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SPECIAL ARTICLE

Physician staffing needs in critical care departments☆

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Abstract Departments of Critical Care Medicine are characterized by high medical assistance costs and great complexity. Published recommendations on determining the needs of medical staff in the DCCM are based on low levels of evidence and attribute excessive significance to the structural/welfare approach (physician-to-beds ratio), thus generating incomplete and minimalistic information. The Spanish Society of Intensive Care Medicine and Coronary Units established a Technical Committee of experts, the purpose of which was to draft recommendations regarding requirements for medical professionals in the ICU. The Technical Committee

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defined the following categories: (1) patient care-related aspects; (2) activities outside the ICU; (3) patient safety and clinical management aspects; (4) teaching; and (5) research. A subcommittee was established with experts pertaining to each activity category, defining criteria for quantifying the percentage time of the intensivists dedicated to each task, and taking into account occupational category. A quantitative method was applied, the parameters of which were the number of procedures or tasks and the respective estimated indicative times for patient care-related activities within or outside the context of the DCCM, as well as for teaching and research activities. Regarding non-instrumental activities, which are more difficult to evaluate in real time, a matrix of range versus productivity was applied, defining approximate percentages according to occupational category. All activities and indicative times were tabulated, and a spreadsheet was created that modified a previously designed model in order to perform calculations according to the total sum of hours worked and the hours stipulated in the respective work contract. The competencies needed and the tasks which a Department of Critical Care Medicine professional must perform far exceed those of a purely patient care-related character, and cannot be quantified using structural criteria. The method for describing the 5 types of activity, the quantification of specific tasks, the respective times needed for each task, and the generation of a spreadsheet led to the creation of a management instrument.

PALABRAS CLAVE
Actividad;
Servicio medicina intensiva;
Unidad de cuidados intensivos

Estimación de las necesidades de profesionales médicos en los servicios de medicina intensiva

Resumen Los servicios de medicina intensiva se asocian a una alta complejidad asistencial y un alto coste monetario. Las recomendaciones sobre el cálculo de las necesidades de intensivistas adolecen de baja evidencia y favorecen un criterio estructural y asistencial (proporción médico/camas), lo que origina modelos reduccionistas. La Sociedad Española de Medicina Intensiva y Unidades Coronarias constituyó una comisión técnica para redactar unas recomendaciones sobre la necesidad de intensivistas en los servicios de medicina intensiva. La comisión técnica definió 5 actividades: 1) asistencial; 2) actividades extra-UCI; 3) seguridad del paciente y gestión clínica; 4) docencia; y 5) investigación. Para cada actividad o categoría se crearon subcomités específicos que definieron criterios para cuantificar el porcentaje que supone cada tarea para los intensivistas por rango profesional. Para las actividades asistenciales dentro y fuera de la UCI, y también para las actividades docentes e investigadoras, se siguió un sistema cuantitativo del número de procedimientos o tareas por tiempos estimados. En relación con las actividades no instrumentales, más difíciles de evaluar en tiempo real, se siguió una matriz de ámbito/productividad, definiendo los porcentajes aproximados de tiempo dedicado por categoría profesional. Se elaboró una hoja de cálculo, modificando un modelo previo, atendiendo la suma de horas estipuladas por contrato. Las competencias exigidas van más allá de la asistencia intra-UCI, y no pueden calcularse bajo criterios estructurales. La metodología sobre 5 actividades, la cuantificación de sus tareas específicas y tiempos y la construcción de una hoja de cálculo generan un instrumento adecuado de gestión.

