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Daily classification of complexity/level of intensive medical care

Does it allow the monitoring of the managerial process in ICU?

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The Foundation-for-Research-on-Intensive-Care-in-Europe has a large database of ICU patients. In particular, the database of the European ICUs-I study,[1] a Concerted Action included in the Biomed-1 Programme of the Commission of the European communities designed to assess the relationship between management and outcome, has available the following data for each of the included patients. Namely: a score for nursing workload (Nine Equivalents Nursing Manpower Score NEMS[2]) in each day record, a severity score at admission day (Simplified Acute Physiological Score: SAPS II), age, admission characteristics, length of stay, outcome. The study enrolled patients in 89 ICUs (adult general, medical or surgical) of 12 European Countries, selected by the national Coordinator on a voluntary basis. The selected Units had to be able, as judged by the presence of advanced technology and adequate human resources, to provide a medium-high level of care.[1, 3]

A huge amount of retrospective use of this database was done in the last 4 years aiming to set up a new friendly-to-use definition of grades of complexity/level of medical care supplied daily in the ICU at patient level.[4] Obviously, complexity of care was related to the observed (measured) activities of treatment in the ICUs.

The key role of this data to define the ICU's activity is very clear.

Four levels of intensive care were first described by the Bethesda Consensus Conference (BCC) in 1981.[5] This classification assumed that the average number of nurses per patient did indeed express the average complexity of the care required by the patients under treatment.

FRICE has reviewed these results [1] using the number of nursing staff per ICU-bed for the definitions of 3 levels of intensive care. A task force of the European Society of Intensive Care Medicine [3] has recently endorsed the conclusions of this study.

The new classification should enable the analysis and the comparison of the daily use of resources at patient level, offering at the same time, a simple methodology for guiding the planning of staffing the units. The classification should therefore use elements of care readily identified by clinical and non-clinical observers, offering ICU-

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TABLE I.—*List of NEMS[2] items used.*

Item	Description	Acronym
Basic monitoring	Hourly vital signs, regular record and calculation of fluid balance	m
Mechanical ventilatory support	Any form of mechanical/assisted ventilation, with or without PEEP, with or without muscle relaxants	**R**
Supplementary ventilatory care	Breathing spontaneously through endotracheal tube; supplementary oxygen any method	r
Single vaso-active medication	Any vaso-active drug	c
Multiple vaso-active medication	More than one vaso-active drug, disregarded type and dose	**C**
Dialysis techniques	All	d

TABLE II.—*Items used for classification of complexity of care[4].*

Complexity of care	Major criteria	Additional criteria	
High (HT)	MR	Mrc	
	mC	mrd	mcd
Low (LT)	mr	m	d
	mc	r	
	md	c	

managers a real-time available tool for the frequent appraisal and guidance of resource allocation in the unit.

Development of the instrument: summary of the research

The 6 NEMS items relating to organ failure were utilized for classifying complexity of daily medical treatment in the ICU (Table I).

Enrollment of patients was limited to those of whom the whole stay in the ICU coincided with the study period. Patients with missing values and/or discharged to "other ICU", or to "other hospital" were excluded if they were receiving "high complexity of care" at the moment of discharge.

Finally, data from 12,615 patients were used in the analysis. 55,464 daily NEMS records were available. The classification of complexity considers 2 levels of complexity of care: higher demands for care (HT: active support of 1 or more organ dysfunctions, utilizing advanced tech and moderate invasive support of at least 2 organs) and lower demands for care (LT). The description of these categories is summarized in Table II. It can be noted that HT includes levels of care II and III of the classification of ICUs according to FRICE.[1, 3] LT corresponded to level I of the same classification.[1, 3]

Table II does not describe all combinations possible. As a matter of facts, 22 different patterns of demands for care were identified by only 6 items: 14 aggregated as HT and 8 as LT.

