Nursing activities score

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Objectives: **The instruments used for measuring nursing workload in the intensive care unit (e.g., Therapeutic Intervention Scoring System-28) are based on therapeutic interventions related to severity of illness. Many nursing activities are not necessarily related to severity of illness, and cost-effectiveness studies require the accurate evaluation of nursing activities. The aim of the study was to determine the nursing activities that best describe workload in the intensive care unit and to attribute weights to these activities so that the score describes average time consumption instead of severity of illness.**

Design: **To define by consensus a list of nursing activities, to determine the average time consumption of these activities by use of a 1-wk observational cross-sectional study, and to compare these results with those of the Therapeutic Intervention Scoring System-28.**

Setting: **A total of 99 intensive care units in 15 countries.**

Patients: **Consecutive admissions to the intensive care units.**

Intervention: **Daily recording of nursing activities at a patient level and random multimoment recording of these activities.**

Results: **A total of five new items and 14 subitems describing nursing activities in the intensive care unit (e.g., monitoring, care of relatives, administrative tasks) were added to the list of therapeutic interventions in Therapeutic Intervention Scoring System-28. Data from 2,041 patients (6,451 nursing days and 127,951 multimoment recordings) were analyzed. The new activities accounted for 60% of the average nursing time; the new scoring system (Nursing Activities Score) explained 81% of the nursing time (vs. 43% in Therapeutic Intervention Scoring System-28). The weights in the Therapeutic Intervention Scoring System-28 are not derived from the use of nursing time.**

Conclusions: **Our study suggests that the Nursing Activities Score measures the consumption of nursing time in the intensive care unit. These results should be validated in independent databases. (Crit Care Med 2003; 31:374–382)**

KEY WORDS: nursing activities; nursing work load; intensive care unit; scoring systems

In 1974, Cullen et al. (1) described the Therapeutic Intervention Scoring System (TISS). TISS was designed to classify nursing workload in relation to the severity of illness of patients in intensive care units (ICUs) as judged by a panel of experts. TISS was used to stratify patients by severity of illness until specific instruments for measuring severity of illness were developed (2). Since then, it has been commonly used for measuring nursing workload. Over the years, the instrument has been updated (3), adapted to specific populations (4), or simplified (5, 6). In all these versions, the original philosophy of the instrument remained unchanged: nursing workload is related to severity of illness; the type and number of therapeutic interventions in the ICU are related to the severity of illness of the patients.

Intensive care has, however, changed in the last 20 yrs. There has been a clear increase in the average age and the severity of illness of the admitted patients, the complexity and number of therapeutic interventions, and the volume of the administrative tasks undertaken by nurses. Therefore, recalibration of the weights attributed to the items within particular scoring systems may be necessary.

The use of resources within the ICU has become an area of concern in recent years. Nursing staff is by far the largest single economic investment in an ICU (around 50% of total cost). TISS has been used for assessing the allocation and use of resources in hospitals (7–9) and, in particular, patient populations (10–12). In these studies, TISS was used for measuring the use of nursing resources or as a proxy of overall hospital resources (13). TISS is often used for costing procedures in the ICU (14, 15). Recently, TISS was selected as the primary end point in a multicenter investigation of a new medication (16).

The question of whether TISS is a reliable measure of resource use is therefore relevant. In a study by Clermont et al. (17), it was concluded that TISS was an appropriate indicator of ICU resource use in their hospital. In another study, Dickie et al. (18) showed that although TISS described validly the overall cost of the population studied, this was less true for the individual patient.

If TISS is to be used in studies of nursing workload and costs, it is important to be sure that the assumption that TISS reliably measures the use of nursing time in relation to patient care is true. This assumption has, however, never been tested directly. The work of nurses in the ICU is composed of multiple activities. TISS describes a selected set of these activities in relation to therapeutic interventions. The major criterion for selection of the interventions was that they

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were related to severity of illness. However, the relation between severity of illness and the use of nursing time is known to be not perfectly linear (5). Moreover, it was shown that nurses spent only 43.3% of their time performing the activities related to the items in TISS-28, with 34.3% being spent on patient care not included in TISS-28 (5).

To use TISS to study the relationship between nursing time and patient care, two important questions need to be answered. First, what items should be added to the TISS-28 items so that nursing activities that relate to patient care are more adequately represented? Second, what weights should be attributed to the items in the score so that time consumption, not illness severity, is represented? The purpose of the present study was to address these two questions.