Introduction

Productivity in critical care medicine departments (CCMD) is a complex issue, and costs are high, which is why it is absolutely justified to address the problem of the workforce sizing of intensivists. There have been intensive care (IC) societies that have elaborated recommendations on the needs for intensivists[1,2] based on very different healthcare models on the management of critical patients (CP) rather than on adequacy analyses of the intensivists' productivity by measuring the intensivist/bed ratios (the reference source is shown in electronic tables 1,[3–11] 2[1,2,12–15] and 3[5,16,17] of additional material). In Spain, several recommendations have been proposed,[14] but all with the same philosophy of taking the doctor/bed ratio into consideration. Since they do not take productivity into consideration, such recommendations have called for reducing the number of intensivists. For all these reasons, in 2013, the Spanish Society of Intensive Care Medicine and Coronary Units established a technical taskforce of experts to assess the reference sources and recommendations from other similar societies, provide its own experience, and elaborate recommendations on the

need for intensivists in the CCMD setting including their entire productivity, and a method to estimate the real number of intensivists needed (see the spreadsheet provided in the additional material). These recommendations should include the existing new trends on the management of CPs, issues of economic effectiveness and efficiency, and giving explicit value to the intensivists' know-how.

Methodology

The technical taskforce including eight expert intensivists categorized productivity into the following five areas of knowledge (or 5 subcommittees) corresponding to five activities that make up the service portfolio of most CCMDs: (1) healthcare; (2) activities outside the ICU (AO-ICU); (3) research; (4) teaching; and (5) patient safety (PS) and clinical management (CM). Two senior intensivists joined this technical committee and collected all the feedback (FG, EP).

The reference search included four databases: PubMed, Excerpta Medica data BASE (EMBASE), the Index of Scientific and Technical Literature of Latin America and the Caribbean (LILACS), and the Spanish Bibliographic Index of Health Sciences (IBECS); 845 references were found from the year 2000 (including prior quotations when needed) to the year 2015 that were reduced to 155 and then categorized based on the aforementioned five subcommittees.

The results from each subcommittee are expressed in a double way. On the one hand, the activities to be conducted (healthcare, AO-ICU, teaching, research, and CM/PS) are listed, and, on the other hand, the time that every intensivist spends conducting each activity expressed in activity percentage. For the time estimate a double methodology was used based on whether we would be dealing with healthcare activities or less instrumental activities. When it comes to healthcare activities—internal (within the ICU) and outside the CCMD, they can easily be measured using experience and elaborated by consensus from the subcommittee, yet we are talking about illustrative time frames so that every CCMD can present its best value based on its structural reality and logistics, while making recommendations that the final value should be feasible and reproducible in case of authorship. When it comes to less instrumental activities—research, teaching, and CM/PS, assessment is more difficult both in its type and time spent, which is why choosing one qualitative criterion can always be arbitrary. In view of all this, one tool was used for the CM of CPs: the setting/productivity matrix of the critical patient (PMCP)[18] (Table 1) that stipulates what percentages of time each intensivist spends, based on his professional category, doing each and every one of the five activities associated with the management of CPs. This PMCP is generic yet associated to the singularities of each CCMD, in particular, being 100 the maximum percentage of time spent for allocation purposes. The PMCP makes no sense if we consider the ICU but not the CCMD when only implemented it to pick up the activity occurring inside and outside the ICU. The PMCP vertical axis describes the physical action setting of the team managing the CP (with allocated time percentages) and the PMCP

Table 1 PMCP pertaining to ''healthcare''; ''activities outside the ICU''; ''research''; ''clinical management''; and management and safety of a generic internal medicine unit with 5 physician assistants; 1 clinical director, and 1 service director.

Setting/activity	Healthcare subcommittee 1	Teaching subcommittee 2	Research subcommittee 3	Clinical M. subcommittee 4	M. and safety subcommittee 5
ICU	PA 1 60%	10%	10%	5%	15%
	PA 2 60%	10%	10%	5%	15%
	PA 3 60%	10%	10%	5%	15%
	CD 20%	10%	10%	15%	20%[a]
	SD 10%	10%	10%	40%	15%[a]
SICU	PA 4 30%	10%	10%	5%	15%
	PA 5 30%	10%	10%	5%	15%
	CD 10%				
	SD 5%				
Hospital floor	PA 4 10%				
	PA 5 10%				
	CD 5%				
	SD 5%				
Post-critical *Emergency room*	PA 4 20%				
	PA 5 20%				
	CD 10%				
	SD 5%				

AO-ICU: activities outside the ICU; CD: clinical director; SD: service director; PA: physician assistant; IMR: internal medical residents; ICU: intensive care unit; SICU: semi-intensive care unit.

