cared for within the unit is also variable. We have therefore defined underuse of DSI as utilization in none of the patients.

2.2. Statistical analysis

A classification tree analysis was used to divide HCPs into homogenous groups with respect to underuse of sedation scales and DSI. The classification tree is a nonlinear and nonparametric alternative to linear models for classification issues and is increasingly being used in health care decision models, including ICU mortality prediction models [32–35]. Advantages of this method in the context of our research include the following: (1) simplicity of use and interpretation, as it does not require data to be linear or additive and deals simply with possible interactions between factors; (2) possibility of using incomplete data sets because missing data for predictive factors can be estimated using surrogate variables; and (3) a random forest providing relative importance of each predictor in the construction of the tree. This last is essential, considering our objectives of identifying predictors of underuse and prioritizing them so that they can be effectively addressed in KT-Is. Results of the multivariate regression analysis are presented as (*a*) a regression tree and (*b*) a table showing discriminatory power ranking of the different variables. The minimum cost tree was selected as the most useful tree. Results are presented as percentages (%) and frequencies (n/N) at each splitter.

We used univariate and multivariate logistic regressions to confirm predictors of underuse of sedation scales identified by classification tree analysis. The results of logistic regressions are presented as odds ratios (ORs) and 95% confidence intervals (CIs). Variables to be entered into each model were defined a priori, using a literature review and a previous qualitative study [16]. These variables were divided into system characteristics, local analgosedation management characteristics, and individual characteristics of HCPs (demographics and common perceptions). Statistical analyses were performed using R software version 2.12.0 (Free Software Foundation, Inc, Boston, MA) for multivariate logistic regression and CART version 6.6 (Salford Systems, San Diego, CA) for the classification tree modeling.

3. Results

3.1. Response rate and demographic characteristics

Global response rate was 60.2% (898/1491) of all participants, representing 94.1% (95/101) of all hospitals. Response rates were 49.6% (323/651) and 68.5% (575/840) for physicians and nurses, respectively. Respondents' individual and hospital characteristics have been described elsewhere [11].

3.2. Rates of underuse of sedation scales and daily sedation interruption

Underuse of sedation scales (ie, using them <3 times a day) was found for 16.6% (102/613) of all clinicians, corresponding to 22.6% (51/226) of physicians and 13.2% (51/387) of nurses. Similarly, DSI was never used by 32.5% (282/869) of clinicians, corresponding to 23.3% (70/300) of physicians and 37.3% (212/569) of nurses.

3.3. Predictors of underuse of sedation scales

Predictors, dividing clinicians into homogenous groups with respect to underuse of sedation scales using classification tree analysis, were identified among all HCPs (Fig. 1). Disagreeing with the statement that daily use of sedation scales does not take much time was the strongest predictor of their underuse. Among those agreeing with the latter statement, profession was the next predictor of underuse of sedation scales, which was more frequent among physicians than nurses. Among physicians, perceived ability to measure sedation levels without using sedation scales further predicted their underuse. Among nurses, a further predictor was nurse/ICU bed ratios, as ratios less than 1.98 corresponded to more underuse. Although they did not appear as the main splitters in the final tree, other factors were also important predictors of underuse of sedation scales, as shown by their discriminatory power ranking included: proportion of patients for whom DSI was used and perception that sedation scales helps to monitor costs (Table 1).

These predictors were confirmed using univariate and multivariate logistic regressions (Table 2). No system characteristics were associated with underuse of sedation scales. Among local analgosedation management characteristics, use of propofol as the main sedative was the only characteristic that was independently associated with underuse of sedation scales. Neither proportion of patients for whom DSI was used nor availability of an analgosedation protocol and a main analgosedation regimen containing opiates influenced use of sedation scales. Among individual characteristics of HCPs, variables independently associated with underuse of sedation scales included being a physician (rather than a nurse) and having the perception that sedation scales may be used to control costs. Conversely, having the perception that using sedation scales does not take a lot of time and that sedation scales may be used to evaluate pain independently reduces the likelihood of underuse.

