Artículo especial

Critical care medicine in the hospital: lessons from the EURICUS-studies

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We have performed a retrospective analysis of the EURICUS-studies using their database at the Foundation for Research on Intensive Care in Europe (FRICE) and other related documents, among which the various reports produced to the European Union which granted the studies, with the following purposes: a) to select and describe the most relevant observational and experimental results of the EURICUS studies; b) to inventory the main obstacles to the appropriate organization of intensive care medicine in the Hospital and c) to highlight amid the acquired knowledge those subjects which could have a direct and primary impact for improving the organization and management of intensive care units (ICUs). The EURICUS-studies have shown a rather non-systematic variation on the variables of the organization and management, resulting in a significant waste of resources and in a generally perceived insufficient performance of ICUs in Europe. Three major roadblocks were found: a) the lack of a clear concept of Critical Care Medicine; b) the lack of defined objectives both regarding the planning of the facilities and the activities to be developed in the ICU and c) the lack of a purposeful organization and management of work in the ICU. The further development and integration of each ICU in the Hospital should consider the following: a) the system approach to the analysis and standardization of processes of care; b) the redefinition of all jobs in each ICU; c) the definition of patient/nurse ratios in each ICU and sibling departments and d) to professionalize the organization and management of the ICU.

KEY WORDS: *EURICUS studies, organization and management, processes of care, job-analysis.*

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LA MEDICINA CRÍTICA EN EL HOSPITAL: UNA LECCIÓN DE LOS ESTUDIOS EURICUS

Hemos hecho un análisis retrospectivo de los estudios EURICUS, usando la base de datos de la Fundación para la Investigación en Medicina Intensiva en Europa (FRICE) y otros documentos relacionados, incluyendo los diferentes informes dirigidos a la Unión Europea, la cual financió los estudios, con los siguientes objetivos: a) seleccionar y describir los resultados más relevantes de los estudios tanto observacionales como experimentales EURICUS; b) hacer un inventario de los principales obstáculos a la organización óptima de la medicina intensiva en los hospitales y c) destacar los temas entre los conocimientos adquiridos que puedan tener un impacto directo y primario en la mejora de la organización y dirección de las Unidades de Cuidados Intensivos (UCI). Los estudios EURICUS han revelado una variación considerablemente no sistemática en las variables relacionadas con la organización y dirección, con el resultado de un malgasto importante de recursos y un rendimiento de las UCI en Europa que generalmente se considera insuficiente. Se encontraron tres obstáculos mayores: a) la falta de un concepto claro de la medicina intensiva; b) la falta de objetivos definidos, tanto en la planificación de las instalaciones como en las actividades a desarrollar en la UCI y c) la falta de una organización y dirección decisiva del trabajo en la UCI. En el desarrollo y la integración de la UCI en los hospitales se debería considerar

cada uno de los siguientes: a) el abordaje sistemático integrado *(system approach)* al análisis y estandardización de los procesos médicos; b) la redefinición de todos los trabajos en la UCI; c) la definición de la ratio paciente/enfermera en cada UCI y departamentos relacionados y d) la profesionalización de la organización y dirección de la UCI.

PALABRAS CLAVE: *estudios EURICUS, organización y dirección, procesos médicos, análisis de trabajo.*

THE EURICUS PROJECT

In 1986, an international group of 19 researchers in the health care organized a three-days meeting in Groningen, the Netherlands, for discussing the integration of the critical care medicine (CCM) activities in the organization of the modern hospital. A report of this meeting was published[1]. In the sequence of that work, an European multidisciplinary group composed by 25 researchers was formed, with the aim of defining the instruments required for the study of clinical and non-clinical performance of intensive care units (ICUs) in Europe. This work lead to the publication of a manuscript called «Management of intensive care: guidelines for better use of resources»[2].

A rather stable network of European researchers was created along the years. It was then found necessary to create a formal structure which might give effective strategic insight and guidance to the research activities to be developed by the truly multidisciplinary network: The Foundation for Research on Intensive Care in Europe (FRICE) was born in 1989.

FRICE designed a large research project to study ICUs as a health care sub-system in the countries of the European Union using a methodology based on the «general system theory» in which the relations between inputs: throughput: outputs come under analysis (see below for more detail). This project was called EURICUS (European ICU Studies).

Given its complexity, the project was divided into complementary studies. Three studies have been performed: a) EURICUS-I, or the effect of organization and management on the effectiveness and the efficiency of ICUs in the countries of the European Union; b) EURICUS-II (prospective intervention/control randomized study), or the effect of harmonizing and standardizing the nursing tasks on the ICUs and c) EURICUS-III (prospective intervention/control randomized study), or the implementation of guidelines for budget control and cost calculation, and their effect on the quality of management of ICUs. These studies have been accomplished as Concerted Actions in the BIOMED Research Programs (1 and 2) of the European Union.