METHODS

1. Survey of Items to Include

A group of 25 ICU professionals (15 physicians and ten nurses representing 15 countries) was asked to identify patient-condition–related nursing activities that are not addressed by the therapeutic indexes and that might have a significant influence on the use of nursing time in the ICU. A detailed cover letter explained the importance and the shortcomings of the therapeutic indexes available and presented the objectives and the design of the present study. The distinction between patient conditions and diagnoses (to be avoided [e.g., sepsis, ruptured aortic aneurysm]) was also discussed. Copies of specific publications and a list of the relevant literature were provided.

After eliminating interventions confounded with diagnosis (only burns and brain death were accepted), experimental or uncommon interventions (e.g., nitrous oxide therapy), and interventions already in TISS (e.g., initiating dialysis), a list of 15 new interventions (items) was obtained (Table 1, first column). More than one respondent listed the items included.

In a second round of correspondence, the group was asked to rate each item, keeping in mind its relation to the consumption of nursing time, according to a 5-point Likert scale, ranging from low to high relevance. The inclusion of a new item (intervention or activity), or the justified re-inclusion of one item previously listed but discarded in the first round, was made possible. Table 1 shows the percentage of agreement between respondents, divided into physicians and nurses. In this analysis, the scores were arranged to increase the meaningfulness of the response: *low relevance* included scores 1 and 2; *medium relevance/undecided,* score 3; and *high relevance*, scores 4 and 5. Six items were rated as very relevant by 50% or more of all respondents: hygiene, restlessness, prone position, brain death, burns, and continuous bedside observation. It has to be noted that these items may involve a number of diagnoses, patient conditions, and nursing activities. The last column of Table 1 shows that the response of physicians and nurses differed significantly (chi-square test) in two items (care and support of families and continuous bedside observation). In both cases, nurses scored much higher than physicians, appropriately so because it concerns more the core of their job. Finally, nine items/activities were selected for further study: hygiene, restlessness, prone position, brain death, care and support of relatives, team lifting, mobility, burns, and continuous observation (Table 1).

Table 1. List of 15 new items initially defined by the panel of experts

Variable	Physicians, $n = 15$ (% in 4/5)	Nurses, $n = 10$ (% in 4/5)	Total, $n = 25$ (% in 4/5)	Significant Difference (χ^2)
Hygiene	73.3	80.0	76.0	0.464
Restlessness	80.0	100.0	88.0	0.321
Isolation with barrier nursing	46.7	40.0	44.0	0.211
Prone position	46.7	80.0	60.0	0.241
Brain death	53.3	70.0	60.0	0.574
Care and support relatives	13.3	70.0	36.0	0.015
Team lifting	33.3	60.0	44.0	0.283
Mobility	33.3	70.0	48.0	0.110
Rehabilitation	14.3	33.3	21.1	0.068
Oral alimentation	13.3	20.0	16.0	0.783
Age	14.3	11.1	13.0	0.576
Burns	83.3	66.7	76.2	0.269
Continuous observation	40.0	100.0	64.0	0.009
Admission-discharge procedure	20.0	50.0	32.0	0.289
Chronic vs. acute clinical condition	9.1	22.2	15.0	0.241

2. Selection and Description of the Final List of Items

In the second phase of the study, a panel of eight people (two ICU physicians and two ICU nurses, of three different countries, together with four of the authors) prepared the selection and description of the final list of items. During a 2-day meeting, using breakouts and joint sessions, the listed items were first divided into patient conditions (e.g., incontinence, leaking wound), nursing interventions (e.g., hygiene, mobilization), and the corresponding nursing activities (e.g., changing linen, washing, dressing). Linking nursing activities to patient conditions was discussed. This exercise was important because different patient conditions (e.g., closed surgical wounds vs. burn wounds) can make significantly different use of the same nursing activities.

Five nursing interventions were identified: monitoring and titration, hygiene procedures, mobilization and positioning, support and care of relatives and patients, and administrative and managerial tasks. These five nursing interventions were broken down into nursing activities covering the nine items previously selected (Table 2).

The five nursing interventions were described so that 1) they could be unequivocally understood by different raters, 2) they contained at least one quantified element; and 3) they could be subdivided into a hierarchy of mutually exclusive levels of complexity (expressing the estimated time consumed in the performance of the involved activities). The baseline of this hierarchy, in each intervention, reflected the activities considered routine practice for that intervention, in any ICU. For example, for the intervention "monitoring and titration," these activities would be hourly vital signs, regular registration, and calculation of fluid balance.

The final list of nursing activities produced by this panel of eight persons was circulated among and approved by the larger panel of 25 experts. The final list of nursing activities, combining the items in TISS-28 and the five newly described, totals 30 test items (Table 2). For validation of the new score, a detailed operational manual was prepared (see below).