We analyzed predictors of underuse of sedation scales in both professions separately (Supplementary files 1 and 2). For physicians, only individual characteristics of HCPs independently predicted underuse of sedation scales. These predictors included physician's confidence in their own ability to assess sedation without using sedation scales and their agreement with the statement that sedation scales are too complex for daily use. For nurses, region was the only system-level characteristic independently associated with underuse of sedation scales, as nurses from Flanders were more likely to use sedation scales, compared with nurses from Brussels. Using propofol as the main sedative was the only local analgosedation management characteristic that was independently associated with underuse of sedation scales. Among individual characteristics of HCPs, perception that daily use of sedation scales does not take a lot of time independently decreases the likelihood of underuse.

Table 1
Random forest showing overall discriminatory power ranking of variables

Variable	Score
Agrees "It doesn't take much time if you use sedation scales every day"[a,b]	100.0
Profession[b]	87.2
Nurse/ICU bed ratio[c,d]	69.3
Agrees "I can measure the level of sedation without using sedation scales"[a,b]	61.0
Proportion of sedated patients with daily sedation interruption[e]	49.5
Agrees "Sedation scales help to monitor costs"[a,b]	26.7
Physician/ICU bed ratio[c,d]	11.5
Occupational rate (mean length of stay × no. of ICU admissions)[d]	8.4
No. of hospital beds[d]	7.9
Agrees "Using sedation scales is beneficial for the patient"[a,b]	3.1
Region[d]	2.8
Availability of a protocol[b]	2.2

[a] Responses were provided in the form of a 6-point Likert scale ("strongly disagree," "disagree," "inclined to disagree," "inclined to agree," "agree," "strongly agree").
The positive answers ("inclined to agree," "agree," "strongly agree") were compiled in a one and only category, and the negative answers ("strongly disagree," "disagree," "inclined to disagree") were compiled into another unique category.
[b] Health care professional–level data collected through the main survey addressed to physicians and nurses.
[c] Nurse or physician per ICU/bed ratios is calculated as follows: nursing or physician staff in FTEs working in the ICU/number of ICU beds. Assuming an occupational rate of 80% of the beds, a 1.98 nurse per ICU/bed ratio corresponds approximately to a 0.47 nurse per patient.
[d] Site-level data collected through the preliminary survey addressed to the HRDs.
[e] Site-level data collected through the main survey addressed to physicians and nurses.

3.4. Predictors of underuse of daily sedation interruption

Predictors, which divided clinicians into homogenous groups with respect to underuse of DSI using classification tree analysis, were identified for physicians (Fig. 2) and nurses (Fig. 3).

