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Quality assessment in intensive care units: proposal for a scoring system in terms of structure and process

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Abstract *Objective:* We present a score for assessing the quality of ICU care in terms of structure and process, based on bibliographic review, expert consultations, field test, analysis, and final consensus, and analyze its initial application in the field. *Design and setting:* This feasibility and observational study was conducted within the framework of a French regional clinical research project (NosoQual); 40 ICUs were visited and assessed between November 2002 and March 2003 according to standardized procedures. *Measurements and results:* The grid consisted of 95 variables. The overall score derived from seven independent quality dimensions: human resources, architecture, safety and environment, management of documentation, patient care management, risk management of infections and evaluation, and surveillance. The average level of achievement of the scores varied from 48% to 63% of theoretical maxima. Variability in the individual dimensional subscores was greater than that of the overall score (CV = 0.15). *Conclusions:* Evaluation this scoring system encounters the limitation of the absence of a "gold standard." However, this is counterbalanced by the rigorous design methodology, the characteristic strengths of the quality dimensions. The survey also highlights also feasibility and the potential interest for specific tools for the assessment of ICUs.

Keywords Intensive care · Quality indicators · Performance · Assessment and risk management

Introduction

Quality assessment in healthcare was started in 1918 in the United States and Canada by the American College of Surgeons, organized as on-site hospital inspections aimed at verifying a "minimum standard" [1]. Over the next 30 years quality standards were developed, leading to the establishment of organizations dedicated to the assessment of quality of healthcare, the oldest (1951) and probably the most well known being the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). In the United Kingdom the National Health Service, created in 1948, established its own official framework for evaluating quality of care in the 1980s [2]. During the same period an enormous effort was also made by the Australian authorities; the Australian Council on Healthcare Standards was established in 1974 to assess the performance of healthcare facilities. In 1991 France included assessment requirements in hospital law [3] and in 1996 created the ANAES (now "Haute Autorité de Santé"), as a scientific organization responsible for accreditation in the healthcare sector [4].

Most quality assessment models have taken as a starting point the reference research work of Donabedian [5]. In 1980 he introduced to the healthcare sector the analytical framework "structure–process–result", used to describe and evaluate quality in other fields [6]. The intensive care unit (ICU) is one of the major targets of the quality assessment process in hospitals (particularly in relation to healthcare-associated infections) [7]. ICUs are complex organizations requiring various fields of knowledge, technical devices, and diagnostic and therapeutic methods. Their history has been marked by many technological advances in the fight to save lives threatened by serious illnesses [8]. In most countries intensive care is expanding (in terms of number and size of units, budget), and new technologies are constantly being introduced. The evolving accreditation and evaluation in the healthcare sector have manifested the need to develop specific quality assessment tools for ICUs. In 1997 the European Society of Intensive Care Medicine (ESICM) produced general guidelines for continuous quality improvement and recommendations on minimal requirements for ICUs [9, 10]. Later a safety checklist (58 standards for nursing, respiratory therapy, and maintenance) was initiated in 1999 by the Veterans Affairs Ann Arbor Health System (VAAHS) [11]. In 2005 the JCAHO released a new manual for national hospital quality measures related to both ICU processes and outcomes [12], and the Spanish Society of Intensive and Critical Care and Coronary Units published its first edition of the quality indicators in critically ill patients (as yet only published in draft format).

NosoQual is a clinical research project (PHRC) funded by the French Health Ministry and carried out by three university hospitals (Lyon, Nice, and Montpellier) in collaboration with the regional coordination center for infection control C.CLIN Sud-Est (Lyon). Its objective is to test the correlation between standard quality measures in ICUs and surgical units (in terms of structure and process) and rates of healthcare-associated infections (HAI) that several European healthcare authorities consider as potential indicators of hospital performance.

The first phase of the project consisted of developing specific quality assessment tools for intensive care and for surgery. Theses tools were presented as sets/grids of selected criteria allowing the calculation and the attribution of quality scores. The objective of this phase was to design a global score independent of the outcome indicators (HAI) and based on structure and process criteria only. The present contribution describes the method of constructing the ICU quality assessment grid and presents the results obtained (in terms of correlation and variability of the scores across ICUs) following an on-site visit. The second step of the project will be to analyze the correlation between the scores expressed by these grids as resource-process performances and HAI. If validated, the scores could be also used both for evaluating the impact of changes in processes and structures and for assessing and comparing quality in different ICUs and surgical units.

