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*Development of nursing time standards as a problem  
of optimisation of health care system management.  
II. Comparative analysis of demand for nursing care*

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Normowanie czasu opieki jako problem optymalizacji  
zarządzania systemem ochrony zdrowia.

II. Analiza porównawcza zapotrzebowania na opiekę pielęgniarską

The implementation of a new method of staff scheduling, irrespectively of the specific character and type of the organisational system, is a methodological problem associated with the correct classification of patients into defined categories of care, as well as the psychological issue connected with the fear concerning the reduction in the number of nursing staff, in the case of confirming a smaller demand (3).

At the preliminary stage of conducting research work in order to determine the demand for direct nursing care ( $T_{dir}$ ) an available PCS method was applied according to which patients were ascribed to four categories of care – the nursing time being: Category I – 30 min/day/patient; Category II – 60 min; Category III – 90 min and Category IV – 210 min. Standard deviations (SD) which were: 10, 15, 20 and 35 min/day/patient, were also considered (5). After own method had been developed it became clear that the demand for direct nursing care in Polish hospitals fell into three categories of care: Category I – 38 min/day/patient; Category II – 95 min; and Category III – 159 min. In own studies SD was small, and the values in three categories of care were: 0.45; 0.79; and 0.97 min/day/patient.

Based on the analysis of the research material from three *Measurements* it may be assumed that the demand for direct nursing care determined by the author and the research team (*Measurement 3*), defined by the number of patients in individual categories of care, is the closest to the real needs. This demand was: for Category I of care – 74.85%; II – 17.32%; III – 5.92% and IV – 1.91% of the total number of patients. In the records kept by nurses in the ward, especially in *Measurement 1*, patients were significantly more often classified into Category IV of care (6.00%) according to the subjective evaluation of the state of health of those patients who were considered “the most severe” in the ward on a particular day, and by objective criteria of care. In *Measurement 1* the following data were obtained for individual categories of care: I – 46.79% of patients; II – 35.15%; and III – 12.06%.

For the purpose of general analysis of patients' demand for direct nursing care, according to a previously applied method, and that verified by the author of the present paper, mean  $T_{dir}$  times were calculated which were obtained from three measurements in 27 wards of military hospitals. According to the previous method, the data from four categories of care were analysed in order to determine  $T_{dir}$  time, whereas, by own method, patients of Category IV were included in Category III of care.

The essential problem is – answers to the following questions: *Are there any differences in direct nursing time ( $T_{dir}$ ) when patients are ascribed to IV or III category of care? What is the effect of both methodological proposals for the determination of direct and auxiliary nursing time on the number of nursing staff on an annual scale (P)?*

## MATERIAL AND METHODS

The material collected in 1993 and 1994 from three measurements in 27 wards of military hospitals was qualified for comparative analysis. Own direct nursing time standards were determined, based on 930 time-scheduled measurements of various nursing activities performed in 102 patients (N) hospitalised in three surgical wards in the Military Clinic in Cracow, National University Hospital No. 4 in Lublin and in surgical and internal diseases wards in the Military Hospital in Lublin (4).

The formula to calculate the direct nursing time ( $T_{dir}$ ) for four categories of care, according to the proposal by another author, has the following form (5):

$$T_{dir} = 30 N_I + 60 N_{II} + 90 N_{III} + 210 N_{IV} + 1.28 V_t + 2 \text{ min } N$$

The author of this method acknowledged that time demands have a normal distribution and are statistically independent, thus, on this basis the maximum, as well as an expected direct nursing time was assessed (2). The basis of the calculation was the calculation of the total variance ( $V_t$ ) of demand as a root of the sum of product of variance and number of patients in individual categories, according to the following formula:

$$V_t = \sqrt{N_I V_I^2 + N_{II} V_{II}^2 + N_{III} V_{III}^2 + N_{IV} V_{IV}^2}$$

Variances  $V_I$ ,  $V_{II}$ ,  $V_{III}$  and  $V_{IV}$  are quadrants of the standard deviations (10, 15, 20, 35 min). In order to calculate the demand for the direct nursing time the product of  $V_t$  variance and 1.28 standard deviation is added or subtracted, and the time of 2 minutes is added for each patient during the hours 24.00 – 06.00.