3. Work-Sampling Study

Selection of ICUs. Different types of ICUs, from different countries, were included to broaden the variation of the data collected. Participation was on a voluntary basis; therefore, the listed ICUs (Table 3) do not specifically represent any country or geographic region. Of the 99 ICUs enrolled, 51 were from university hospitals (1).

Data Collected. Two types of data were collected:

Table 2. Nursing activities and frequency of their performance

Item		RNA FORM		MMRs FORM	
		Frequency	%	Frequency	%
Category 1, 80.8%					
1	Monitoring and titration[a]				
1A	Hourly vital signs, regular registration, and calculation of fluid balance	3190	49.4	18978	14.8
1B	Present at bedside *and* continuous observation *or* active for 2 hrs or more in any shift, for reasons of safety, severity, or therapy such as noninvasive mechanical ventilation, restlessness, mental disorientation, prone position, donation procedures, and preparation and administration of fluids or medication	2005	31.1	4176	3.3
1C	Present at bedside *and* active for 4 hrs or more in any shift for reasons of safety, severity, or therapy such as those examples above (1B)	1176	18.2	2283	1.8
2	Laboratory	5035	78	4362	3.4
3	Single medication	1452	22.5	5609	4.4
4	Multiple intravenous medication	5370	83.2	2790	2.2
5	Hygiene procedures[a]				
5A	Performing hygiene procedures once per day such as dressing of wounds, changing linen, washing patient, special room cleaning procedures (e.g., following certain infections that require wall washing)	3815	59.1	9658	7.5
5B	Performing hygiene procedures three times per 24 hrs such as those due to burns dressings and leaking wounds	1476	22.9	2924	2.3
5C	Performing hygiene procedures more than three times per 24 hrs such as those due to vomiting, incontinence, barrier nursing (staff hygiene)	869	13.5	1597	1.2
6	Care of drains	1913	29.7	643	0.5
7	Mobilization and positioning[a]; including procedures such as turning the patient, mobilization of the patient, moving from bed to chair and team lifting (e.g., immobile patient, traction, prone position)				
7A	Performing procedure(s) up to three times per 24 hrs	2290	35.5	2735	2.1
7B	Performing procedure(s) more frequently than three times per 24 hrs	2600	40.3	4480	3.5
7C	Performing procedure with three or more nurses, any frequency	844	13.1	1988	1.6
8	Support and care of relatives and patient[a], including procedures such as telephone calls, interviews, counseling				
8A	Routine communication allowing staff to continue with other nursing activities such as communication with patients during hygiene procedures, communication with relatives while present at bedside, and observing patient	4744	73.5	2831	2.2
8B	Support and care of either relatives or patient requiring *full dedication* for about 1 hr in any shift such as to explain clinical condition, dealing with pain and distress, and difficult family circumstances	1187	18.4	631	0.5
8C	Support and care of either relatives or patient requiring *full dedication* for 3 hours or more in any shift such as: death, demanding circumstances (e.g. large number of relatives, language problems, hostile relatives)	181	2.8	416	0.3
9	Administrative and managerial tasks[a]				
9A	Performing routine tasks such as: processing of clinical data, ordering examinations, professional exchange of information (e.g. ward rounds)	5295	82.1	19928	15.6
9B	Performing administrative and managerial tasks requiring *full dedication* for about 2 hours in any shift such as: research activities, protocols in use, admission and discharge procedures	884	13.7	2270	1.8
9C	Performing administrative and managerial tasks requiring *full dedication* for about 4 hours or more of the time in any shift such as: death and organ donation procedures, co-ordination with other disciplines	106	1.6	2306	1.8
10	Mechanical ventilation	3760	58.3	984	0.8
11	Supplementary ventilatory support	1409	21.8	333	0.3
12	Care of artificial airways	3588	55.6	1346	1.1
13	Treatment for improving lung function	4394	68.1	4035	3.2
14	Single vasoactive medication	1669	25.9	386	0.3
15	Multiple vasoactive medication	1154	17.9	267	0.2
16	Intravenous replacement of large fluid losses	654	10.1	396	0.3
17	Arterial catheter	3621	56.1	326	0.3
18	Left atrium monitoring	592	9.2	199	0.2
19	Central venous catheter	4834	74.9	394	0.3
20	CPR	61	0.9	130	0.1
21	Hemofiltration techniques	385	6.0	941	0.7
22	Quantitative urine output	5257	81.5	669	0.5
23	Active diuresis	1176	18.2	74	0.1
24	Intracranial pressure	129	2.0	47	0.0
25	Complicated metabolic acidosis/alkalosis	244	3.8	64	0.1
26	Hyperalimentation	964	14.9	575	0.4
27	Enteral feeding	2704	41.9	814	0.6
28	Single specific intervention in the ICU	822	12.7	559	0.4
29	Multiple specific interventions in the ICU	238	3.7	88	0.1
30	Specific interventions outside the ICU	452	7.0	172	0.1
Category 2				8043	6.3
Category 3				14,291	11.2
Category 4				2631	2.1
Total		6451	100	127,951	100

RNA, daily registration of nursing activities; MMRs, multimoment recordings of nursing activities; Category 1, items scored at patient level; CPR, cardiopulmonary resuscitation; ICU, intensive care unit; Category 2, activities not relating directly to patient and not medical; Category 3, activities for the nurse themselves; Category 4, activities could not be scored in the other categories.