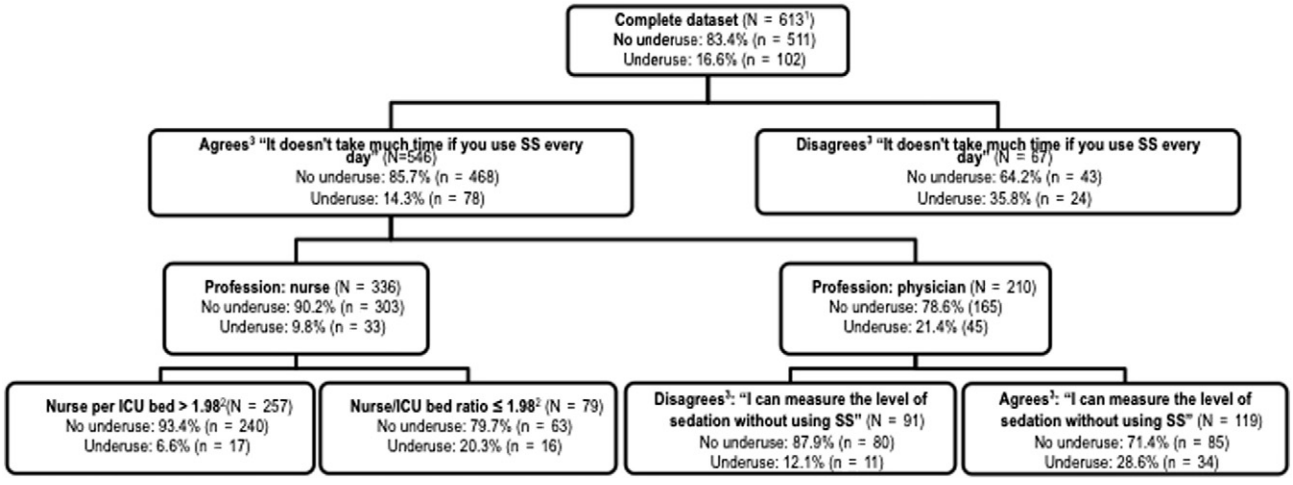

Fig. 1. Classification tree of predictors of underuse of sedation scales among all healthcare professionals.
Abbreviations: SS (sedation scales).
Footnotes: [1]N does not equal 899, as we excluded: (1) respondents for whom an occupational rate could not be calculated (number of ICU admissions per reference year or mean length of stay in within the reference year were missing data), as the latter variable was considered extremely important, and (2) respondents for whom the frequency of use of SS was missing data; [2]Nurse or physician per ICU/bed ratios is calculated as follows: Nursing or physician staff in full time equivalents working in the ICU/Number of ICU beds. Assuming an occupational rate of 80% of the beds, a 1.98 nurse per ICU/bed ratio corresponds approximately to a 0.47 nurse per patient. [3]Responses were provided in the form of a 6-point Likert scale ("Strongly disagree," "Disagree," "Inclined to disagree," "Inclined to agree," "Agree," "Strongly agree"). The positive answers ("Inclined to agree," "Agree," "Strongly agree") were compiled in a one and only category, and the negative answers ("Strongly disagree," "Disagree," "Inclined to disagree") were compiled into another unique category.

Table 2
Predictors of underuse of sedation scales for HCPs (logistic regression)