The nursing time in the own method was calculated based on the following formula:

$$T_{dir} = 38 N_I + 95 N_{II} + 159 N_{III} + 2 \text{ min. } N + V_t 1.28$$

In order to unify the method of  $T_{dir}$  data, calculation of the determination of  $V_t$  was considered in own method, practical application of which is not recommended due to small SD values.

$$V_t = \sqrt{0.45^2 N_I + 0.79^2 N_{II} + 0.97^2 N_{III}}$$

As described in Part I of the paper, the number of staff is determined by the auxiliary nursing time ( $T_{aux}$ ), which may be defined according to the number of beds, with their usage index ranging from 85–90%, as suggested by foreign authors (1). If this index is smaller, which is the case in Polish hospitals,  $T_{aux}$  time should be referred to the bed usage index.

$T_{aux1}$  – was determined in proportion to the number of beds: 30 beds – 50 hours/day,  $T_{aux2}$  – was determined from bed usage index,

$$T_{pc} = T_{dir} + T_{aux}$$

$$P = \frac{T_{pc} 365}{T_d}$$

In order to discover the value of differences between the number of duties per day ( $T_{pc}$ ) or nursing posts ( $P$ ) on an annual scale, calculated according to the number of beds ( $P_1$ ) and by their usage index ( $P_2$ ), t-Student test was applied, considering indices for individual hospitals separately and analysing collected data from all military hospitals in general. In addition, for the determination of the values of differences between  $P_1$  and  $P_2$  an interval estimation method was applied, and by this method the confidence interval was indicated where the difference occurred.

## RESULTS

The analysis of the demand for direct care ( $T_{dir}$ ) in the Military Hospital in Lublin showed that the mean  $T_{dir}$  time devoted to nursing for three categories of care was generally greater (31.68 hour/day/hospital), compared to four categories of care (23.88 hour/day/hospital). This resulted from greater elementary time in Categories I, II, and III of care in own method, compared to the proposal assuming the classification of patients into four categories of care – which, due to small number of patients who were ascribed to Category IV of care, had little effect on the general time on a daily scale. The differences observed between mean daily  $T_{dir}$  time with reference to the classification of patients into four categories of care were by almost eight hours more on 24 hour scale, to the advantage of the method with three categories. In the Military Hospital in Przemyśl this difference was slight – 3.7 hour/day, whereas in the Military Clinic in Cracow – 5.8 hour. In general, for all the three military hospitals, the mean  $T_{dir}$  time according to the proposals for the classification of patients into three or four categories of care, differed by approximately 5.8 hour of  $T_{dir}$  care during day/hospital, on the behalf of the method with three categories of care Fig. 1.

Apart from the analysis of the demand for  $T_{dir}$  care according to classification of patients into three or four categories of care, which showed slightly greater demand in own method, the following issue was of interest: Does the demand for  $T_{dir}$  in patients classified into four categories differ statistically from that among patients classified into three categories? An answer to this question was essential, as some hospitals currently use the proposal of classification of patients according to four categories, however, taking into consideration that this method requires verification as the organisa-