[a]New nursing interventions.

1. For the registration of the nursing activities of care at the patient level (RNA) during the previous 24 hrs, the activities to be scored were those in TISS-28 (5) and the newly defined activities described above (Table 2). The RNA was performed every day, at the same time, by the same rater or team of raters, as is usual with TISS.
2. Work-sampling was obtained by multimoment recordings (MMRs) of the nurses' activities during every 24-hr period. The moments for sampling were randomly generated by a computer program capable of determining 30 random moments between 0.0 and 24.0 hrs. All the nurses on duty in each ICU were asked to record their activities on appropriate forms (about ten times per each 8-hr shift). Each ICU chose its own method of indicating the moment to record their activity (bell, alarm clock, etc.). At each moment, the answer to the question "what am I doing at this exact moment" was chosen from a list of nursing activities within the ICU (19, 20).

Nurses had to indicate at each moment whether their activity belonged to one of four categories:

1) For nursing activities of care at patient level, items paralleled that in the RNA form. However, in case the duration of the activity could only be estimated at the time of scoring, the formulation of the items in both forms differed slightly. Nurses might not know for how long the activity they were performing might last. For example, the RNA subitem *b* in monitoring and titration (Table 2) is "present at bedside and continuous observation or active for 2 hrs or more in any shift." The corresponding description in the MMR form is "present at bedside and continuous observation for reasons of safety, severity, or therapy, usually involving a moderate amount of time (about 2 hrs)."
2) Activities not relating directly to a patient and not medical, including meetings dealing with organizational issues, the making of duty-rosters, general refilling of supplies for the whole team, trainee supervision, research activities, following professional training in time of service, contact with the general hospital services (category 4 in [5]).
3) Personal activities for the nurse: taking a break, going to the toilet, waiting, chatting (category 5 in [5]).
4) All performed activities that could not be included in the above categories.

Participation in the Work Sampling. Only those ICU personnel who are usually involved with direct patient care and who belonged to the nursing budget were involved. Personnel in the nursing budget but not expected to be involved in patient care (e.g., ICU secretary, cleaning staff) did not participate in the work sampling. Members of hospital personnel who do not belong to the nursing budget (e.g., respiratory therapists, social workers, research monitors) did not participate in the work sampling.

Procedure. The study lasted 2 wks. During the first week, the study was explained to the nursing staff, and the nurses were exposed to the forms and the procedures involved in the work sampling. A detailed operational manual that contained the following was delivered to each ICU:

1. Definitions of the items listed in the RNA.
2. Field research procedures (e.g., code numbers, patient logbook, forms) and attribution of tasks (e.g., coordination, checks of completeness and exactness).
3. Instructions for participating nurses.
4. Checklists.

Table 3. Summary of participating intensive care units (ICUs)

Country	No. of ICUs	ICU Type			No. of Patients	No. of TISS Forms
		Medical	Surgical	General		
Australia	9			9	220	577
Austria	5		1	4	73	294
Belgium	10	2	3	5	249	780
Brazil	7	3		4	115	325
Denmark	5			5	94	230
Estonia	5	1	2	2	87	301
Germany	11	3	6	2	310	764
Italy	6			6	88	302
The Netherlands	3		2	1	78	201
Norway	4		1	3	65	186
Portugal	7			7	80	305
Spain	15		1	14	403	1360
United Kingdom	6			6	88	313
United States	1	1			14	24
France	5	2	3		108	452
Total	99	12	19	68	2072	6414

TISS, Therapeutic Intervention Scoring System.

During the second week (from Monday, January 25, through Sunday, January 31, 1999) both forms were scored according to the protocol. During the 2 wks, a 24-hr help desk was available.

4. Analysis of Data

1. Weighting the Items. After the unequivocal description of the nursing activities to be scored, the weights of the items were computed based on the work sampling method (19). The basic principle of work sampling is that by taking concurrent samples of the work-related activities of employees (e.g., nurses), the relative amount of time spent on each activity can be estimated, resulting in a time-spending pattern.