[a] These specific percentages are interchangeable whenever a PA has a more significant participation in a safety committee or risk committee.

horizontal axis shows the specific productivity (with allocated time percentages). It is assumed that depending on this or that autonomous community and this or that labor contract, every intensivist should have three possible annual schedules: 1825 h (or 40 h/week), or 1750 h (or 38 h/week), or 1711 h (or 37.5 h/week).

Finally, the time frames and activities established by every subcommittee were tabulated in a spreadsheet derived from another spreadsheet developed by 3 German authors (MW, TI and GM)[19] that these authors helped modify; such a spreadsheet was used as the basis for the ultimate spreadsheet proposal (see additional material). One expert physician savvy on spreadsheets and databases (EG) developed the final model.

Results

Management and healthcare activities in the intensive care unit

The healthcare activities and estimate time frames occurring within the ICU are shown in Table 2 and they have to do with the hospitalizations of patients, with routine daily care, with hospital discharges, clinical sessions, and with extraordinary administrative procedures. The healthcare activities occurring within the ICU associate procedures and estimate time frames that are shown in Table 3. Using the PMCP, the time percentages spent conducting healthcare activities within the ICU and tabulated by professional category are shown in Table 1.

Managerial and healthcare activities conducted outside the intensive care unit

The AO-ICU illustrates both the management of a CP outside the ICU (not necessarily an emergency) and the prevention of critical conditions, normally with regard to one or more organic dysfunctions. In other words, AO-ICU intends to improve morbimortality through: (1) the early detection of the CP outside the ICU; and (2) the early implementation of healthcare initiatives. The AO-ICU can be ''instrumental'' and ''non-instrumental'', or respectively, activities associated with any given diagnostic and/or therapeutic procedure or activities associated with a certain type of patient—including, or not, the CP code. The ''instrumental'' activities requiring transfer of CPs outside the ICU to perform this or that diagnostic and/or therapeutic procedure such as CAT scans are shown in Table 4, as well as the 9 ''non-instrumental'' activities. The specific time frames of these ''non-instrumental'' activities are shown in electronic Table 4 (see additional material) including the four basic codes for the CP. These time frames are not an absolute written-in-stone description of the activities but are probably common to 90% of all Spanish CCMDs. See the differences and distinctive features based on whether the patient is: ''non-critical''; ''critical'' (''reversible'' or ''reversible with limitations of life-support therapy''); ''sub-critical''; and ''post-critical''. The time percentages spent to AO-ICU by professional category are also shown in Table 1.

Table 2 Routine healthcare activity time frames in the CCMD.

Procedure	Time (min)
Admission	
Hospital reception of the patient	5
Clinical medical examination	5
Request diagnostic testing	5
Write clinical history in the CCMD	20
Write down the therapy	10
Achieve basic diagnoses	5
Interviews with other specialists involved	5
Information for next shift staffing	5
Combined pass (if it comes to that)	5
Daily routine	
Medical examination in the CCMD	5
Write down the clinical evolution	10
Write down the therapy	5
Interhospital transfers	5
Interviews with other specialists (microbiology, radiodiagnosis, others)	15
Information to family members	10
Reference search for the case	10
Medical/nursing common goals	3
Discharge or transfer	
Final medical examination	3
Gather documentation to write the report	15
Write the report	20
Contact the destination hospital and physicians in charge of the transfer	15
Special administrative proceedings	
Medical reports detailed for judiciary organizations and insurance companies	15
Death certificate	15
Visits or shift changes	
The following data will need to be entered:	
Specify the number of sessions in business days, Saturdays, Sundays and public holidays	
Detail the number of doctors per patient	
Indicate time spent with every patient	

CCMD: critical care medicine department.

Research activities

In this document and for the sake of scientific research we have imagined a generic CCMD with the following percentage of intensivists to perform all of its activities: ''physician assistant'' 65–0%; ''clinical director'': 20–25%; and ''service director'': 10%. Neither doctors on call or residents were included basically because their duties have to do with healthcare and because they are on a training contract. The time percentages translated into hours for the sake of research using the PMCP and other activities performed by the intensivists are shown in Table 1. In the example showed and to make it easier, none of those seven doctors would practice prehospital AO-ICU. Always according to this matrix, the following would be the annual hour

Table 3 Procedures performed at the intensive care unit.