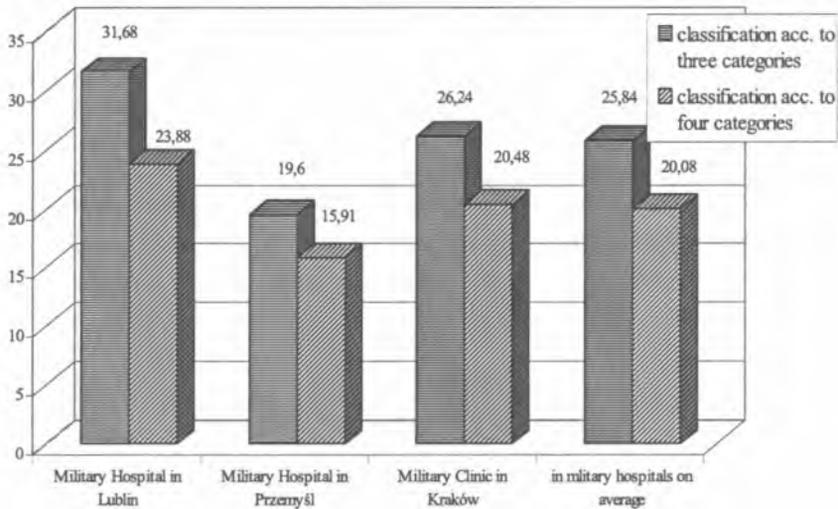


Fig. 1. Mean demand for direct nursing care in military hospitals in classification of patients into three and four categories of care (hour/day/hospital)

tion of nursing care is improving and PCS methods become adjusted to the practice in Polish hospitals.

In order to evaluate the differences between the two proposals of calculating direct nursing time, a comparison of  $T_{dir}$  mean values was performed by means of t-Student test, with reference to individual Military Hospitals in Lublin, Przemyśl and Cracow, as well as in all these hospitals in general Table 1. Based on the statistical analysis, no significant differences were noted in  $T_{dir}$  time between both methodological proposals.

Auxiliary activities are performed away from the patient. The tasks associated with the preparation for procedures according to doctor's instruction, documentation, cleaning, purification, supply-

Table 1. Demand for direct nursing care in military hospitals according to classification of patients into three and four categories of care – statistical analysis

Military hospital	$T_{dir}$ time according to:	Mean $T_{dir}$ time	Standard deviation	Test function	Probability	Significance
Lublin	4 cat. of care	23.88	14.10	- 0.93	p > 0.05	lack
	3 cat. of care	31.68	18.98			
Przemyśl	4 cat. of care	15.9	6.90	- 0.85	p > 0.05	lack
	3 cat. of care	19.6	8.91			
Cracow	4 cat. of care	20.48	11.50	- 1.06	p > 0.05	lack
	3 cat. of care	26.24	15.40			
Total	4 cat. of care	20.30	11.40	- 1.61	p > 0.05	lack
	3 cat. of care	26.20	15.40			

ing the ward and communication with other members of the staff took the nurses 50–70% of  $T_{dir}$  time, according to the type of hospital and type of wards. Such a structure of the working time did not always depend on nurses or their direct supervisors. It was generally conditioned by the lack of well organised auxiliary activities, such as: transport within an individual ward, supply of equipment, underwear, drugs, dressing materials, availability of the results of tests from laboratories to the wards. Due to the above,  $T_{aux}$  time had the greatest effect on the number of nursing staff both during a day ( $T_{pc}$ ) and on an annual scale ( $P$ ). The number of working staff ( $P$ ) was also affected by the discretionary time ( $T_d$ ) which is worked out by nurses in individual hospital wards during a year.

The demand for non-nursing time ( $T_{aux}$ ) differed according to the method of calculation. The amount of  $T_{aux}$  time was greater, and in consequence the number of nursing staff increased if this time was calculated in proportion to the number of beds. It decreased, however, when the point of reference was the index of bed usage in percentages, especially of low values.

Although in individual hospitals the method of  $T_{dir}$  calculation did not indicate statistically significant differences, while considering the general number of working posts on an annual scale, the data referring to  $T_{aux}$  time in association with the method of  $T_{dir}$  time calculation according to four or three categories of care, exerted a significant effect on the number of posts in an individual hospital.

The general number of work posts in the Military Hospital in Lublin, where the  $T_{dir}$  time was considered, calculated according to three categories of care, was greater Fig. 2. While calculating  $T_{aux}$  time according to the hospital bed usage index, expressed in percentages, according to own method, the number of work posts was 125 and differed by 13.6 from the method with four categories to the advantage of that with three categories. If the method of calculating  $T_{aux}$  time by the number of beds (150 posts) is considered – which is rejected as not very reliable – the method with three categories of  $T_{dir}$  time would indicate the demand for a greater number of nurses by 67 posts more, compared to the 83 posts currently at the hospital's disposal. In three categories of  $T_{dir}$  care, however, and with  $T_{aux}$  time calculated based on the hospital bed usage index, the deficiencies in the number of work posts in the Military Hospital in Lublin would be 41 posts, with 83 workplaces available.