TABLE 1. **Intensive care capacity in the hospital. Percentage of hospital beds allocated to the ICUs in the hospital**

	% hospital beds
Austria	2.8
Belgium	3.7
Denmark	4.1
France	3.3
Germany	3.4
Holland	3.6
Spain	3.0
Sweden	3.3
Switzerland	3.8
United Kingdom	2.6

RESULTS OF THE EURICUS-STUDIES

The facilities

The calculation of the required number of ICU beds for a hospital or for a given region or country never has been developed in a scientific manner. The first calculations making their appearance in the years 70[3], were simply derived from the existing facilitie. Regarding the amount of hospital beds which should be dedicated to CCM, recommendations between 3% and 10% were made and included in the official documents of critical care societies.

In a multinational study published in 1990[2], Abizanda has reported that the number of ICU beds allocated per hospital was highly variable with the country (between 2.6% in the UK and 4.1% in Denmark), and always smaller than the recommended figures (table 1). In this context, the results of the EURICUS-I study were very surprising (table 2): the occupancy rate (OR) of the facilities varied largely and apparently not in direct relation to the percentage of beds allocated to CCM. Besides, the overall OR was low (70%).

These observations, together with the values of other parameters, such as the annual number of admissions per bed (ABY), the length of stay in the ICU (LOS), and the number of elective surgery versus emergency surgery and medical admissions (table 2), suggest diversity in the use of the facilities among countries. The turnover of patients in the ICU (reflected by the ABY, in linear relation with LOS), is usually associated to the number of elective surgery admissions. Therefore, a high ABY value is common in those ICUs with a predominant «recovery-room function».

Another point of relevant divergence between countries regarded the nursing-staffing of the ICUs. The number of nurses in each unit can be expressed by the number of nurses per ICU-bed (N/b), or the number of patients per nurse in each shift (P/N ratio). There is a large variation of N/b, and of the resulting P/N ratios between countries (table 2).

During the site-visits to the participating units, all countries reported shortage of nurses, resulting in the unnecessary death of patients and in the frequent reduction in the number of beds available. Yet, the

TABLE 2. **Results of the survey of ICUs in Europe (EURICUS-II)**

	Number of beds per ICU (mean)	Number of nurses per ICU bed (mean)	P/N ratio (mean)	Annual ICU mortality (%)	SMR (mean)	ABY (mean)	LOS (mean)	OR (mean)	WUR (mean)	Elective surgery (%)
Poland	6.0	3.2	1.65	19	0.96	34	3.5	58.1	0.59	7.0
Germany	16.7	2.8	1.51	6	0.80	77	1.2	84.7	1.12	57.1
Denmark	8.3	4.5	1.05	13	1.24	76	1.0	61.3	0.49	24.7
Finland	10.2	3.7	1.14	8	1.00	71	1.0	70.4	0.65	45.1
Netherlands	8.0	4.1	1.04	10	1.00	80	1.0	80.6	0.76	48.2
Belgium	12.7	2.4	1.82	7	0.81	87	1.9	68.8	1.00	47.8
France	13.0	2.6	1.74	16	0.95	43	3.7	73.3	0.89	7.0
United Kingdom	5.8	6.5	0.71	20	1.12	60	1.7	58.5	0.40	20.7
Italy	6.9	3.2	1.36	18	1.04	51	3.0	79.7	0.86	27.2
Spain	11.3	3.2	1.38	15	1.05	60	3.5	82.7	0.91	11.4
Portugal	7.8	3.2	1.39	14	0.91	35	5.6	84.7	0.91	26.1
Overall	9.55	3.6	1.33	13	1.00	57	2.0	70.1	0.72	30.1

PN ratio: annual mean number of patients per nurse; SMR: standard mortality ratio; ABY: annual mean number of admission per ICU-bed; LOS: length of stay in the ICU (days); OR: occupancy rate; WUR: work utilization ratio. WUR represents the nursing work used (equal to the total measured number of points of NEMS[12] or an equivalent index), divided by the number of points which could be produced by the nursing staff during the same period of time[2].

variation in staffing among countries was huge: from 2.4 N/b in Belgium to 6.5 N/b in the UK and even 10 N/b in Norway (EURICUS-II). These observations do suggest that the staffing of Norway would not be the solution for the perceived poor performance reported in Belgium; additionally, table 2 shows no relation between nursing-staffing and the Standardized Mortality Ratios (SMR)[4].

Because of the costs involved, the volume of nursing staff, in relation to the total number of beds, is the key issue in the planning and running of CCM, remaining a source of significant differences among ICUs. Other aspects regarding the allocation of resources in the ICU, such as medical staff, equipment, integration with hospital services and medical departments were largely improved in the last 15 years, becoming rather in line with the existing recommendations.