Procedures	Time (min)
Paracentesis	15
Insertion of venous catheters	15
Insertion of arterial catheters	15
Diagnostic bronchoscopy	40
Interpretation of hemodynamic data (termodilution catheter/PiCCO)	15
Liver function monitoring system (LIMON and the like)	30
RRT (heparin)/establish-change[a]	30
RRT (citrate)/establish-change[a]	40
Segstaken–Blakemore probe	30
Monitoring of de hepatic dialysis[a]	120
Thromboelastography	20
Decubitus position	20
Blood transfusion/hemoderivatives/procoagulant agents (per unit)*	5
Scheduled cardioversion	15
Insertion of thermodilution catheter (Swan/Picco/Lidco)	40
Extracorporeal membrane oxygenation	60
Measurement of intracranial pressure	20
Transcranial Doppler ultrasound	15
Lumbar puncture	30
Endotracheal intubation	15
Non-invasive mechanical ventilation	20
Patient transfer to/from the operating room	20
Patient isolation/day	10
Implantation of epidural catheter	15
Pericardiocentesis	30
Thoracocentesis	15
Transesophageal echocardiogram	40
Transthoracic echocardiogram	15
Thoracic drainage	30
Percutaneous tracheostomy (dilation/plastic)	45
Temporary transvenous pacemaker	30
Transcutaneous pacemaker	3
Definitive pacemaker[b]	90

CCMD: critical care medicine department; RRT: renal replacement therapy; ICU: intensive care unit.
[a] Whether it is done by intensivists.
[b] Whether it is implanted by intensivists.

Table 4 Techniques conducted outside the intensive care unit that require transfer and instrumental activities conducted outside the ICU.

Procedure	Time (min)
Coronary angiography (diagnostic/interventional)	75–90
Medical examination[a]	45
Wiring/unwiring	20
Transfer to a different hospital	30
Transfer to the unit of hemodynamics in-house	15
Brain angiography	
Medical examination[b]	150
Wiring/unwiring	20
Transfer	20
Other angiographic procedures	85
Medical examination[a]	45
Wiring/unwiring	20
Transfer	20
CT scan	45
Medical examination[a]	20
Wiring/unwiring	20
Transfer time	20
MR	65
Medical examination[a]	20
Wiring/unwiring	30
Transfer time	15

Instrumental activities in AO-ICU and time requirements

Activity	Time (min)
Sedation and analgesia	75
Cardioversion	65
Central venous vascular access	75
Non-invasive mechanical ventilation	100
Total parenteral nutrition	5
''ABC'' (airway, breathing, circulation)	15
Advanced life-support	76.5
Early inter-hospital transfer	35
Emergency medical teams	49

AO-ICU: activities outside the ICU; ICU: intensive care unit.
[a] Time based on whether the procedure takes place in the hospital or a reference center.
[b] Take into account the presence of the intensivist in the room, if necessary.

allocation for the three categories (physician assistant; clinical director, and service director): 175 annual hours per physician (10%), that is, out of a team of 7 physicians with an overall annual contract of 1250 h, an annual set of 1225 h would be explicitly assigned to research, which is equivalent to 70% of a single physician's working day.

Activities that have to do with teaching and college

Training needs to be continuing medical education (CME) after students become college graduates.[20] When it comes to college teaching this can be easily seen in the greater number of medical schools, elective subjects, use of simulations and objective, structured clinical assessments.[21] When it comes to post-graduate degree teaching[22] in order to do quality teaching in the CCMD, accreditations abiding not only by the specialty official program but also by the competences of the European program CoBaTrICE[23,24] are required. Although CME is not regulated,[25] it is certainly necessary. The fact that the intensivists from a CCMD teach college degrees, post-graduate degrees and CME programs is clearly beneficial but requires time and effort that even though is hard to ponder on, should be taken into consideration when designing the staff of intensivists. How should we determine the time that specialists

Table 5 Teaching and continuing medical education (CME) in the Autonomous Community of Madrid.