The weights were computed on the data collected with the MMR forms and the data collected with the RNA forms. The two forms (RNA and MMR) were matched according to patient code number and date. The affirmative score of items in the RNA form indicated that the score of the item in the MMR (1 or 0) could be expected. Conversely, if one item was not scored in the RNA form, its score in the MMR (1 or 0) could not be expected. In this case, a missing value was attributed to the item in the corresponding MMR form.

Theoretically, because there were ten random scoring moments in each nursing shift, if one particular item was scored in all ten times, the item would have used 100% of the nursing time. To give a time dimension to the MMR score, therefore, a value of 0.10 (10% of time) was assigned to each moment the item was affirmatively scored in the MMR form (recoded scores). For each item, the computed weight was equal to the sum of recoded scores (0.10 and 0.00) in the total database divided by the total number of times it was scored (yes or no) in the MMR forms. Two examples:

a) Item 10 (care of airways) was scored (0 or 1) in as much as 52.3% of all MMRs; the scores were 0.10 in 0.95% of the cases and 0 in 51.35% of the cases. Therefore, the computed weight of care of airways (Table 4) is 0.95/52.3 or 0.018 ($\times 100 = 1.8$).
b) Item 15 (cardiopulmonary resuscitation) was scored (0 or 1) in only 0.7% of all MMRs; the scores were 0.10 in 0.05% of the cases and 0 in 0.65% of the cases. Therefore, the computed weight of cardiopulmonary resuscitation (Table 4) is 0.05/0.7 or 0.071 ($\times 100 = 7.1$).

2. Reduction of the Number of Items. After the first analysis, three items scored <1% of the nursing time (arterial catheter, central venous catheter, and active diuresis). These items were eliminated, and the MMRs applying to those items were combined with the MMRs of other items. The MMRs applying to arterial catheter and central venous catheter were combined with the subitems of hygiene procedures (new item 4 in Table 4); the MMRs

Table 4. Nursing activities score items and weights

	Basic activities	Points
1	Monitoring and titration	
1a	Hourly vital signs, regular registration and calculation of fluid balance	4.5
1b	Present at bedside *and* continuous observation *or* active for 2 hrs or more in any shift, for reasons of safety, severity, or therapy such as noninvasive mechanical ventilation, weaning procedures, restlessness, mental disorientation, prone position, donation procedures, preparation and administration of fluids or medication, assisting specific procedures	12.1
1c	Present at bedside *and* active for 4 hrs or more in any shift for reasons of safety, severity, or therapy such as those examples above (1b)	19.6
2	Laboratory, biochemical and microbiological investigations	4.3
3	Medication, vasoactive drugs excluded	5.6
4	Hygiene procedures	
4a	Performing hygiene procedures such as dressing of wounds and intravascular catheters, changing linen, washing patient, incontinence, vomiting, burns, leaking wounds, complex surgical dressing with irrigation, and special procedures (e.g. barrier nursing, cross-infection related, room cleaning following infections, staff hygiene)	4.1
4b	The performance of hygiene procedures took >2 hrs in any shift	16.5
4c	The performance of hygiene procedures took >4 hrs in any shift	20.0
5	Care of drains, all (except gastric tube)	1.8
6	Mobilization and positioning, including procedures such as: turning the patient; mobilization of the patient; moving from bed to chair; team lifting (e.g. immobile patient, traction, prone position)	
6a	Performing procedure(s) up to three times per 24 hrs	5.5
6b	Performing procedure(s) more frequently than 3 times per 24 hrs, or with two nurses, any frequency	12.4
6c	Performing procedure with three or more nurses, any frequency	17.0
7	Support and care of relatives and patient, including procedures such as telephone calls, interviews, counseling; often, the support and care of either relatives or patient allow staff to continue with other nursing activities (e.g., communication with patients during hygiene procedures, communication with relatives while present at bedside, and observing patient)	
7a	Support and care of either relatives or patient requiring *full dedication* for about 1 hr in any shift such as to explain clinical condition, dealing with pain and distress, difficult family circumstances	4.0
7b	Support and care of either relatives or patient requiring *full dedication* for 3 hrs or more in any shift such as death, demanding circumstances (e.g., large number of relatives, language problems, hostile relatives)	32.0
8	Administrative and managerial tasks	
8a	Performing routine tasks such as processing of clinical data, ordering examinations, professional exchange of information (e.g., ward rounds)	4.2
8b	Performing administrative and managerial tasks requiring *full dedication* for about 2 hrs in any shift such as research activities, protocols in use, admission and discharge procedures	23.2
8c	Performing administrative and managerial tasks requiring *full dedication* for about 4 hrs or more of the time in any shift such as death and organ donation procedures, coordination with other disciplines	30.0
Ventilatory support		
9	Respiratory support: any form of mechanical ventilation/assisted ventilation with or without positive end-expiratory pressure, with or without muscle relaxants, spontaneous breathing with or without positive end-expiratory pressure with or without endotracheal tube supplementary oxygen by any method	1.4
10	Care of artificial airways: endotracheal tube or tracheostomy cannula	1.8
11	Treatment for improving lung function: thorax physiotherapy, incentive spirometry, inhalation therapy, intratracheal suctioning	4.4
Cardiovascular support		
12	Vasoactive medication, disregard type and dose	1.2
13	Intravenous replacement of large fluid losses. Fluid administration >3 L/m^2/day, irrespective of type of fluid administered	2.5
14	Left atrium monitoring: pulmonary artery catheter with or without cardiac output measurement	1.7
15	Cardiopulmonary resuscitation after arrest, in the past period of 24 hrs (single precordial thump not included)	7.1
Renal support		
16	Hemofiltration techniques, dialysis techniques	7.7
17	Quantitative urine output measurement (e.g., by indwelling urinary catheter)	7.0
Neurologic support		
18	Measurement of intracranial pressure	1.6
Metabolic support		
19	Treatment of complicated metabolic acidosis/alkalosis	1.3
20	Intravenous hyperalimentation	2.8
21	Enteral feeding through gastric tube or other gastrointestinal route (e.g., jejunostomy)	1.3
Specific interventions		
22	Specific intervention(s) in the intensive care unit: endotracheal intubation, insertion of pacemaker, cardioversion, endoscopies, emergency surgery in the previous 24 hrs, gastric lavage; routine interventions without direct consequences to the clinical condition of the patient, such as: radiographs, echography, electrocardiogram, dressings, or insertion of venous or arterial catheters, are not included	2.8
23	Specific interventions outside the intensive care unit: surgery or diagnostic procedures	1.9