Materials and methods

The score was developed between April 2001 and March 2005, and the process consisted of five phases: (a) bibliographical review, (b) experts reconsideration, (c) field test (pilot test and on-site visits), (d) descriptive analysis, and (e) final consensus. The bibliographical review used intensive care, quality indicators, performance, assessment, and risk management as basic key words, followed by brainstorming by the project investigators. This led to a definition of "quality" in terms of structure and process for designing of the score. This primary step led to the creation of a first version of the score consisting of recommended measures, regulations, and factors that could potentially affect the work organization, management, and ultimately performance of the unit. These elements were classified into several dimensions of the quality focusing on structure and process indicators.

Experts' reconsideration took place in two stages. First, a committee of reviewers including five experienced intensive care physicians was asked to give an opinion on the selected items and their classification. The grid was considered globally as relevant and some consensual suggestions were subsequently carried out. Secondly, a national group of 25 experts from numerous fields was selected to review the questionnaire through a Delphi investigation. This consisted of professionals and experts in intensive care, quality assessment, and/or infections control. Two consecutive reviews were necessary to arrive at a consensus. The experts were asked to rank the selected criteria according to three statements: (a) level of association between the criteria and the quality of care in ICU (ranked from 0/no link to 3/strong link), (b) availability of information (ranked from 0/not available to 3/always available), and (c) formulation of the criteria (not ranked, but suggestions for modifications were solicited). Only criteria which achieved the highest rank (3) were integrated into the grid, which consisted at the end of seven quality dimensions related to the ICU and a general component of the global descriptors of the healthcare facility.

A pilot testing of the consensual grid in the field was carried out in two ICUs to demonstrate the acceptability and feasibility of the investigations. An ICU team represented each unit during the on-site visits, consisting of an intensivist and an intensive care nurse from the unit together with a member of the Infection Control Committee, the Risk Management Team, or the Quality Department of the hospital. Preparation of the visit by the ICU team was

Table 1 Synthesis of the classification and the variables of the final ICU consensual grid

Components	Variables
Dimension 1: human resources	(12 variables, weight = 24)
Physician quota	Doctor-bed ratio
	Ratio of full-time to part-time physicians
Staff quota	Nurse-bed ratio [13–15]
	Allocation of a physiotherapist (1 full-time equivalent) [16]
	Allocation of a secretaries (1.5 full-time equivalent)
Organization	Replacement of nurses during sick leave in more than 75% of cases
Staff training	Existence of a training procedure for new nurses [14]
	Density of medical training, density of paramedical training
Dimension 2: architecture	(13 variables, weight = 20)
Structure [17]	Ratio of the number of beds to surface area [18]
	Organization and distribution of the preparation and decontamination areas [19, 20]
	Existence of waiting room for the patient relatives
	Single room to the number of rooms ratio [21]
Equipment characteristics	Smooth wall lining [19, 22]
	Absence of a false ceiling [23]
	Wash stand ratio per number of beds
	Existence of a specific wash stand for the patient relatives
Dimension 3: safety and environment	(20 variables, weight = 21.5)
Security standards required	Existence of a backup power generating unit [24]
	Existence of functioning emergency procedures for fire protection [25]
	Existence of a well identified waste disposal [26]
	Sterilization subject to quality assurance [27–29]
Distinctiveness of ICU and other critical care units	Existence of a policy for the implementation of single use materials
	Existence of an air renewal system [19, 20]
	Existence of adequate cleaning procedures [19, 30]
Dimension 4: management of documentation	(16 variables, weight = 17.5)
File administration	Systematic identification on medical file elements (patient's name, author's name, date and hour on each entry) [26, 27]
	Integrity and quality of the nursing and medical filing system infrastructure [31, 32]
	Coherence of the organization of the patient filing system [31, 32]
Procedures control	Existence of a procedure for document control (document standards, storage, diffusion) [31]
	Notification of the operational conditions of the procedure
	Notification of the committee reviewing and validating the procedure
Dimension 5: patient care management	(10 variables, weight = 13)
Welcome guide for patient relatives	Notification of the visitation schedule in the guide
	Existence of glossary of current medical terms
Procedure availability	Existence of transversal procedures (patient transfer, interaction with the laboratory for exchanging samples and results)
	Existence of a procedure for appropriate glove use [33]
	Existence of a procedure for antiseptic use [34]
Hygiene precautions	Systematic absence of jewels and watches
	Use of alcohol-based solutions as an alternative for traditional hand washing
Antiseptic management	Storage with respect to the principle of "first in, first out"
	Notification of the date of opening or expiry date on every opened flask
Dimension 6: risk management of infections	(12 variables, weight = 16)
Antibiotherapy	Existence of prescription procedures (nominative, modalities)
	Reevaluation of anti-biotherapy at 3 days or after microbiological results [35]
Medical procedures, devices	Existence of a procedure for the insertion of central venous catheter, wearing of gloves and respect of the asepsis during catheter insertion [36]
	Existence of intubations procedures (modalities for changing respirators circuits, closed system for the bronchial aspiration) [37]
Dimension 7: evaluation and surveillance	(12 variables, weight = 14)
Surveillance organization	Existence of an intensivist responsible for data collection
	Data control operated by a third party, external to the ICU
	Availability, visibility and active feedback of the surveillance results
	Multiresistant bacteria tracking (systematic on entry and during the stay if suspicion) [38, 39]
Evaluations carried out	Participating in at least one medical and paramedical audits
	Follow-up of adverse events