	Time	Credits (career development program)
CME		
Masters degree	300 h	8
Graduate degree	150 h	4
Accredited courses	20 h	0.75[a]
Training stays	1 month	0.25
Teaching		
Degree, post-graduate degree, and CME	20 h	1
Lectures	20 h	1
Tutors	4 months	1
Doctoral thesis defense (presented and passed)	1 thesis	4

[a] Equivalent to two credits in CME.

should spend teaching—both as instructors and teachers? One possible recommendation would be following the actual legislation.[26,27] In order to make an approximate estimate of the time that intensivists should spend participating in CME programs and teaching, the rules and regulations published by different health systems from different autonomous communities such as the Health Department from the Community of Madrid[28] (shown in Table 5) should be observed. The additional material shows the activities that would be recognized as CME programs and teaching that give physicians points to promote their professional careers in compliance with the rules from the Health Department from the Community of Madrid. For example, and always from the perspective of this community, intensivists should dedicate 40 h/year to training, and 20 h/year to teaching. additional material (electronic Table 5) also shows the activities and amount of time that intensivists should spend teaching.

Activities related to the patient's clinical management and safety

There is no doubt that healthcare, teaching and research are still at the heart of all medical specialties, and during the last few decades, we have witnessed the birth of two new complementary concepts: CM and PS. When it comes to CPs, the CM is defined as the set of coordinate actions within a given CCMD aimed at achieving effectiveness and efficacy. The CCMD operates as a healthcare responsibility center in the understanding that the CP is managed both in and out of the ICU (e.g. expansion of the CCMD areas of competence and healthcare grading). It promotes and implements scientific knowledge for the management of CPs, while abiding by the clinical practice guidelines, and set of recommendations elaborated by its scientific committees and technical taskforces. CM refers to the participation of healthcare professionals in the management of the CCMD by promoting that these professionals establish not ''what''—reserved for the hospital management and the corporate strategy, but ''how'' healthcare, teaching, and research should really be. The quality of healthcare aims at the CP, based on process management, and is carried out by healthcare professionals during the management of CPs, using the right competences and training, specific means, specific clinical information systems and documentation based on the existing medical literature.

The CCMDs have the responsibility of defining, gathering, and analyzing all the information coming from the risk management system on achieving security goals, effective operational programs, and briefing on any PS-associated incidents. The activities and time spent on CM/PS are shown in electronic Table 6 (see additional material). Adjusted by professional categories, each physician should spend a certain amount of time on CM/PS. These are percentages estimated by the experience accumulated, which means that they are, inevitably, generic. In order to make these percentages logical, the time percentages associated with ''healthcare''; ''teaching'' and ''research'' adjusted by professional category should be on the record. When it comes to the PMCP, and assuming that a working day amounts to 1750 h, the time percentages translated into hours for the CM/PS combo should be like the ones shown in Table 1, that shows the percentages of all the intensivists' activities according to their professional setting. The overall time estimates for the hours spent on CM and PS, and the participation in hospital committees are shown in Table 1 too.

Discussion

After reviewing the reference sources on the staff of intensivists, several important organizational conclusions can be drawn that can be generalized to the staffing models of the United States, Europe, and Spain; conclusions, however, that do not provide one valid, single rule to estimate when the intensivists are really needed. When it comes to Europe (where High Intensity Staffing is predominant), in its staffing recommendations, the ESCIM only provides one rule to make the calculation without giving any fixed numbers.[1] Recently, the World Federation of Societies of Intensive and Critical Care Medicine discussed the disparities, in the Western world, on the management of CPs,[29] including the amount of emergency rooms per 100,000 inhabitants, and the disparity of emergency rooms depending on whether we are in metropolitan or rural areas. It goes without saying that when non-Western countries are included in this analysis (World Federation), disparities are just huge.