The performance

The high cost of CCM is a constant source of questions regarding the effective and efficient use of the resources invested. After its description, the SMR's have been advocated as a measure of performance of the ICUs. SMR is defined as the ratio of the observed number of deaths divided by the expected number of deaths. The expected number of deaths is calculated using the outcome predictive capability of severity of illness scoring systems, such as the APACHE and the SAPS systems[5,6]. This predictive capability was developed with «the scores and the outcome data» of a so-called standard population: composed by the patients of the ICUs willing to participate in the development of the scores.

It is not the intention to discuss here the pros and cons of the use of SMR's in the ICU. Besides, SMR is, to date, the only instrument generally accepted for measuring performance of ICUs. It is however important to focus shortly on the issue of the «standard population». The calculation of SMR's originates from the epidemiology: the mortality of a population under study is compared to the mortality of a standard population, assuming that the study and the standard populations have «identical» characteristics. In other words, SMR's simply look for the difference of the rates of observed/expected mortality of the study population in relation to the standard. The application of SMR's to appraise the outcome of ICUs, however, is supposed to fulfill a double task: besides identifying the eventual difference of mortality rates, it assumes that the difference is related to (clinical) performance (at ICU level). This could only be done if, besides the similarity of patients (identical scores of severity of illness), the ICUs were also identical in both groups (e.g. size, resources, organization, etc.). These factors were not inventoried in those studies. Therefore, the ICUs participating in the development of the scoring systems were not standardized.

The importance of these aspects is documented in several studies. Let us look at a few. In a report of the Leapfrog Group, the presence of an intensive care physician in the ICU reduced the chance of dying by more than 10%, after controlling for case-mix; better equipped and more experienced hospitals reduced the chance of dying by more than 30%[7]. In a study of Pronovost et al, the absence of daily ward rounds by an ICU physician was associated with a 3-fold increase in in-hospital mortality, and the increase between two and three times of the risk of cardiac arrest, acute renal failure, septicemia, platelet transfusion and reintubation[8]. In the EURICUS-I study, exploring organization and management differences among European ICUs, the chance of dying could vary up to a factor 6 among ICUs, after controlling for severity of illness (though not reaching the level of significance) [unpublished data].

Concerning the standardization of clinical management in the ICU, the EURICUS-II project studied the effects of improving collaborative practice among ICU-professionals upon patient's outcome[9]. Besides mortality in the ICU and after ICU discharge, the hourly incidence of abnormal physiolo-

gic parameters (systolic blood pressure, heart rate, oxygen saturation and urinary output) was also included in the outcomes monitored. Out of 2 million measurements, the study identified 300.000 abnormal physiologic measurements. After controlling for severity of illness and diagnoses, there was a large variation in the incidence of abnormal measurements among ICUs. The analysis of the data has also confirmed that the incidence and particularly the duration of the abnormal measurements were significantly predictive of organ system failure and of mortality (Rivera et al, J Crit Care under publication).

In summary, although the predictive capability of the scoring systems is moderately accurate (area under the receiver operating characteristic curve, ROC, is around 80%), the important question is to what extent the differences between expected and observed mortalities are associated to clinical performance. This remains to be tested.

There is more to performance than only SMR's. Let us look to table 2. The ICUs of France and of Poland score similarly a SMR < 1. The P/N ratio in both countries is around 1.7. In France, at least, because the anesthesia department claims the post-operative care of patients, the percentage of post-elective surgery in the ICU is small (7%). In both countries, the lower ABY (34 and 43) and the larger LOS (3.5 and 3.7) indicate the predominant admission of medical and emergency surgical patients. However, the waste of resources in Poland was much higher (OR = 58% and WUR = 59%) than in France (OR = 73% and WUR = 89%).

The ICUs of the UK and of Italy score similarly a SMR > 1, but they show a large difference of P/N ratios (0.71 vs. 1.36). Although the SMR's are about equal, the investment/waste of other resources is very different (OR 59% vs. 80% and WUR 40% vs. 86%).

The table 2 also shows national patterns in the use of the facilities: in the countries in the North of Europe (Germany, Finland, Netherlands and Belgium) the ICUs have a predominant «recovery-room» function (high ABY and low LOS; about 50% of the admissions concern elective surgery). Conversely, the ICUs in the countries of the South of Europe (France, Italy, Spain and Portugal) admit predominantly medical and emergency surgical cases (low ABY, higher LOS), showing a better use of the resources in terms of OR and WUR.