Variable	Univariate OR (95% CI)	Multivariate OR (95% CI)
System-level characteristics[a]		
No. of hospital beds (reference = <250 beds)		
≥250 and <500 beds	1.65 (1.02-2.64)	1.69 (0.99-2.88)
≥500 and <750 beds	0.88 (0.46-1.67)	0.88 (0.42-1.82)
≥750 beds	0.99 (0.48-2.03)	0.80 (0.33-1.94)
Academic hospital (reference: nonacademic)	1.10 (0.50-2.42)	
Region (reference: Brussels)		
Wallonia	0.71 (0.40-1.27)	
Flanders	0.88 (0.50-1.54)	
No. of hospital ICU units (reference: 1 unit)		
≥2 and <4 units	1.03 (0.64-1.66)	
≥4 units	1.01 (0.47-2.14)	
No. of ICU beds (≤10 beds)		
≥11 and <21 beds	0.94 (0.58-1.53)	
≥21 beds	0.98 (0.61-1.56)	
ICU type (reference: medical)		
Surgical	1.35 (0.38-4.78)	
Medicosurgical	1.08 (0.41-2.86)	
Mean patient days of admission in ICU	1.00 (1.00-1.00)	
Proportion of patients with mechanical ventilation	0.96 (0.85-1.07)	
Proportion of patients with elective surgery	1.05 (0.95-1.17)	
Staffing physicians (FTE/ICU bed)	1.10 (0.93-1.31)	
Staffing nurses (FTE/ICU bed)	1.03 (0.69-1.55)	
Local analgosedation management–level characteristics[b]		
Frequency of use of DSI (reference: never)		
< 25%	0.88 (0.38-2.07)	
25-75%	0.67 (0.30-1.49)	
>75%	0.62 (0.27-1.41)	
Availability of a sedation protocol (reference: no)		
Yes	1.09 (0.72-1.63)	
I don't know	1.37 (0.54-3.47)	
Main sedation regimen contains opiates	0.75 (0.41-1.38)	
Main sedative used (reference: midazolam)		
Propofol	2.59 (1.31-5.12)	2.57 (1.19-5.53)
Propofol and/or midazolam	1.71 (0.85-3.43)	1.88 (0.86-4.11)
HCPs' individual characteristics (demographics, common perceptions)[c]		
Profession (reference: nurse)		
Physician	1.89 (1.28-2.79)	1.95 (1.22-3.11)
Position: head of ICU	1.49 (0.95-2.35)	
No. of years of experience		
2-5 y	0.71 (0.29-1.75)	
6-10 y	1.03 (0.45-2.35)	
11-20 y	0.70 (0.31-1.60)	
>20 y	0.77 (0.34-1.75)	
Perceptions on sedation scales[d]		
I don't know any	1.17 (0.33-4.18)	
I know how to use them	0.94 (0.50-1.77)	
Using them influences the administration of sedatives by nurses	0.72 (0.47-1.10)	
Using them is beneficial for the patient	0.93 (0.35-2.49)	
Using them influences the prescription of sedatives by physicians	0.80 (0.52-1.24)	
I can measure the level of sedation without using them	1.48 (0.99-2.20)	
It doesn't take much time if you use them every day	0.28 (0.17-0.46)	0.37 (0.20-0.68)
They are too complex for everyday use	3.03 (1.67-5.50)	1.80 (0.85-3.84)
They make it possible to communicate better on the basis of objective figures	0.62 (0.38-1.03)	
They make it possible to make sedation practice consistent	0.84 (0.51-1.40)	
They restrict physicians' autonomy	0.79 (0.44-1.42)	
They help to monitor costs	1.59 (1.07-2.37)	1.59 (1.01-2.53)
They help to monitor the administration of sedatives by nurses	1.08 (0.70-1.67)	
They are not useful for nurses	1.19 (0.61-2.29)	
They enhance the nurses' role	0.72 (0.47-1.10)	
They are useful for physicians	1.06 (0.62-1.83)	
They help to monitor the prescription of sedatives by physicians	0.64 (0.43-0.95)	0.66 (0.42-1.03)
They give nurses more autonomy	0.91 (0.59-1.41)	
Indications for sedation scales		
To evaluate the level of sedation	0.41 (0.20-0.86)	
To evaluate the level of pain	0.65 (0.42-0.99)	0.58 (0.36-0.95)
To adapt sedative dosages	0.49 (0.33-0.72)	
To adapt analgesic dosages	0.57 (0.36-0.90)	

[a] Site-level data collected through the preliminary survey addressed to the HRDs.
[b] Site-level data collected through the main survey addressed to physicians and nurses.
[c] Health care professional–level data collected through the main survey addressed to physicians and nurses.
[d] Responses were provided in the form of a 6-point Likert scale ("strongly disagree," "disagree," "inclined to disagree," "inclined to agree," "agree," "strongly agree").
The positive answers ("inclined to agree," "agree," "strongly agree") were compiled in a one and only category, and the negative answers ("strongly disagree," "disagree," "inclined to disagree") were compiled into another unique category.

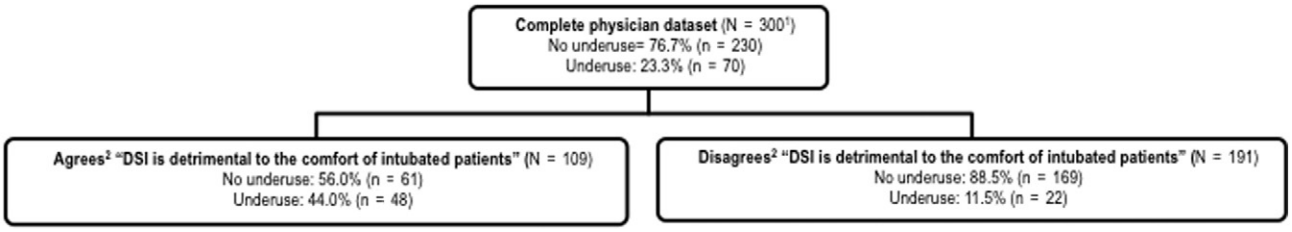

Fig. 2. Classification tree of predictors of underuse of daily sedation interruption among physicians.
Abbreviations: DSI (Daily sedation interruption).
Footnotes: [1]N does not equal 323, (2) respondents for whom the frequency of use of SS was missing data; [2]Responses were provided in the form of a 6-point Likert scale ("Strongly disagree," "Disagree," "Inclined to disagree," "Inclined to agree," "Agree," "Strongly agree"). The positive answers ("Inclined to agree," "Agree," "Strongly agree") were compiled in a one and only category, and the negative answers ("Strongly disagree," "Disagree," "Inclined to disagree") were compiled into another unique category.