In Spain, the Standards of Healthcare in Intensive Care Units[14]—a model that was similar to the European one, were published in 2010:

a. *Level III Medical* and Surgical *Critical Care* Unit: one full time intensivist for every 4–5 patients from 8:00 to 18:00 h, plus one intensivist for every 12 patients from 18:00 to 8:00 h—Saturdays and public holiday included.
b. *Level II Medical* and Surgical *Critical Care* Unit: one intensivist for every 6–10 patients from 8:00 to 18:00 h—Saturdays and public holiday included, plus one intensivist from 18:00 to 8:00 h.
c. *Level I Medical* and Surgical *Critical Care* Unit: one intensivist for every 8–12 patients.

With such model disparity and low level of evidence in the reviewed medical literature we can only do approximate estimates of the intensivist/bed ratio, and adjust the Spanish model per hour and ICU healthcare level. The technical taskforce responsible for this document considered that even though these formulas are easy to get, they under or overestimate the workforce needed based on the level of activity. Not always a fixed number of beds is consistent, in a linear way, with this or that level of activity. These premises are based on a concept of a Spanish intensive care healthcare model characterized by CCMDs as structures that determine professional development, activity-based management (whether input-based, or intermediate results-based), the superficial distinction between healthcare/teaching/research in the daily work, the ''convenience'' and adaptation to the vertical hospital organization chart, and a full-time commitment to CPs, or the CCMD. It is evident that this situation can generate inefficiencies when the actual productivity is not adjusted to the estimated productivity based on the CCMD size, or case-mix.

While trying to come up with an answer to a key question to the problem of what the workforce sizing of intensivists should be in ICUs in the United States, the capacity to sustain such staff and the structure of a controversial model of management of the CP in this country has been put into question.[30] Only in the United States, the authors identify a breach between the number of intensivists for the management of actual and future CPs; but if we really want to solve this problem, we should not hire or train more intensivists for the following reasons: (a) training is expensive; (b) if more intensivists were hired, they would probably not be assigned where, theoretically speaking, they are more widely needed—rural areas, but metropolitan areas; (c) the management of CPs is both inter and multidisciplinary; and (d) if this lack of intensivists is common to other 22 medical specialties, why should we make the intensivist management of CPs a priority and sideline other medical specialists? Basically, the problem of this lack of intensivists is more of an offer/supply mismatch rather than a real need, which would lead us to two possible solutions: (1) improving healthcare and not the number of intensivists; and (2) reducing the number of CPs by not allowing more new beds in ICUs through a specific legal framework, by establishing triage policies, and limiting the life-support therapies.

One alternative approach that would help estimate more efficiently the actual need for intensivists would be to consider a model that incorporates the notion that the intensivist should follow the CP wherever he may be, and reject the notion that the physical structure conditions the number of intensivists. Other than keeping full-time commitment to the CP, the intensivist's management of healthcare should be implemented where needed (expansion of the CCMD). Even so, in Spain a CCMD should include a holistic healthcare spectrum and gradation system for the management of CPs such as ICUs, SICUs, medical emergency teams, emergency rooms, hospital floors, subcritical patients, post-critical patients, pre-hospital patients, etc. One way to contribute to the non-exclusive expansion of the CCMD would be process organization through functional units led by intensivists guaranteeing the observance of a certain healthcare continuum, both through competences and feasible economic plans (or when the simultaneous production of various outputs in a single institution is cheaper than the individual production of such outputs, such as the hospital management of CPs, and not just the ICU management of CPs).

The professionals included in this model would be intensivists whose training is already defined in the official program of their specialty both through the CoBaTriCE program and the guides and protocols of every CCMD.[24] The CCMDs that abide by this model should have the participation of 24/7 full-time intensivists. There are several arguments to justify this statement: (a) healthcare reasons—since there are physicians responsible for every CP that guarantee the ongoing care of CPs and allow multidisciplinary and interdisciplinary interactions in and out of the ICU; (b) pedagogical reasons—teachers who already teach within the CCMD; (c) research reasons—basic, applied and translational research, since research activities are conducted within the CCMD; (d) CM reasons—generation of scale economies (price cut by concentration) projected into the future with higher healthcare and economic efficiency; the socialization of knowledge and a reduced variability in the clinical practice; and (e) PS reasons—implementation of a CP-specific risk management system. If we assume this CCMD model, those specialists working in such a model should perform ICU healthcare-oriented activities, AO-ICU, teaching and research activities, and initiatives aimed at promoting CM and PS. Thus, the actual activity of a CCMD cannot be based on the obsolete, rigid notion of the number of beds anymore, since this notion only includes the healthcare activity taking place within the CCMD assuming that there is a conceptual linearity among the structure, the possible severity and measurable activities. The medical staff should be reckoned by the CCMD actual overall productivity (outputs), regardless of the number of beds assigned, in all activities that have to do with the management of CPs. This productivity metrics includes the total number of activities performed every year divided by the time spent conducting every activity. The number of physicians should be obtained by dividing the overall activity time by the maximum number of annual hours established by the labor contract. Now, how can we make an estimate of this activity and assess it effectively? Well, we would start by assessing the amount of time spent implementing classic, routine healthcare activities, procedures for the management of UCI patients, plus EAUCI instrumental activities, and measurable and describable time frames in a potentially agreed range.