The case of the ICUs of Denmark deserves a special note: the same as in other countries of the North of Europe, the Danish ICUs have a predominant recovery-room function (ABY = 76, LOS = 1). However, the low number of elective surgery admissions does not fit in that function. During the site-visits to the participating units we understood that, due to communication difficulties between the ICUs and the surgical wards, the «elective surgical» admissions were not announced in advance to the units and were consequently included in the emergency type of admissions. As we will see later, the predictability of work-flow (influenced by the level and the quality of communication) is significantly associated to ICU outcomes concerning both patient care (e.g. mortality), and the management of the unit (e.g. job satisfaction and burnout).

The waste of resources

In 75% of the ICUs examined, there was found an important mismatch between the resources made available and those used. This concerned the use of the beds (OR = 70%) and the use of nursing manpower (WUR = 72%). In one ICU, the waste of resources (regarding both beds and nursing manpower) amounted to 75% of the resources invested.

It has to be noted that the real waste of resources was much higher than the overall 30% indicated in table 2. Of the 16,000 patients enrolled in the EURICUS-I, 8,000 (50% of all admissions) stayed in the ICU for ≤ 2 days. The study of this particular group of patients shows: a) a Weekly admission/discharge pattern, in which admissions are higher than discharges from Monday to Wednesday, after which the ratio decays and reverses until saturday, resulting in the lowest OR during the week-end and b) a clear daily pattern was also found, with the discharges starting at 8 in the morning, having a pick between 10-12 hours a.m., time when the admissions start until late afternoon[10]. This indicates the predominance of the surgical use of the ICUs in Europe. For 5,000 patients admitted for ≤ 1 day, they only made full use of the facilities for the very few hours until the vital functions regain autonomy after surgery. This means that the related beds were administratively occupied for several hours while waiting for the patient to be admitted from the operating theatre; and they were unnecessarily occupied waiting for the patient to be discharged the next morning, after vital functions did recover from the effects of surgery and anesthesia shortly after admission. All together, this entails a real loss of about 70% of resources in this particular group of patients.

Part of the above is caused because: a) the recovery-room is closed after 18.00 hours until next morning in 70% of all hospitals and b) in a large number of institutions, it was arranged that the elective post-operative cases of some specialties would always be directly admitted to the ICU, bypassing systematically the recovery-room.

The management skills

In the EURICUS-studies, the waste of resources was associated to important shortcomings in the general management and organization (OM) performance of the ICUs. On its turn, the clinical outcome of patients (measured as patient mortality after controlling for severity of illness) was significantly associated to OM variables, such as: «organization commitment», «results-oriented culture», «decision latitude of nurses», «predictability of work-flow»

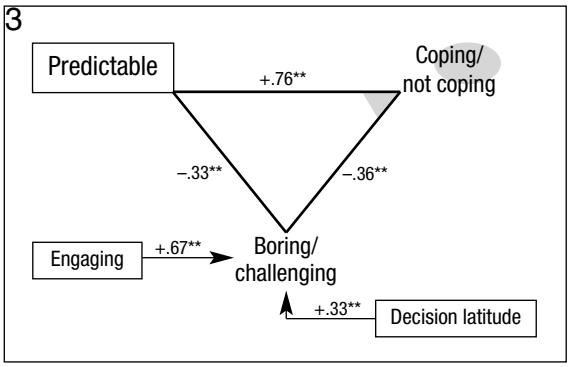

*Figure 1. The predictability of workflow and burnout. The association between variables was calculated by Pearson's correlation test. Significance: * –p < 0.05; ** –p < 0.001.*

and «basic organizational framework». The interested reader is referred to the report of EURICUS-I[10].

Of the variables indicated above, the predictability of the workflow appeared to be most important: burnout and job-dissatisfaction, for example, were more dependent of work uncertainty and less of nursing workload[10].

Figure 1 depicts some interrelations between predictability of workflow and burnout of the nursing staff. Burnout is described to have three subscales: emotional exhaustion, depersonalization and personal accomplishment (in the figure represented by «coping/not coping with the job»)[10].

Predictability of workflow is a dimension including six categorical variables: predictable vs. unpredictable, easy vs. difficult to plan, constant vs. irregular, scheduled vs. unscheduled, organized vs. chaotic, obvious vs. unclear. About 60% of the variance of the perceived capability of coping with the job can be explained by the predictability of the workflow.

Another factor explaining the capability of coping (for about 13% of its variance) is the sense of a job being «boring vs. challenging». In the EURICUS-studies, predictability explained about 10% of the variance of «boring/challenging». This latest was also seen in relation with two other dimensions: «engaging» (explaining about 45% of its variance), and «decision latitude of nurses» (explaining about 10% of its variance).