recognized to be crucial for completing the ICU visit appropriately in 1 day. The in situ data collection took place over a 5-month period (November 2002–March 2003) via interviews (using standardized questionnaires for each of the members of the ICU team) and observations (single or multiple observations to report the presence/absence or to the cumulative measure of a criteria in the unit). All the ICUs participating in a large regional network for the surveillance of HAI in ICU "REA Sud-Est," were invited to participate. Forty units agreed to receive investigators on a voluntary basis for a 1 day visit; a list of the participating ICUs is presented under "Acknowledgements."

Descriptive analyses were produced using SPSS package (version 12). These consisted essentially of: frequency tables aimed at identifying and deleting homogeneous variables and those with missing values and correlation ma-

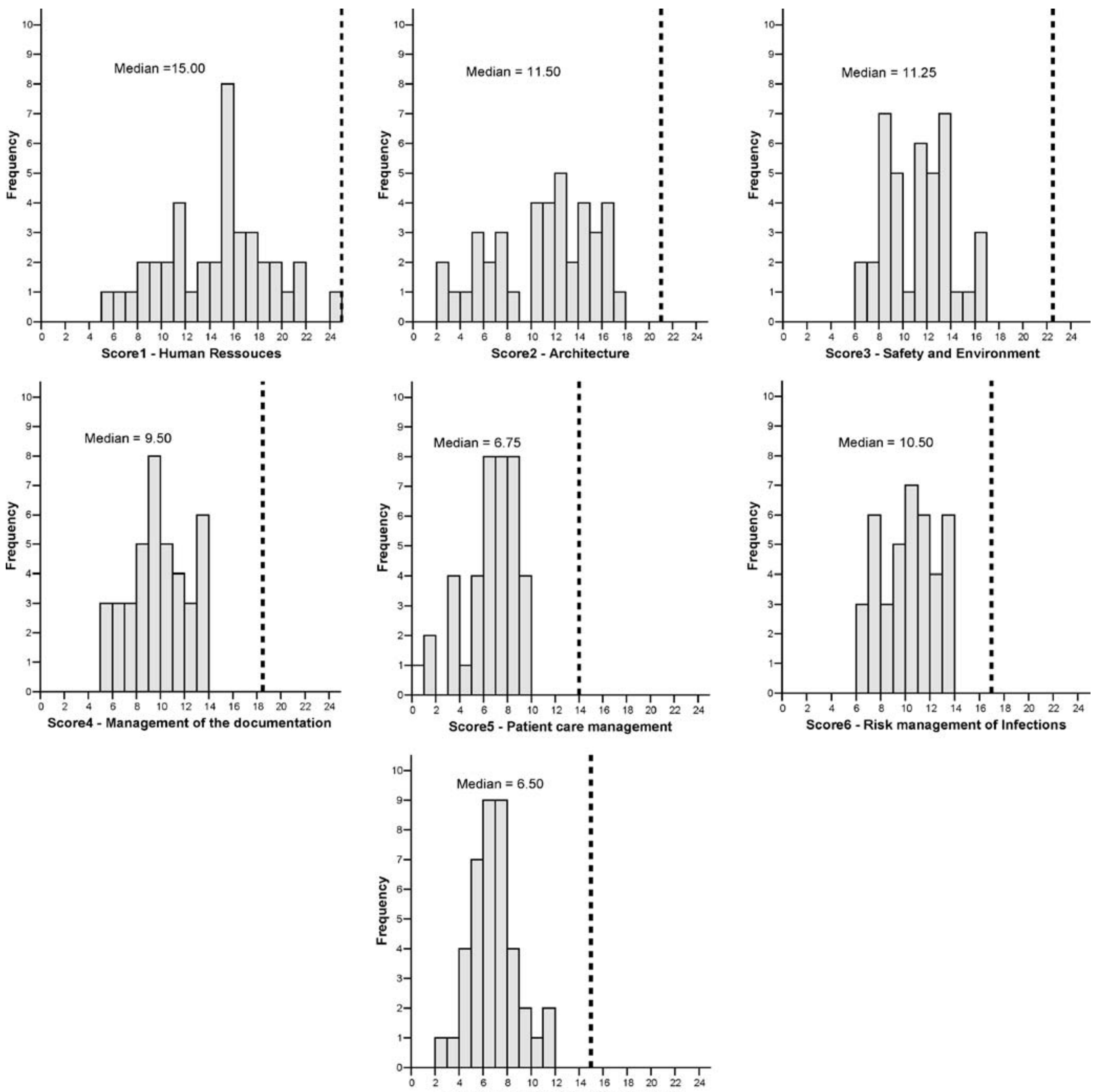

Fig. 1 Variability of the ICU performance according to the different dimensions of "quality"

trices leading to the reformulation, combination, or suppression of variables for which the Pearson test identified significant correlation with another variable expressing the same or similar quality measure. These analyses led to the deletion of, respectively, 85 deleted and 45 variables.

Finalization was carried out jointly by some of the experts of the Delphi investigation and the investigators of the project. These considered the results of the analysis and decided consensually whether to retain the remaining discriminating variables in the final quality assessment grid. Some criteria were reformulated or combined to generate ratios to attribute to the score quantitative assessment ability. For each selected variable a weight and a threshold was defined.

Results

The preliminary instrument after bibliographical review and brainstorming included 234 variables; this grew to 331 after the experts' consultation. This was the questionnaire that was used during the field test (November 2002–March 2003). The subsequent analysis led to the removal of nondiscriminating and intercorrelated variables, leaving 146 variables, and the present ICU quality assessment grid consisting of 95 variables emerged from