If we take into account that in many CCMDs, the teaching and research activities happen outside the intensivists' working schedule, it seems difficult to try to assess the necessary time, or time spent doing these less ''instrumental'' tasks such as teaching, research, CM, and PS. One approach to this would be to establish one illustrative PMCP with fixed scheduled activity percentages (healthcare, management, teaching, research). In this document, this tool has been used to be able to make an estimate of the research activity going on, and the activities aimed at implementing CM and PS. However, and because all matrixes are merely illustrative, a system with different levels of healthcare, service portfolios, and teaching/research capabilities cannot be imposed on all CCMDs as the only valid model. Different CCMDs will score different final percentages, making it hard to come up with the exact number of intensivists needed.

Nevertheless, this can be a valid tool if we just wish to make estimates when the activity is hardly measurable, such as in this case. There is a different model, suggested by German authors[7] that we think may suit the reality of the proposed intensivist variable activity better. In this formula, the needs for intensivists follows the actual activity measured in hours, according to a available amount of hours, based on the legal working hours. Therefore, the measurement and quantification of activity is essential to know if what is being done equals a higher number than the hourly capabilities of the available ''workforce''. To this end, the activities conducted in every CCMD and its available working hours are measured. Then the healthcare provided by the staff is divided by the time working load (days, shifts of different duration), while observing the organizational peculiarities of every CCMD. This model includes three sequential steps. The first step being the definition of the basic tasks within a services portfolio representative of most Spanish CCMDs. The second step being the estimate of illustrative, average time frames adjusted for the peculiarities of each CCMD, valid enough to allow external auditing. And the last step being the total number of yearly tasks and patients, that will later be multiplied by the estimate time frames for each task and patient. This is how we will achieve the sum of the annual working load, healthcare activities (at the ICU and AO-ICU), and non-healthcare activities (teaching, CME, research, CM and PS), that we will later divide by the average hours established by the labor contract—always within the legal framework and always being respectful of the PS, to finally achieve the right number of intensivists needed.

The limitations of this paper already appear in the methodology. Time frames are illustrative and mainly based on the opinions of experts and medical literature. Time frames that should necessarily vary based on the structure and conditions of every CCMD, but also true and externally auditable time frames. The estimate method proposed requires a trustworthy, reliable, and sustainable clinical management information system. A priori this fact may be a barrier that makes estimation hard to achieve. In short, it will be a mandatory requirement for all CCMDs—documenting their healthcare activity through a minimal, basic set of data chosen by the CCMD, and providing diagnostic, severity, and procedural data. Failure to do so leads to a lack of transparency unfit for the needs of both patients and healthcare managers. The latter may not enlarge their roster of intensivists if not justified through documentation and proven through a comprehensive and externally auditable tool.