The differences in the demand for nursing care according to the method of calculation, expressed by the number of work posts in general, were also observed in the Military Hospital in Przemyśl Fig. 3. When the classification of patients into four categories of care was considered,  $P_1$  was equal to 88.5 work posts and  $P_2$  – 68.5. These differences increased in figures when the data calculated for three categories of  $T_{dir}$  time – taking into consideration the number of beds (96.3 posts) and their usage index (74 posts) – were included into the comparative analysis. The comparison with the actual number of workplaces during the study (54) indicated a deficiency equal to 20 posts, taking into consideration the bed usage index and classification of patients into three categories of care.

The demand for nursing care in the Military Clinic in Cracow, calculated according to the number of beds ( $P_1$ ) and four  $T_{dir}$  time categories, showed the need for 217 posts, whereas while considering bed usage index ( $P_2$ ) – a demand for 167.7 posts Fig. 4. The difference was 50 posts, which, when compared to the number of posts at the hospital's disposal (121) constituted 41% of the total number of nurses employed. When the calculation of  $T_{dir}$  time in four categories (167) and in three categories (183) was included into the comparative analysis, the difference observed in the demand was 15 posts, to the advantage of the method considering classification of patients into three categories of care and the calculation of  $T_{aux}$  time based on hospital bed usage index. In the Military Clinic in Cracow, the

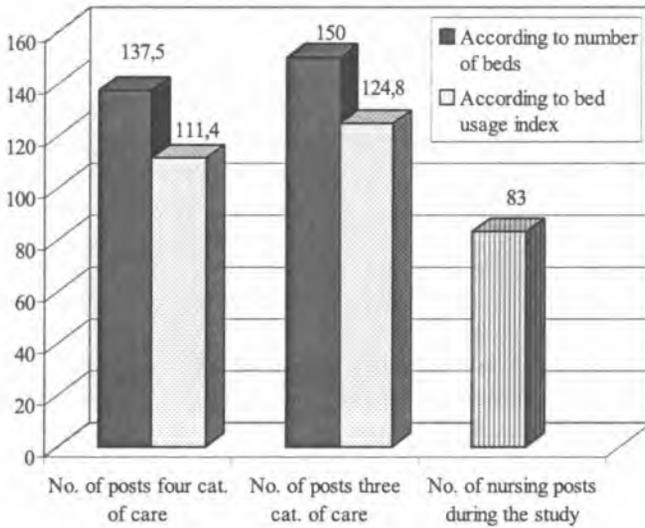


Fig. 2. Demand for nursing posts according to number of beds and bed usage index in classification of patients into three and four categories of care in the Military Hospital in Lublin

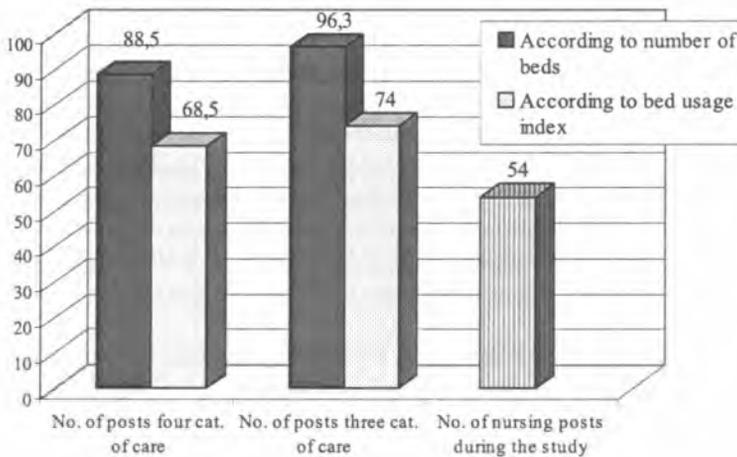


Fig. 3. Demand for nursing posts according to the number of beds and bed usage index in classification of patients into three and four categories of care in the Military Hospital in Przemyśl

comparison of the number of posts currently available (121) and the desired number of posts, determined based on own method with three categories of care and considering bed usage index, showed the demand for 62 nursing staff posts.