the stage of final consensus. These were classified into the following seven dimensions (Table 1): human resources (quotas, organization, training of ICU staff), architecture (unit structure and architectural characteristics), safety and environment (security requirements and environmental ICU specifications), management of documentation (management of protocols, medical and nursing files), patient care management (various procedures and standards related to patient care), risk management of infections, and evaluation and surveillance.

Each dimension included variables which were considered during the final phase to be discriminating, uncorrelated, nonredundant and therefore representative of quality of care in ICUs. For each of the 95 variables a ruling modality and a weighting from 0.5 to 3 was attributed according to the importance and the relevance of the variable in terms of quality of care. Thus a theoretical maximum score was calculated for each of the seven dimensions. The highest scores were those on dimensions 1–3 (score 1 = 24, score 2 = 20, score 3 = 21.5) and the lowest those on dimensions 5–7 (score 5 = 13, score 6 = 16, score 7 = 14). The sum of the "dimensional scores" generated a "maximum theoretical score" of 126.

Using the grid presented in Table 1, an individual score was calculated for the 40 ICUs assessed by the investigations (one score for each dimension as well as a total score for each unit). Fig. 1 shows the wide variability in scores between the participating units. This variability was observed particularly for the dimensions of "human resources," "architecture," and "patient care" (coefficient of variation over 0.3). However, the total score expressed a relative homogeneity (coefficient of variation 0.15); this varied from 36.5 to 89.5, and 45% of the units achieved the mean value of 68.6 (Fig. 2).

Since the various dimensions had different theoretical maxima, the levels of performance (average and maximum levels) were measured in terms of percentage of achievement of the maxima: The average level of achievement of the score varied from 48% (dimension 7) to 63% (dimension 6) of the theoretical maximum score, whereas the maximum observed score attained 75–100% of the theoretical maximum (Fig. 3).