Besides coinciding with the classifications based on the use of resources, the presented classification is based on clinical judgment and experience and, therefore it is readily recognized and meaningful to ICU-professionals. Moreover, it can be performed with a quick glance at the clinical data-sheet.

New insights on ICU organization

About 60% of this ICU bed-capacity was allocated to the "higher level of complexity" of care. Conversely, 40% of the ICU-bed capacity was dedicated to the "lower level of complexity" of care. These results are important, as they coincide with the classification of 3 levels of care proposed by FRICE and the ESICM. In a recent study [6] on the same case-mix, the bed capacity of the 2 more complex levels of care (levels III and II together), measured by the NEMS score in terms of nursing workload, totalled about 65%.

It is noteworthy that:

— Major high complexity criteria classified 85% of high complexity days, and

mechanical ventilation/CPAP was applied on 80% of high complexity days. Of note, *r±m* classified 60% of low complexity days, while *m* alone 31%.

— Patients admitted for HT, as well as patients with LT for the whole ICU stay, associated with different severity scores (as measured with SAPS-II). Interestingly, we found that SAPS II significantly overestimated the hospital mortality in the HT *R* and m*rc* categories, as well as in all LT categories. This overestimation involves about 70% of all patients.

— We found also that high complexity treatment occurring during ICU stay, as compared to low complexity for the entire stay, was associated with a risk of mortality 10 times higher in ICU and 5 times higher in the hospital. These differences were also consistent among all the patterns of demand of care aggregated into 2 complexity levels just on the day of admission. Moreover, a significant positive additive effect of the association of respiratory and/or circulatory support level in determining mortality was found.

— The number of consecutive high complexity days (called critical length of stay) also had a significant impact on the outcome, the longer this period and the higher the mortality. Three days length of high complexity seems to be the inflection point for ICU and hospital mortality.

Application in the field

New markers of ICU organization and performance are allowed by the complexity of care classification. One application of the instrument (even if in a preliminary version, not so different from the final one [7]) is just available. It concerns the assessment of the appropriateness of ICU resource utilization. Up to date, the appropriateness of ICU is inferred from the overall Unit occupation rate, even if this rate gives a misleading by optimistic impression of the level of ICU use. The appropriateness of ICU resource utilization should consider not only bed occupancy, *per se*, but also the treatment that is provided in that bed. Hence, it could be operatively defined as the use of high-facility beds to provide high level of care and low-facility beds to provide low level of care. Then the definition of the level of ICU beds activity is requested. High facility bed allows the performance of monitoring, mechanical ventilation, vaso-active drug infusion, dialysis, along with at least 1 nurse every 2 patients on a 24-hr basis. Low facility bed lacks advanced tech and has a lower nurse/patient ratio. Moreover, to identify the degree of appropriateness it is also mandatory to register, for a reasonable period of days, the complexity of care provided in each ICU bed.

The analysis for each ICU can be performed using 3 parameters: the overall bed occupancy rate, the high-level bed occupancy rate and (if the case) the low-level occupancy rate. Obviously, the accepted variability range has to be defined. For a busy ICU, 90-97% occupancy rate is considered reasonable.

According to available human and technological facilities, every ICU bed can be classified as able to provide high or low complexity care.

ICUs belong to 2 mutually exclusive groups: the one composed only of high facility beds and the other with a mix of high and low facility beds.

In ICUs with only high facility beds, overall occupancy rates less than 97-100% quantifies empty high facility beds. Of note, the difference between overall and high-level occupancy rate defines the rate of the high beds working at low level.

In ICUs with high and low facility beds (combination even more frequent than supposed) several different scenarios are possible.

— If overall, high and low facility beds occupation rates are less than 100%, both kind of beds are empty. These units could be over-dimensioned to their case-mix.

— Only high facility beds are empty when overall and high facility beds occupation rate is less than 100% and low facility

occupation rate is about 100%. These units are probably over-dimensioned in high facility beds.