«Engaging» includes three categorical variables: (the work is) repetitive vs. varied, quiet vs. busy, mechanical vs. (needing) thinking. «Decision latitude» includes two sub-dimensions: *titration of vital parameters* including, adjustment of prescribed drugs and interventions (e.g. correction of electrolytes, dose adjustment of vasoactive-, sedative-, and anti-arrhythmic drugs, the adjustment of mechanical ventilation), and the initiation of cardiac defibrillation; *acute life support* including manual mask ventilation, oxygen administration, the initiation of vasoactive drugs, the initiation of cardiac massage. The decision latitude of nurses was significantly related to the clinical outcome of care in the ICU: *Logit of mortality = .065*SAPS + .066*titration of vital parameters + .083*acute life support* [unpublished data].

MAJOR ROADBLOCKS FOUND

The concept of critical care medicine

CCM is today a fully recognized (sub)specialty: about forty to fifty years should elapse before recognition was achieved. During these years, the development and growth of CCM followed local views and constraints in the absence of centrally defined standards. Not being a specialty, the distinction between CCM and other specialties was focused on the high-technological environment (beds, equipment, etc.) in which very specific medical activities took place. In other words, CCM was confounded with the ICU. The recognition of CCM as a specialty, however, underscored the clear distinction between CCM (the professional competence) and the ICU, the hospital facility in which the medical activity takes place. The distinction between CCM and ICU parallels the difference between Surgery and Operating Theatre. However, these concepts remain still rather confounded in the minds of many.

Let us analyze the importance of the problem in the development of step down units, in particular the High Dependency Units (HDU). HDU made its appearance in the UK[11]. The British guidelines for admission of patients to the HDU indicate: (patients) not undergoing medical interventions; only one organ supported (excluding advanced respiratory support); nursing activity between ICU and ward (e.g. close monitoring); earlier discharge from ICU. In the same guidelines, admission to the ICU is indicated for: advanced respiratory support; acute organ support; more than one organ support. Disregard the ambiguities in the used definitions, the guidelines for triaging patients between the ICU and the HDU are based upon two identifiers: «competence» (or the grade of complexity of the activities of care needed), and «staffing».

As discussed above, the attribution of levels of «competence» to the ICU/HDU is not justified, particularly after CCM became a recognized specialty. The performance of CCM tasks in the ICU became therefore exclusively dependent on the allocation of resources: equipment and staff.

We have looked in more detail to «staffing», the other identifier of admissions to these facilities. Using the data of 114 ICUs in the database of EURICUS, the units were divided into two groups (table 3): the «ICU Group», with P/N ratio < 1.5, and the «HDU Group» with P/N ratio > 1.5. The patients in the two groups did not differ regarding severity of illness (SAPS-II) nor regarding intermediate (SOFA) and final outcomes (mortality). The «performance» measurements considered (SMR, OR and LOS) did not differ. The only significant differences concerned obviously the parameters re-

TABLE 3. **Intensive Care Unit (P/N ≤ 1.5) versus High Dependency Unit (P/N > 1.5)**

	P/N ≤ 1.5	P/N > 1.5	p
Number	66	48	
P/N ratio	1.1 ± 0.26	2.8 ± 5.2	<0.001
SAPS-II	34.6 ± 6.3	34.1 ± 5.4	ns
Mortality	20.1 ± 8.6	17.2 ± 9.0	ns
SMR	1.07 ± 0.47	0.95 ± 0.27	ns
SOFA	5.1 ± 1.7	4.7 ± 1.3	ns
OR	72.5 ± 18.5	69.6 ± 17.3	ns
WUR	0.62 ± 0.24	0.86 ± 0.26	< 0.001
LOS	2.7 ± 2.8	3.7 ± 3.7	ns

P/N: mean number of patients per nurse; LOS: length of stay in the ICU (days); WUR: work utilization ratio; OR: occupancy rate; SMR: standard mortality ratio.

lated to the selection of the groups: P/N ratios and WUR. These results allow us to conclude:

1. In Europe, ICUs and HDU's, or the equivalent facilities regarding P/N ratios, are functioning exactly in the same way concerning case-mix and clinical and organizational outcomes.

2. Assuming that the outcome of patients stratified according to severity of illness and complexity of care is related to P/N ratios (as measured by therapeutic indexes), it is fair to conclude that the outcome of patients will improve when the match between severity of illness (measured as required P/N ratio) and the available P/N ratio is the most relevant criterion for admission/discharge policies.

The objectives of the activities and the planning of the facilities

During the site-visits to the ICUs participating in the EURICUS-studies, not a single unit was found in which the vision and the mission of its activities were formally expressed[10]. Besides not written down, the objectives of the unit were not at all clear to the staff of the unit, and different staff-members would refer «soft objectives» such as: «work hard», «give the best care to the patients», «doing our best», etc. Obviously, the definition of very specific objectives is necessary for distinguishing the roles of the different wards in the hospital and to understand how their individual efforts contribute to the overall care of patients. The expressed objectives of the unit should be known and shared by all those working in the unit, as well as it should be known in the units or departments interacting closely with the ICU.