The relationship between the scores was tested using Pearson's correlations matrix. The scores were rather independent; few significant correlations were observed: "management of documentation" was significantly correlated to both "human resources" ($r = 0.09$, $p = 0.01$) and "environment" ($r = 0.389$, $p = 0.05$; see Table 2).

The consensual grid was sent to the participating units together with a summary table of the descriptive results. Individual scores were highlighted for each ICU to allow them to compare their position to the sample. The intensivists were invited to express their opinion of the tool and the degree to which it reflects the reality of their units. Apart from the units which had been moved after the investigation, the participants were satisfied with their results; two units asked for a return visit from investigators, and two others asked for authorization to use the grid for self-evaluation.

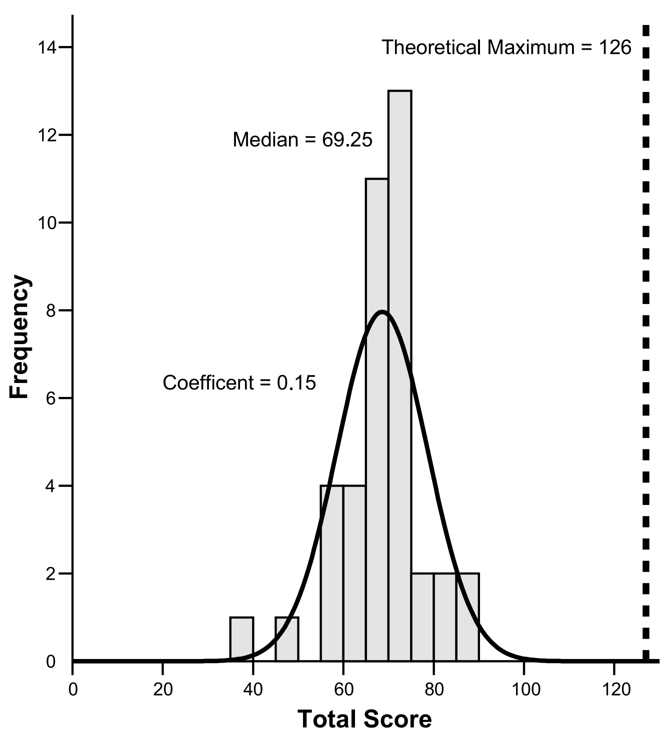

Fig. 2 Variability of the ICU total score in the 40 units

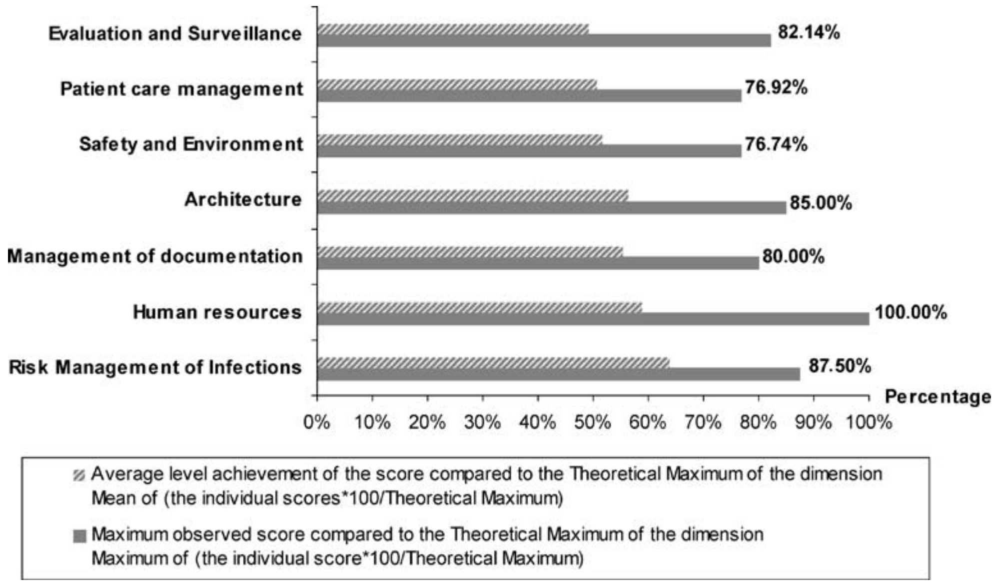

Fig. 3 Level of achievement of the quality dimensions

Table 2 Pearson's correlation coefficients (r) between the quality dimensions: human resources (1), architecture (2), safety and environment (3), management of documentation (4), patient care management (5), risk management of infections (6), and evaluation and surveillance (7)