— High facility beds (occupation rate less than 100%) are in part empty and in part inappropriately working at low level when the low facility occupation rate is greater than 100% (*i.e.* more low level treatment days than the possible ones according to the number of low facility beds). These units could have been over-dimensioned for high facility beds and under-dimensioned for low facility beds.

— Low facility beds are variably empty and in part are used for patients receiving high level care. This is demonstrated by the combination of low facility bed occupation rate less than 100% and high facility occupation rate greater than 100%.

In this scenario, the overall occupation rate about 100% clearly indicates an ICUs that inappropriately use low-facilities beds (*i.e.* inadequate resources for patients' severity).

Nevertheless, if the overall occupation rate is less than 100%, the patients could still be appropriately treated. In fact frequently, the only difference between high and low facility beds is the number of nurses actually available per patient and not the availability of advanced tech per bed.

In this sense, an ICU manager could solve the problem (the number of treated critically ill patients is bigger than it should be, considering the number of nurses actually available) by temporarily reducing the number of available low-facilities beds. This way, the nurses previously dedicated to these curtailed beds are shifted to the remaining low-facilities beds, enhancing their nurse/patient ratio and transforming them in high-facilities beds.

This kind of flexible ICU size could help the director of an ICU planned to have only high facility beds. As the use of the complexity of care instrument clearly demonstrates, every patient recently weaned from active procedures often needs a variable period of low level of care before safe discharge to the ward. In this period, the planned Unit-nurse patient ratio is too much even if all beds are full.

Generally, in a medium sized ICU, 2-3 patients are in this phase. The availability of space for a bed (oxygen, vacuum, non-invasive monitoring) additionally to the official high-facility beds, could allow the treatment of these patients in the posthigh complexity phase and, at the same time, of a further high level patient without increasing the number of nurses.

Such an adjustment is obviously possible in Units with at least 1 wide open room and 7-9 beds, the size shown to be the most effective based on mortality rate [6].

Moreover, this flexibility leads to a mix of intensive and intermediate beds particularly useful in hospital with only 1 ICU [8].

Our findings seem to confirm the utility of implementing in the ICU routine the use of complexity of care classification for a more appropriate admission and discharge policy based on calibration of available human resources and on the assessment of demand for care. Moreover, it facilitates the benchmarking process according to meaningful markers of clinical activity.

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Commento di:

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Classificazione giornaliera della complessità e dei livelli di cure. È possibile un controllo della gestione manageriale in una struttura di terapia intensiva?

La terapia intensiva è una funzione ad elevato impegno gestionale che necessita di una metodologia di controllo precisa e finalizzata a classificare in modo oggettivo la complessità degli aspetti manageriali che sono alla base dei processi di cura; è frequente che i pazienti ricoverati in terapia intensiva siano in condizioni critiche, a causa di malattie rapidamente evolutive e di tale gravità da essere considerati in serio pericolo per la vita; la risoluzione di tali scenari richiede il concorso di differenti strategie e in particolare di una analisi rigorosa della intensità delle cure erogate per giustificare l'entità delle risorse necessarie. Le unità di terapia intensiva per funzionare al meglio necessitano di determinati standard, in particolare: elevate capacità professionali, diagnostica e attrezzature di monitoraggio avanzate, disponibilità di fornire trattamenti sofisticati in grado di vicariare determinate funzioni vitali, possibilità di utilizzare terapie farmacologiche impegnative. L'organizzazione della terapia intensiva è un aspetto importante e in tale contesto si è sviluppato l'interesse per i ricercatori e i clinici ad individuare determinati parametri di controllo utili per valutare la differente complessità dei carichi di attività assitenziale; in particolare, se si considerano le unità ad elevata e a bassa intensità di cure. L'argomento è di grande interesse; il Prof. Iapichino esperto del settore offre ai cultori della materia un interessante spunto di aggiornamento sulla gestione manageriale di una struttura ad elevata criticità come la terapia intensiva.