The absence of clear objectives is documented by the mismatch between planned and operative levels of care (LOC) observed in the EURICUS-study[10]. The planned LOC (planned P/N ratio) was computed from the number of beds and the number of nursing full-time-equivalents (FTE's). The operative LOC was derived from the mean annual P/N ratio at patient level using the Nine Equivalents of nursing Manpower (NEMS)[12].

Of the 89 ICUs in EURICUS-I:

1. Sixty-one were planned to operate with P/N = 1, 49 operated with P/N = 2, and 7 with P/N = 3. Only 5 ICUs operated with P/N = 1.

2. Twenty-two ICUs were planned to operate with P/N = 2, and 14 ICUs did indeed operate at this level. Four ICUs did operate with P/N = 3 and 4 with P/N = 1.

3. Six ICUs were planned to operate with P/N = 3, but 3 of them operated with P/N = 2.

In summary, 75% of the ICUs did operate at a level different of the level which was planned. In 7 ICUs (8%), the operative level was higher than the planned level. In these ICUs, the number of FTE's would have been insufficient for ensuring an occupancy rate around 85%.

The organization and management of staff and work

CCM is composed of an enormous diversity of activities. The successful performance of these activities at patient level, besides the necessary skills and accuracy (in relation to their complexity), is very much dependent upon a well functioning titration therapy system: observation → registration → judgment → action, usually involving the contribution of more than one professional group. Three elements of organization and management are therefore in focus: the complexity of the activities; the repetitiveness (frequency in time) of the activities; the interdependence of different professionals for the execution of the activities. As reported by the EURICUS-studies, the OM of the ICUs was insufficient, particularly regarding the address of these three OM-elements.

The EURICUS-II study evaluated the effects of an organization based managerial intervention on the performance of ICUs[13]. The intervention aimed at improving the collaborative practice between physicians and nurses in the ICU and consisted in:

1. Training collaborative practice to nursing and physician's staff concerning issues such as «communication», «conversation techniques», «cooperation as a team».

2. Daily use of two protocols regarding: a) the hourly check of monitoring by the nurse who should make the decision of whether consultation with the physician was necessary (action aiming at «enhancing awareness of processes of care»); b) «building on mutual respect» by standardizing the discussion between nurses and physicians regarding selected

patient issues. Three outcomes to the intervention were measured: final outcome of care (mortality, in the ICU and in the hospital); intermediate outcome of care (number of times and duration during which the hourly monitored physiologic parameters – systolic blood pressure, heart rate, oxygen saturation and urinary output – were out of the range of acceptance).

3. Changes in the perceived collaborative practice (assessed by means of specific questionnaires administered to the involved professionals at three different occasions along the study). This was a randomized controlled trial, conducted for the period of 10 months, in which the intervention was applied to 20 ICUs, being the control group composed by 19 other ICUs.

In the results, mortality was significantly higher in the control group, after controlling for severity of illness[13]; the chance for having out of range measurements (in each of the four parameters considered) was significantly higher also in the control group[13]; the incidence, as well the duration of out of range measurements were significantly related to mortality[13]; the increase in SOFA-score was preceded by the occurrence of out of range measurements (Rivera et al, under publication).

In the EURICUS-III study, the implementation of guidelines for budget control and cost calculation improved significantly the quality of management in the ICUs, as well the motivation of the leaders to manage[14,15].

Two important conclusions can be taken from the studies above:

1. Simple, limited and not expensive managerial interventions for improving the management in the ICU will have significant impact upon patient outcome.

2. The detailed analysis of the processes of care, shall point out the most effective ways of working in relation to specific task in the ICU.

LESSONS OF THE EURICUS-STUDIES

The system approach

The integration of the ICU in the hospital should be approached following the «general system theory». A system is a collection of interrelated work processes, activities and tasks, such that the collection and the interrelationships together avoid disorder[16]. The hospital is a system of care. In the system, the inputs (clinical conditions admitted) are transformed into the outputs of the hospital (the clinical conditions at discharge). The system of care therefore, addresses the work (processes, activities, and tasks) of transforming inputs into outputs. In the hospital, different professionals and specialties contribute to the work of transformation (also called the throughput of the system). Therefore, to enable the appropriate analysis of the throughput of the hospital, the overall system should be divided into sub-systems. In each sub-system, the activities are so specific that they should be considered to form a system in its own right. The ICU, as well the operating theatre, the general ward, etc. is one of these sub-systems. The integrative analysis of the sub-systems should be made in such way that the output of one is the input of the next one. For example, the output of the operating theatre is often the input of the ICU; the output of the ICU becomes usually the input of the general ward, etc.