	1	2	3	4	5	6	7
1	1	−0.033	0.138	0.407**	0.110	0.266	0.281
2	−0.033	1	−0.074	0.044	0.162	−0.185	0.018
3	0.138	−0.074	1	0.389*	0.237	−0.096	0.293
4	0.407	0.044	0.389	1	0.228	−0.075	0.198
5	0.110	0.162	0.237	0.228	1	−0.095	−0.160
6	0.266	−0.185	−0.096	−0.075	−0.095	1	0.178
7	0.281	0.018	0.293	0.198	−0.160	0.178	1

$^{*}p \leq 0.05$, $^{**}p \leq 0.01$

Discussion

Evaluation of the NosoQual system for scoring the "quality" of ICUs is subject to some limitations. The major one of these is the absence of a "gold standard" against which to evaluate other tools. Nevertheless some elements in the design have been identified to assess and discuss this score. The data were collected by trained investigators during the on-site visit using standard questionnaires and checklists to perform interviews and observations. This process guaranteed an accurate data collection. However, remarks can be formulated regarding the time of on-site visits and level of specialization of investigators for a better observation of practices; however, intensive care specific practices were not included in the survey protocol. Furthermore, biases may have occurred in relation to the previous experiences of the experts involved in the different phases of the score conception. Experts were enrolled on voluntary bases according to their interest in quality management and ICU performances. This selection may have led to the over- or underscoring of some of the quality dimensions. Concerning representativeness the score was designed in consideration of the descriptive results of 40 ICUs in a surveillance network at the regional level, knowing that the sample size represented 60% of the ICU network. A comparison between the characteristics of participating ICUs and the others within the network revealed a similarity regarding to the type of ICU but a difference in relation to the type of the participating healthcare facilities. One of the elements that could not be tested in this study was sensitivity (in relation to time). The ability of the tool to represent slight modifications in time has not been checked after the grid conception. If tested, relevance could be one of the added values of this tool. Finally, the score was not tested after its finalization, which may have been a strong argument for the dissemination of the tool among professionals.

Despite these limitations, several reasons support the idea of a potential usefulness of the score for evaluating "quality" of ICUs. (a) The methodology of developing the score was respected throughout all the phases of the process. (b) During both the Delphi investigation and the stage of the final consensus only variables which reached 100% of agreement were retained in the score. (c) The survey was supported by direct observations, which helped to ensure the on-site situation of the units was recorded. In addition, the modalities of performance of these observations guaranteed that most subjective interpretations were eliminated. (d) The total score covered almost entirely the components of quality of care in intensive care, using discriminating uncorrelated variables. (e) The high variability and the independent faculty (poor intercorrelation) of each quality dimension allows the level of performance in each component to be revealed separately. (f) The feedback of participating ICUs, which expressed interests for further uses of this tool, was encouraging particularly as a self-assessment and also for performance comparison within a specific network. (g) Compared to some available standards for evaluating quality of care in ICUs, the NosoQual grid displays some equivalence: the safety checklist of the VAAHS [11] was organized into various components (e.g., medications, environment) and included a set of standards some of which some were common to our model (e.g., adherence to isolation protocols, medication administration record, signed, clear passage in hallway); on the other hand, the latest JCAHO manual of ICU specifications [12] consists of six measures, two of which are very similar to some variables of the sixth dimension of the NosoQual score "risk management of infection" (central line associated bloodstream infection, ventilation associated pneumonia prevention, patient positioning). Regarding the quality indicators proposed by the Spanish Society of Intensive and Critical Care and Coronary Units, 7 of the 15 sections classifying the 120 indicators also showed interesting parallels with the NosoQual indicators (acute respiratory insufficiency, infectious diseases, nursing, bioethics, planning and management, internet and training).

In conclusion, this survey highlights the feasibility and the potential interest for designing specific tools for the assessment of quality in ICUs. The tool developed in this study was oriented to structure and process evaluation and targeted at unit level, but it could also be associated with standards and existing supports for assessing quality at hospital level. Furthermore, such score could be used in multicenter collaborative projects and networks to check relative "quality" of participating ICU using benchmarking. In a different scientific approach this score could be used to test the strength and the correlation with outcome indicators used to measure clinical performance of ICUs.

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