To make the estimates easier for the professionals who decides to implement this proposal, as additional material, the Excel spreadsheet® adapted by Weiss[19] to the Spanish model mentioned has been included, with information on how to fill out its tabs, with generic recommendations and examples. This spreadsheet has been tested by the authors at their respective centers and the unpublished results obtained are very similar to one another—of course this is a temporary statement until the tests go public. Once the right number of intensivists has been achieved, the intensivists can be allocated in shifts and calls through specific regulations as shown on the spreadsheet. In this sense, the proposal from this technical taskforce establishes with the total number of physicians that are needed in a CCMD. The tool used to make the calculations helps achieve this number based on different labor contracts and schedules, but it is useless if we want to allocate the staff based on temporal segments (hours, days) consistent with higher peaks of activity. The hour estimate provided by this document is annual, and not hourly or weekday-based. Following a certain methodological coherence, the proposal intentionally runs away from giving any fixed recommendations on how to allocate the staff. And this is so based on the fact that it is impossible to contemplate every single situation of every single CCMD and center, not even arbitrarily estimate a supposedly majoritarian setting; every CCMD has its own organizational idiosyncrasy that determines the allocation of intensivists in shifts and calls. It is plain to see that this is something that worries the directors of CCMDs, and there is no doubt that not having some sort of drive on this regard can be frustrating.

We did not want to betray the philosophy of our work and in order to help these professionals, we wanted to offer step-by-step premises for the allocation of intensivists in a CCMD: (1) quantify the number of CCMD admissions per hour and day of the week. The presence admissions of a certain kind (such as surgical block) should also be taken into consideration. (2) Write down the hourly and weekly allocation of this or that technique, important AO-ICU in the service portfolio of both the CCMD and the hospital; (3) assess the schedule assigned to teaching, research or CM/PS activities, especially when this happens outside the morning schedule; (4) draw charts including results for managers to see through one comprehensive proposal, while giving relevance to the most time-consuming tasks that are more important on both the healthcare and strategic levels. Always have the hospital mission statement present—mission, vision, values. It is useful to present the data from the spreadsheet suggested in this document; and (5) try to negotiate if it is contractually possible to reach an agreement with good-hearted staff on the actual demand. One of the limitations of this proposal is that it is not applicable during the CCMD first operational year in brand new hospitals, which is why it has been resized facing the possibility of future merges or growth. It is obvious that during the first year, the staffing needs will be different from the needs that may arise during longer time frames with more consolidated activities. Yet when it comes to staffing needs, comparisons with prior experiences can be useful if we wish to set a starting point and a 3–5-year horizon. Also, the estimate suggested could be drawn the very first year in order to document the activity trend.

Conclusions

The model of intensive medicine and that of all CCMDs needs to change following criteria of effectiveness and efficiency. The competences and tasks that an intensivist is required to do go far beyond the mere healthcare duties of an ICU (e.g. AO-ICU, teaching, research, risk management-RM, CM and PS) and cannot be estimated following uniform structural criteria. Every CCMD should be assessed individually when it comes to the actual overall productivity. Both the methodology and task and time description of every one of the aforementioned five specific activities enables every CCMD

to use the tools assigned in an estimate-based spreadsheet by entering verifiable and auditable specific information—both in number and time, and then obtaining adjusted estimates. The tool based on the premise of information and not on supposed qualitative data is one management tool that can be understood, checked and, then, taken into consideration by all managing teams and healthcare systems, in an attempt to guarantee the intensivist that we are dealing with one methodology that can be put to the test. In sum, through a necessarily qualitative spreadsheet, we believe it is feasible to estimate the real needs of intensivist staffs both based on the expansion of the CCMD, and its maximum productivity (healthcare, AO-ICU, teaching, research, RM, CM and PS). Finally, the quantification of the number of intensivists involved in the overall productivity of every CCMD leads us to asking two different questions: What do physicians who work in a responsibility center—the CCMD produce that eats away a significant chunk of the hospital budget? And what intrinsic value do these physicians generate by grading their knowledge in five different activities?

If we keep in mind that the short-term projection in healthcare, in the Western world, is that hospitals will be admitting more and more critical patients, and refer less critical or chronic patients to alternatives different than hospitalization (expansion), we can say that the need for CCMDs and well-prepared intensivists for the management of CPs will grow consequently. Maybe part of the intensivists' mission who manage CPs should be facing this apparent paradox: do whatever necessary so that patients do not progress into CPs, and do whatever necessary when this progression actually happens.

Conflict of interests

The authors of this paper declare no conflicts of interest whatsoever.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.medine.2017.12.001.

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