In the items 1, 4, 6, 7, and 8, only one subitem (a, b, or c) can be scored; the weights represent the percentage of time spent by one nurse on the activity mentioned in the item, if performed.

in the item active diuresis were combined with the MMRs of medication (item 3).

After transforming the MMRs' data into percentage of nursing time, the items mechanical ventilation and supplementary ventilatory support had scored almost equally (respectively, 1.3% and 1.5% of the nursing time). The MMRs of these two items were merged into the new item 9 (respiratory support). Similarly, the MMRs of the items single vasoactive medication (1.14%) and multiple vasoactive medication (1.13%) were brought

together in the MMRs of the new item vasoactive medication.

The question of whether an activity is single or multiple in the day is difficult to detect with a work sampling methodology. Besides, the interpretation of the question may be ambiguous because the basic principle of the methodology is: what are you doing now?. This is probably the reason why the item "single medication" (9.9%) and the item "multiple medication" (2.8%) scored differently than would be expected. Therefore, the MMRs of both items were combined with the MMRs of the new item 3 (medication). Similarly, the MMRs of the items "single specific interventions in the ICU" and "multiple specific interventions in the ICU" were put together with the MMRs of the new item 22 (specific interventions in the ICU).

In the item "support and care of relatives and patient" (Table 2), the subitem *a*, "routine communication (with relatives and patient) allowing staff to continue with other nursing activities," was eliminated. As indicated, the activities in this item were performed together with other activities. The MMRs scored in this subitem (n = 2831) were allocated to the involved items (monitoring or hygiene).

RESULTS

Data on 2,105 patients, with 6,534 RNAs, were collected. Of these RNA, 6,451 (of 2,041 patients) covered 24 hrs (RNA referring to <24 hrs were not used). These records corresponded to 127,951 MMRs collected during the same periods of time. Some 31.5% of the MMRs were collected during the day shifts, 35.6% during the late shifts, and 32.7% during night shifts.

In Table 2, the frequencies of the items in the RNA and in the MMR forms are presented. Considering the five new items included in the instrument, their performance is scored in nearly all patient days. Moreover, these activities together equated to about 60% of the average nursing time.

The performance of nursing activities of care at patient level (category 1) was responsible for about 81% of the total time spent by the nurses in the ICU. The nurses spent about 6% of their time with activities not relating directly to a patient and not medical (category 2) and about 11% with personal activities for the nurse (category 3). The activities that could not be scored in the activities of the other categories (category 4) represented 2% of the nursing time.