Analysis of the processes of care

The activities of care

A process of care (also to be seen as a system) is the conjunction of a number of purposeful tasks aiming at a given objective. For example, one of the objective of mechanical ventilation might be a PaO_2 ≥10 KPa. In the ICU, the processes of care are mainly related to the functioning of organs and systems, the primary mission of the unit. The overall process of care in the ICU can therefore be divided into various sub-processes of care: e.g. respiratory, cardiovascular, renal, metabolic care, etc. Each sub-process is the purposeful organization of selected activities leading expectedly to a previously planned outcome (usually defined by the value(s) of physiologic parameter(s) of a normally functioning organ).

The analysis of the processes in the ICU entail therefore that all activities of care are inventoried. Respiratory support, for example, is composed of various operations such as ventilation, sedation, postural drainage, etc. These operations are specific of the 'respiratory care-system'. Each of these operations is on its turn composed of specific tasks needing to be also inventoried. Other operations of respiratory care, such as monitoring, diagnosis, etc., are not specific of this process of care, as they are to be found in other processes of care as well (cardiovascular, renal, etc.).

The analysis above will result in a matrix describing general activities in the ICU (e.g. maintenance of stocks, activities of prevention, reporting, etc.), activities defining specific processes related to the support of organs or systems (e.g. respiratory care) and the respective sub-processes (e.g. postural drainage), and activities which are common to various processes (e.g. diagnostic procedures, drug administration, etc.).

The use of the system approach is important in the descriptive standardization of the activities (i.e. their sequence in time and the input-output relations), enabling the understanding of the interaction of the professionals involved in their performance.

Re-defining jobs

When the inventory and description of the activities is complete, the re-definition of the jobs and tasks in the ICU may follow.

The description of jobs and tasks in health care has been addressed at several occasions. However,

this never has been done concerning the processes of care in the ICU. At present, the perception of the content of jobs and tasks in the ICU is largely influenced by traditional concepts regarding duties and responsibilities of the involved professionals. As a consequence of the progress made along the years, it may happen that the traditional perceptions/attributions of those duties and responsibilities do not describe the actual performance of some processes of care. On the other hand, it has been shown that sticking to the actual description of jobs and tasks in the ICU may interfere negatively with the effectiveness and efficiency of patient care[10]. For example, a team-like structure in the ICU (including low task differentiation and low centralization of decision making) was the same as for the decision latitude of the nursing staff, associated with a better clinical performance of the ICU.

After the (as complete as possible) description of all activities of care, the tasks of each (sub) process are to be «allocated» to the professionals in the ICU. This allocation, based on the knowledge and skills of each profession, and seeking the effectiveness and efficiency of the processes of care, will finally define the content of the jobs of nurses, physicians, etc., in the ICU.

Concerning some of the activities, it will be noted that the overlap of responsibilities of different professionals may exist. When the overlap is critical because of its importance and/or its complexity, a protocol has to be devised for precising aspects such as: hierarchy, timing, and control of actions, and the respective moments (and content) of communication.

The analysis of the processes of care cannot be done in a professional and independent manner by the ICU professionals alone. It is therefore necessary that this work is explained and supervised by a work-psychologist, and closely guided by job-analysts.

The definition of all (sub)processes will allow for the computation of costs to each of them, resulting in the construction of a «process-oriented costing matrix» in the ICU. This costing matrix allows for the precise calculation of the cost of care.

The P/N ratios question

The clear distinction between ICU (the technical beds) and CCM (the professional specialty), besides describing the reality, is essential for the effective integration of the ICU in the hospital.

The ICU is used to offer intensive and frequent care activities to a limited number of patients during a variable period of their stay in the hospital. The ICU can therefore be seen as a facility for providing specific care not available in the other wards in the hospital. The admission and discharge policies of patients in the ICU are in principle determined by two factors: a) the available means (staff and technology) in the ICU, versus b) the available means (staff and technology) in the ward.

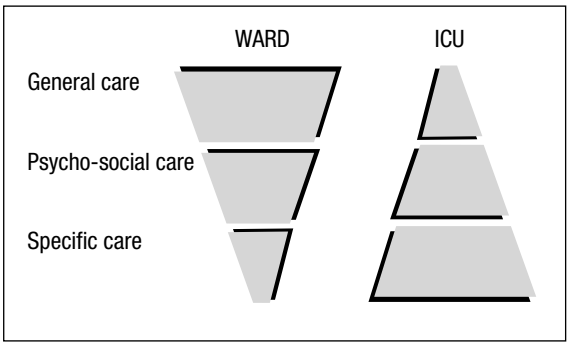

Figure 2. Nursing workload in three areas of care: the ward versus the Intensive Care Unit (ICU).

For reasons of effectiveness and efficiency, the ICU has a much higher concentration of both staff and technology in comparison with the ward. Considering the available technology is subsidiary to the knowledge and skills of the staff, the relevant difference between ICU and ward concerns the concentration of staff: the P/N ratio in the ICU varies between 1 and 3, whereas in the ward it varies between 10 and 20.