Among physicians, perception that DSI is detrimental to the comfort of intubated patients was the strongest predictor of underuse. Other important predictors of underuse of DSI by physicians, identified through their overall discriminatory power ranking, included the following: perception that DSI creates traumatic memories for the intubated patient; perception that complicated weaning from mechanical ventilation is a contraindication for DSI; perception that they, personally, would prefer not to have DSI if they were intubated; and lack of outcome expectancy (ie, "not seeing the point of stopping sedation every day in every patient") (Table 3).

Among nurses, lack of familiarity with DSI was a major determinant of its underuse. Among those familiar with the practice, the next splitter was region as underuse occurred more frequently in Brussels and Flanders, as compared with Wallonia. For nurses from Brussels and Flanders, a third splitter was having the perception that DSI should only be performed upon medical orders. A number of ICU units greater than or equal to 2.5, region (Flanders vs Brussels), and agreeing with the statement that they would personally prefer not to have DSI if they were intubated all further predicted underuse of DSI. The discriminatory power ranking of variables is shown Table 4.

4. Discussion

We have found that a majority of predictors of underuse of sedation minimization strategies are related to individual perceptions of HCPs, rather than to HCPs' demographics, system level, and local analgosedation management characteristics. Physicians and nurses alike experience difficulties in KT, while implementing sedation minimization. However, both professions face different challenges while adopting such strategies. Our findings support the necessity of tailoring KT-Is to physicians and nurses specifically and separately and to prioritize targeting HCPs with specific common misperceptions or beliefs regarding sedation management.