After the reduction of items in MMR category 1, 23 items remained, and the weights for this new instrument named Nursing Activities Score (NAS) were computed. The weights, representing the relative duration, are presented in Table 4. The NAS weights refer to the nursing activities related to patient care. The score of the individual items in the final list of NAS (Table 4) ranged between 1.3 (in enteral feeding and complicated metabolic state) and 32.0 (in support and care of relatives, full dedication for ≥3 hrs). That is, the weight of 1.3 indicates that nursing activities in relation to enteral feeding and complicated metabolic state last 1.3% of 24 hrs. The sum of scores of the 23 items is between 0% and 177% (or about 1.8 nursing full time equivalents per 24 hrs). Applying the new weights to the 6,451 RNA, the NAS score had a normal distribution (mean ± SD): 56 ± 17.5, median 54. The scores in the total sample ranged between 0 (16 cases confirmed) and 170. The TISS-28 score was also computed on the basis of the 6,451 RNAs. The mean TISS-28 score was 26.9 ± 9.9, and the median score was 27. The correlation between NAS and TISS-28 scores was .56 ($p < .001$).

User Guide. NAS is meant to replace the TISS-28 and other therapeutic indexes used in the ICU. The research leading to the new scoring system (Table 4) used the same set of validated nursing activities that was used in the development of TISS-28. The five new items included in NAS describe nursing activities that were studied in TISS-28 but not included in the final score. The inclusion of these five items was made possible by describing, for each item, a hierarchy of mutually exclusive levels of complexity of care (measured as time duration).

The weights of NAS measure time consumed by nursing activities at the patient level. Opposite to the therapeutic indexes (using a panel of experts), the weights of NAS represent the calculated percentage of nursing time (one period of 24 hrs) dedicated to the performance of the activities listed. The sum of the weights of the individual items scored is the amount of time consumed with the executed activities (or nursing work time) during that particular patient/day. Examples: 1) a score of 100 (%) indicates the work of one nurse per shift around the clock; 2) two patients scoring 50 each did utilize the work of one nursing full-time equivalent per shift around the clock; 3) a total of 350 points is scored in 1 day in the ICU: the unit used the work of 3.5 nursing full-time equivalents on that day.

NAS can be used to measure nursing work load at an individual patient level. In addition, it can also be used to measure nursing work load at the ICU level, considering for example all the patients or a particular group of patients, during a given period of time. The weights of NAS were calculated independently of any evaluation of the severity of illness of the recipients of the activities studied. Measuring the time consumed at the patient level, with the performance of a validated list of nursing activities in the ICU, the score of NAS is independent of severity of illness, case mix, and type of ICU. This allows the standardized use of NAS across units, both for clinical and research purposes.

NAS can also be used as a managerial tool: 1) for estimating the amount of nursing care required for a patient during the next period of time, 2) for a much more accurate measurement of the work utilization ratio (8), 3) for measuring changes in nursing work load as caused by management and policy changes in the unit, and 4) for estimating the money resources (regarding nursing staff) used with patient care.

DISCUSSION

The present study used the classification of nursing activities developed for the TISS-28 study (5). It is noteworthy that the items, selected independently by the different panel experts to be included in NAS, covered exactly those that were described in the category 2 (activities relating directly to the patient and not included in TISS-28) and category 3 (activities that are not performed for, or in direct contact with, the patients but that are necessary for the continuity of the personal care of the patient) in the TISS-28 study. The fourth or miscellaneous category (everything which does not possibly fit in one of the above-mentioned categories) was, again, seldom used (1.6% in TISS-28; 2.1% in NAS). Thus, the categories of nursing activities developed in the TISS-28 study (5) were validated in this study. In other words, the nursing activities are appropriately and comprehensively described in the classification used.

A difference from the TISS-28 study is that the present NAS study allocated time to the activities of the nurses related to patient care in the ICU. The time-spent

pattern regarding the first three categories was almost the same in both studies. Some 77.6% of the time in the TISS-28 study (with 43.3% referring to the TISS-28 items) and 80.8% of the time in the NAS study was related to the first three categories. NAS describes about two times more of the nursing time than TISS-28. Moreover, the NAS study has shown that the items in categories 2 and 3 of TISS-28, which are not scored in that instrument, correspond to the activities more relevant for discriminating the use of nursing time in the ICU. The discrimination of use of nursing time is significantly dependent of the scoring of the new five items included. Therefore, the nursing activities in ICUs are better captured by NAS than by TISS-28 and the NAS weights are more appropriate representations of the use of nursing time.

The work sampling study has shown two limitations of the TISS-28 instrument: it describes <50% of the total working time of the nurses in the ICU, and the choice of the items included was guided by the hierarchy of complexity of the interventions rather than by a scale of time consumed with their performance.