Let us take an example: One ICU (with 15 beds; mean P/N = 2) serves the needs of three wards totaling 60 beds (mean P/N = 10). Assuming 85% the OR of both the ICU and the wards, the ICU needs 34 FTE's and the wards 27 FTE's[2]. Figure 2 sketches the amount of time dedicated by one nurse in the ward and by another in the ICU regarding the three major areas of patient care in the hospital. Because of the large number of patients to attend, the nurse in the ward difficultly will be able of dedicating time to the more specific care of each patient (e.g. hourly monitoring, titration of IV medication). Therefore, whenever the need for specific care increases (e.g. a cardiac arrest in the ward; no place in the ICU for a patient deteriorating) other activities will be reduced or even omitted: e.g. «no time to go over the file with the patient»; «patients less often out of bed»; «less attention to family members»; «less monitoring and physiologic checks»; etc. (unpublished results). Consequently, the required P/N has to decrease drastically in the ICU before a patient can be discharged to the ward. The quick decrease of P/N ratio required occurs usually within few hours for the elective surgery patients admitted to the ICU. In the patients staying in the ICU longer than 2 days, however, the more gradual decay of P/N ratio can take some days before it reaches the level the ward could cope with. The creation of step-down-units, with intermediate P/N ratios may be therefore justified.

The information of the P/N ratio required by a (group of) patient(s) is readily obtained with the use of one of the therapeutic indexes available. Leaving strictly professional issues aside, such as knowledge, skills, and required technology, the P/N ratios (available in the unit where the patient lies, and re-

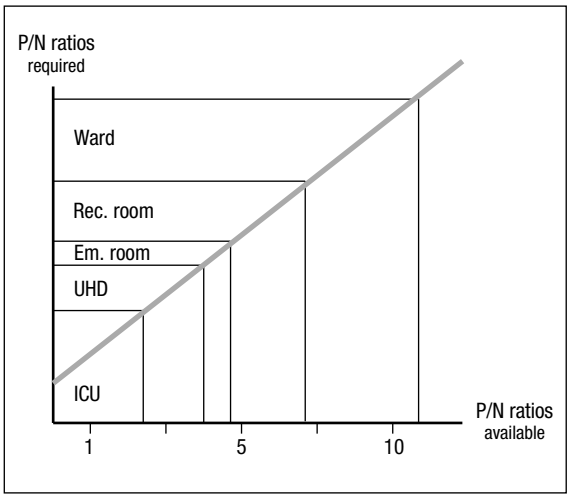

Figure 3. P/N ratios across the hospital. P/N- mean number of patients cared by one nurse; Rec. room: recovery room; Em. room: emergency room; HDU: high dependency unit; ICU: Intensive Care Unit.

quired in the view of his/her clinical condition) are the determinants of the admission and discharge policies. These considerations are applicable to any clinical ward in the hospital (fig. 3). The inventory and mapping of the P/N ratios available (and required) in all wards in the hospital could lead to new insights and better strategies of planning and using of the resources. For example, improving the P/N ratios in the ward could prevent the increase in the number of ICU beds in the hospital.

Professional management

Those working in the ICU, nurses and physicians, are usually not educated and trained in OM. As it was indicated above, however, professional OM in the ICU is absolutely indispensable, particularly when dealing with (re)establishing the basis for the functioning/integration of the ICU in the hospital. It cannot be expected that the health care professionals in the ICU can perform these tasks appropriately, even after following complementary education on OM: because they lack the necessary experience, and also because they are an interested party in the process. ICU-professionals with this education, on the other hand, will be instrumental to facilitate the dialogue and mutual understanding between the ICU-staff and the staff of the Department of OM helping with the tasks towards a professional management in the ICU.

The choice of the Department of OM may vary:

1. To hire the work of a consultancy enterprise specialized in OM. There are two important disadvantages bound to this choice: a) the high cost of the intervention; b) the need for actions of support and maintenance along time (and the related costs).

2. To seek the contribution of the Department of Work Psychology of a nearby University. This modality offers two important advantages: a) the costs involved, if any, will be low. Besides, these university departments are usually eager to collaborate with the working field; b) the interaction between professionals, and the exchange of specific experiences will be like «between colleagues» (maximal teaching effect) rather than between client and provider.

3. To make use of the know-how of OM, if existing, among the professionals working in the Direction of the hospital. This modality has two important advantages: a) brings knowledge and understanding of the working field closer to those responsible to Administration in the hospital; b) maximizes support and maintenance actions whenever required. In our experience this modality is clearly to prefer, in association with the collaboration of the University or, if not available, eventually with the initial support of a consultancy enterprise.

Declaración de conflicto de intereses

Los autores han declarado no tener ningún conflicto de intereses.

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