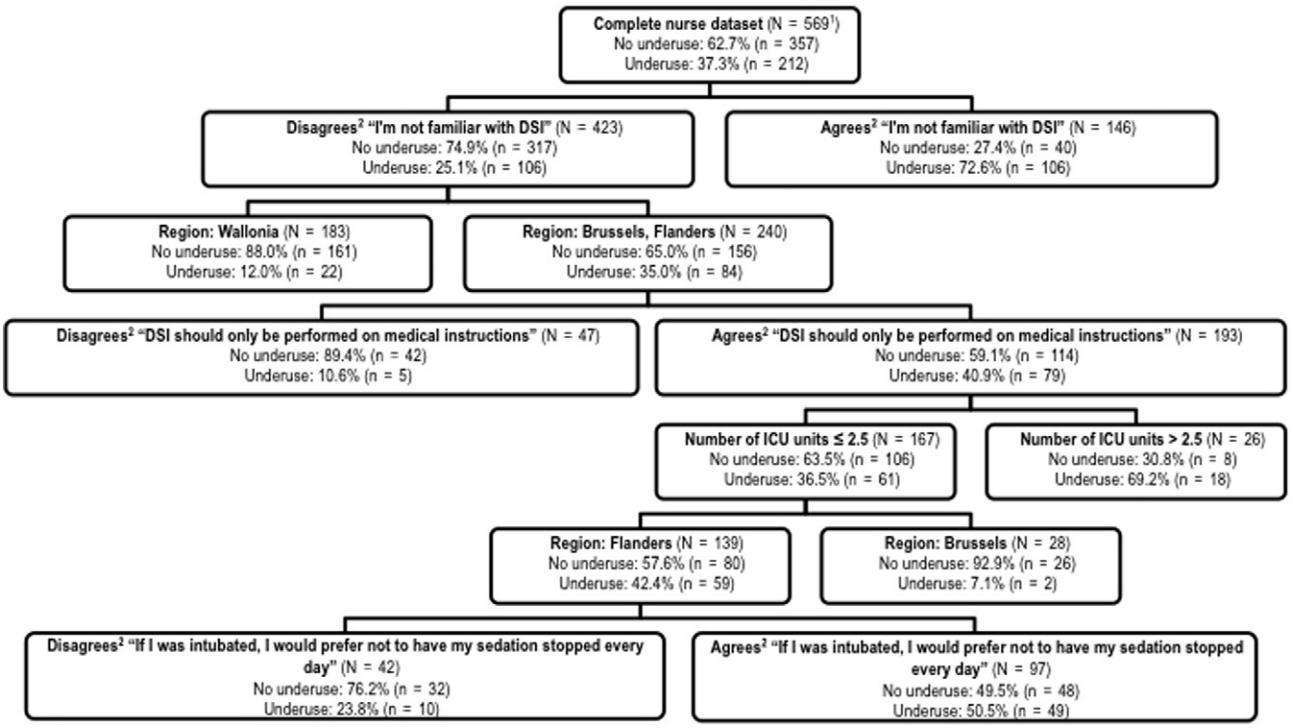

Fig. 3. Classification tree of predictors of underuse of daily sedation interruption among nurses.
Abbreviations: ICU (intensive care unit), DSI (Daily sedation interruption).
Footnotes: [1]N does not equal 575, as we excluded respondents for whom the frequency of use of sedation scales was missing data; [2]Responses were provided in the form of a 6-point Likert scale ("Strongly disagree," "Disagree," "Inclined to disagree," "Inclined to agree," "Agree," "Strongly agree"). The positive answers ("Inclined to agree," "Agree," "Strongly agree") were compiled in a one and only category, and the negative answers ("Strongly disagree," "Disagree," "Inclined to disagree") were compiled into another unique category.

Table 3
Random forest showing overall discriminatory power ranking of variables

Variable	Score
Agrees "DSI is detrimental to the comfort of intubated patients"[a,b]	100.0
Agrees "DSI creates traumatic memories for the intubated patient"[a,b]	77.2
Agrees "Complicated weaning from mechanical ventilation is a contra-indication to DSI"[c]	56.3
Agrees "If I was intubated, I would prefer not to have my sedation stopped every day"[a,b]	53.3
Agrees "If patients are only lightly sedated, DSI is not useful"[a,b]	49.9
Agrees "I don't see the point of stopping sedation every day for every patient"[a,b]	36.1

[a] Health care professional–level data collected through the main survey addressed to physicians and nurses.
[b] Responses were provided in the form of a 6-point Likert scale ("strongly disagree," "disagree," "inclined to disagree," "inclined to agree," "agree," "strongly agree").
The positive answers ("inclined to agree," "agree," "strongly agree") were compiled in a one and only category, and the negative answers ("strongly disagree," "disagree," "inclined to disagree") were compiled into another unique category.
[c] Respondents were provided with a list of potential contraindications and were asked to indicate whether they felt these were or were not contraindications.

Designing KT-Is to enhance an everyday active input from physicians in sedation management is unlikely to be effective, given the barriers identified. Being a physician (rather than a nurse) was associated with underuse of sedation scales. Sedation scales are perceived to have a poor relative advantage, as perception that using scales is time consuming or physicians' confidence in their own ability to measure sedation without using scales is an important predictor of their underuse. Similarly, the perception that DSI is detrimental to patient comfort was also associated with its underuse. At this stage, given the barriers identified, frequently used KT-Is, such as checklists, reminders, audits, and feedback, are unlikely to be effective in enhancing the use of assessment tools by physicians. Given the poor relative advantage of sedation minimization perceived by physicians, setting "default options" (ie, conditions set in place if no alternatives are actively chosen) may reduce the perceived cost of physicians' efforts [36,37]. "Default options" may be set on the range corresponding to minimal or no sedation goals (ie, all patients have their goals set to the "alert, calm and following commands status", unless physicians request otherwise, eg, Richmond Agitation Sedation Scale of 0 or Sedation-Agitation Scale of 4), whereas DSI should be a default option in ICUs working with such a strategy (ie, all patients receive DSI, unless physicians request otherwise). In addition, unraveling misperceptions about DSI, such as its perceived deleterious effects on patient outcomes, is essential. There is a significant body of evidence that shows that DSI is not associated with impaired patient outcomes such as immediate adverse consequences (including device removal) or long-term neurocognitive effects [26,38,39]. Educational interventions may be useful in demystifying such misperceptions.