At the patient level, the time spent with the five new items correlates poorly (R^2 = 7.5%) to the time spent with other items (concerning therapeutic interventions) in the NAS score. The higher correlation observed between the TISS-28 scores and the NAS scores (R^2 = 31%) seems to express the impact of the weights originally attributed by the panel of experts (TISS items). These results suggest that the calculated correlation between NAS and TISS-28 scores indicates the approximate magnitude of the actual relation between severity of illness and resource use in the ICU.

The advantages of the design used in this study can be summarized: 1) the short duration of the study favors the uniformity of data collection: 1 wk for training of the participants and 1 wk for data collection, guided by clear protocols; 2) the large number of ICUs spread over 15 countries improves the capture of different types of patients, particularly of different ways of working; 3) because of the large number of MMRs collected, the results of the study are the expression of simple counts rather than of statistical predictions. Regarding the analyses, it should be noted that by combining the items with frequency lower than 1% with other items, the final weights are based on highly reliable data.

The design of the study presents limitations that should be considered when reading this article:

1) The participating ICUs were selected on a voluntary, not random, basis. This method, although possibly assuring the good will for correct compliance to the protocols, does not exclude bias concerning the clinical (e.g., case-mix) and the organizational (e.g., staffing) benchmarks of the ICUs. The large number of MMRs collected may have played down the impact of eventual bias due to voluntary participation.
2) The MMRs were collected in an unmonitored way. Nurses might have been tempted to score more complex activities more often in the forms. However, we have checked this and found that activities scored in the MMR form corresponded exactly with items scored in the correspondent RNA, which was filled in by an independent rater.
3) Regarding the comparison between the relative TISS-28 weights and the relative NAS weights, the calculation of the first can be criticized. The average of 46 TISS-28 points per nurse per 24 hrs has a SD of 18. Moreover, each sum score refers to a different composition of items. As a consequence, weights based on the time spent, as in NAS, refer to similar underlying measure (time) and are *a priori* better.
4) The number of participating ICUs was not constant per country. Although the number of patients enrolled per ICU is similar among units, the total number of patients admitted per country is different (Table 3). Apart from differences in working practices, differences in the number of patients per nurse (patient/nurse ratios) between shifts is important: namely, the number of MMRs depends on the number of nurses. During times when there is a shortage of staff, essential activities for patient care will seem to be more common. In the TISS-28 study, for example, the distribution of the MMRs among the three daily shifts was not uniform: more recordings were collected during day shifts than during late and night shifts (5). This pattern seems to indicate the marked reduction of nursing staff during some shifts in the Dutch ICUs. The same reduction was not observed in the present study, and thus, the present data are highly representative for all shifts. The more homogeneous distribution of MMRs, suggesting a higher robustness of the present database, may result from the international and multicenter design of the study. A detailed analysis of the data, concerning these aspects, will be published elsewhere.

The Nursing Activities Score system is based on the real-time assessment of the duration of nursing activities, independently of the severity of illness of the recipients of care.

Implications of the System. The NAS system is based on the real-time assessment of duration of nursing activities, independently of the severity of illness of the recipients of care. This is an important difference in relation to the TISS system in which the estimation of the weights was based on the perceived relation between severity of illness and the complexity of nursing activities. With exclusion of discriminating severity of illness, the indications for the use of NAS in the ICU will be similar to the current indications for the use of TISS. It can be anticipated, however, that at least two features of the new NAS system may prove to be relevant.

a) The capability of measuring nursing work load, in terms of time used, is almost three times more accurate with NAS than with TISS-28. As a matter of fact, NAS is not a proxy of use of nursing resources (such as TISS-28); NAS quantifies work load rather precisely. This will improve the daily management of human resource use at patient level in the ICU. Besides, it will also enhance the effectiveness of the duties of planning, costing, and auditing in the ICU.
b) The five new activities included (Table 2), together with the new weighting of all items in the score, improved un-

derstanding of the nursing activities in the ICU. First, of the daily nursing activities, the larger amount of time is dedicated to the performance of the five new items (monitoring, hygiene, mobilization, support of relatives and patients, administrative tasks). The new system will enable a more detailed analysis of the activities carried out by nurses, determining whether improvements could be made in the processes of care and in the distribution of tasks among the various professionals in the ICU. Second, only 30% of the nursing time is spent with activities related to the use of technology specific to the ICU (Table 4). For at least two thirds of the time, therefore, the nurses do perform activities that are not unique to the ICU environment. These findings suggest, on one hand, that the education of intensive care nursing might be more feasible (involving only about one third of the ICU staff) than some would anticipate; on the other hand, they may stimulate, and guide, a new career in the intensive care nursing (e.g., through the structured use of nurse practitioners).

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APPENDIX

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