Table 4
Random forest showing overall discriminatory power ranking of variables

Variable	Score
Agrees "I'm not familiar with this practice"[a,b]	100.0
Region[c]	39.7
No. of perceived contraindications[a,d,e]	17.5
No. of hospital beds[c]	17.0
Agrees "DSI should only be performed on medical instructions"[a,b]	14.3
No. of ICU units in hospital[c]	8.2
Agrees "If I was intubated, I would prefer not to have my sedation stopped every day"[a,b]	6.0
Type of ICU[a]	5.0
Agrees "I don't see the point of stopping sedation every day for every patient"[a,b]	4.3
Academic status[c]	3.3
Agrees "DSI is detrimental to the comfort of intubated patients"[a,b]	0.8
Agrees "If patients are only lightly sedated, DSI is not useful"[a,b]	0.7
Background training[a]	0.7

[a] N does not equal 575, as we excluded respondents for whom the frequency of use of sedation scale was missing data.
[b] Site-level data collected through the preliminary survey addressed to the human resources departments.
[c] Health care professional–level data collected through the main survey addressed to physicians and nurses.
[d] Responses were provided in the form of a 6-point Likert scale ("strongly disagree," "disagree," "inclined to disagree," "inclined to agree," "agree," "strongly agree").
The positive answers ("inclined to agree," "agree," "strongly agree") were compiled in a one and only category, and the negative answers ("strongly disagree," "disagree," "inclined to disagree") were compiled into another unique category.
[e] Respondents were provided with a list of potential contraindications and were asked to indicate whether they felt these were or were not contraindications.

Barriers to nurses' use of sedation minimization strategies differ for sedation scales and DSI. Lack of familiarity with DSI was the strongest predictor of its underuse, further highlighting the need for educational KT-Is aimed at nurses. Interestingly, another important predictor of underuse of DSI among nurses was perception that DSI should be performed only upon medical orders. More than 80% of respondents agreed with this statement, with similar frequencies for physicians and nurses. This reflects a lack of self-efficacy among nurses in performing such tasks as well as a lack of confidence from physicians in nurses' ability to decide whether DSI should be performed. Interestingly, most successful teams have transferred the responsibilities of drug administration and DSI to nurses, leaving it to nurses to adapt drug dosages in a timely manner [2,3,15,40–43]. Some ICUs have effectively implemented the use of DSI, explicitly mentioning that relevant responsibilities were delegated to nurses using previously agreed upon contraindications or safety screens [44]. Unfortunately, we have not evaluated the availability of such procedures in units where DSI is used. Decision making for sedation management is complex and requires clinical judgment skills [45]; therefore, intense educational KT-Is in the form of face-to-face educational outreach visits are warranted. Previous work has shown gaps in bedside education by senior physicians and lack of consensus among senior physicians of the same unit may hamper the learning process of other HCPs [16]. Therefore, nurses, serving as referees for sedation management in within each local ICU and involved in educational outreach, may endorse the role of champions or "change agents." Several successful KT-Is have enhanced appropriate sedation management, using educational outreach and champions [14,15,40,42,46–48]. Addressing nurses' concerns that using sedation scales is time consuming is an important predictor of their underuse. Noteworthy, using scales such as the Sedation-Agitation Scale or the Richmond Agitation Sedation Scale takes less than a minute to use [49].

Nonmodifiable system-level characteristics were scarcely associated with underuse of sedation minimization strategies. Therefore, tailoring KT-Is to factors including hospital and ICU size, academic hospital status, region, ICU type, proportion of mechanically ventilated or elective surgery patients, staffing and occupancy rates is unnecessary. However, nurse/bed ratio predicted underuse of sedation scales among nurses, and such an association was not found for underuse of DSI. To our knowledge, current existing literature offers no guidelines on minimum nurse/patient ratios. Various characteristics (including skill mix, patient mix, and total nursing hours) must be accounted for when measuring nursing workload. However, total nursing hours (which may be measured using the nurse/bed ratio) is an essential component of workload, as it has been shown to affect important patient outcomes [50]. Our results contrast with those of a recent randomized controlled trial evaluating protocolized sedation using hourly sedation assessments combined with DSI, compared to protocolized sedation alone [30]. The addition of DSI did not further reduce duration of mechanical ventilation but did increase perceived nursing workload. Differences in methods of measuring workload may explain discrepancies in results between this study and ours. Mehta et al assessed perceived nursing workload using a visual analog scale, where nurses were invited to rate difficulty in managing patients during their shift from 1 to 10, while we measured actual nurse/ICU bed ratio reported by HRDs as a proxy [11,30]. It is worth noting that nurse/bed ratio is difficult to act upon in the design of KT-Is.

Our research has been conducted in Belgium. We believe our findings to be generalizable at a national level, at least. Transferability of KT research is an issue, and research in ICUs faces particular challenges, as management patterns for critically ill patients may differ dramatically between countries, even neighboring countries with comparable socio-economic parameters [51]. Arguably, our results are transferable to countries or settings with similar contextual characteristics, which may influence practices. Such characteristics include closed ICU models, led by a specially trained intensivist and 24-hour physician staffing (not necessarily intensivist), nurse/patient ratios of approximately 1:3, with a majority (70%) of ICU and emergency care specialized nurses. Additional characteristics include highly variable involvement of physiotherapist's in ICU activities, including mechanical ventilation management and early mobilization, and low coverage of ICUs by clinical pharmacists.

4.1. Scope of the study (limitations and strengths)

Several limitations of the present study are worth mentioning. First, we analyzed predictors of underuse using reported use of DSI and sedation scales, and responder bias may be an issue. However, although we may overestimate the use of evidence-based practices when compared to actual practices, we have used very low thresholds to define underuse and our sampling frame included clinicians working at the bedside, unlike some other surveys [6,9]. Second, nonresponder bias may have occurred. However, our response rate was sufficiently high to ensure adequate power to answer our research questions, as was the number of respondents ($n = 898$). Furthermore, a comparison between hospital characteristics of responders and nonresponders did not show statistical differences [11]. Third, we defined underuse of sedation scales as use less than 3 times a day. We have, therefore, excluded all respondents without an available sedation scale in their unit. Predictors for those respondents may be different, and this requires investigation.

Strengths of this study include diversity of backgrounds and positions of respondents and high respondent and institutional response rate, which increase generalizability of our results. Other strengths also deserve to be mentioned. First, we achieved response rates higher than the expected 50%, which gave us the power required to analyze each profession separately. Second, in contrast to most studies, we did not rely on convenience sampling and avoided using existing contact databases of professional societies that were likely to generate selection bias. Our sampling frame was carefully created as a census of physicians (all Belgian physicians were surveyed) and a probabilistic sampling of nurses, across all Belgian hospitals, through the hospital HRDs. This further reduced selection bias with regard to respondents. Third, we involved a multidisciplinary team to construct the survey instrument and to ensure its face and content validity. Several pretesting methods were also combined to improve the instrument (such as respondent debriefings, test-retest reliability). Finally, we believe our study to be the first to assess predictors of underuse of sedation scales and DSI in physicians and nurses separately, using multivariate analysis (regression trees and logistic regressions).

5. Conclusion

The main challenge to DSI utilization is lack of familiarity with DSI, among nurses, and perception that DSI impairs patients' comfort, among physicians. Conversely, a minimal nurse/ICU bed ratio is essential to ensure utilization of assessment tools among nurses. If increased utilization of sedation scales is to be achieved among physicians, their confidence in their ability to measure sedation without using sedation scales must be challenged. These predictors of underuse of sedation scales ad DSI must guide the design of KT-Is tailored to suit physicians and nurses, taking their perspectives into account.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jcrc.2016.07.021.

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