With reference to three military hospitals in general Fig. 5, the nursing posts calculated by four categories of care and number of beds was 443.6, while according to the bed usage index – 347.6. Taking into account the method with three categories, the general number of posts for three hospitals was 479.3, with the bed usage index – 382; with 258 nursing posts available per 596 patients, and with bed usage index of 77% on average in the military hospitals in Lublin, Przemyśl and Cracow.

A comparative analysis was conducted by t-Student test in order to investigate if statistically significant differences were noted between the index of the number of beds –  $P_1$ , and bed usage index –  $P_2$ , as well as the number of posts calculated based on these indices. Due to the small number of beds in the wards of individual hospitals the data from the three hospitals in Lublin, Przemyśl and Cracow were combined into one set. The posts were compared with consideration of both the classification of patients into Category IV of care  $T_{dir}$  time, as well as Category III. With reference to the posts calculated by the number of beds ( $P_1$ ) and the index of their usage ( $P_2$ ), with the consideration of the classification of patients into Category IV of  $T_{dir}$  care, statistically significant differences were noted in the number of posts calculated according to  $P_1$  and  $P_2$  indices. In order to determine the value of this difference, the confidence interval was calculated by means of an interval estimation method, which defined the interval in which this difference occurred:

$$261.76 < u_{p1} - u_{p2} < 13,293.04$$

The comparison of nursing posts calculated for military hospitals in general according to the number of beds ( $P_1$ ) and index of their usage ( $P_2$ ), with consideration of own  $T_{dir}$  time determination method, showed statistically significant differences in the number of posts calculated according to  $P_1$  and  $P_2$ . The method of interval estimation, based on the confidence interval calculated, showed the interval in which the difference occurred:

$$120.09 < u_{p1} - u_{p2} < 214,455.71$$

## DISCUSSION

The classification of patients into four or three categories of care has no statistically significant effect on the calculation of  $T_{dir}$  time in individual hospitals. Although it should be stressed that with reference to all military hospitals, the analysis showed that the determination of the demand for direct nursing care according to three categories of care, with a higher elementary time for each of them, indicated the need to provide a slightly greater number of nurses on a daily scale than according to the method of patient classification into four categories.

The lack of statistical significance in the determination of the demand for  $T_{dir}$  care, according to three and four categories of care on a hospital scale, allows us to presume that organisational units which currently classify patients into four categories of care may continue to do so, considering, however, that the demand for  $T_{dir}$  time determined by them will be slightly smaller than if they applied the method with three categories of care.

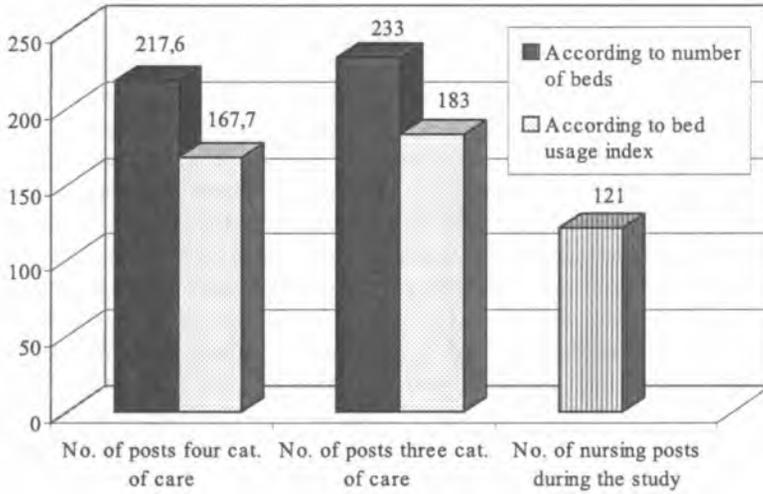


Fig. 4. Demand for nursing posts according to number of beds and bed usage index in classification of patients into three and four categories of care in the Military Clinic in Cracow

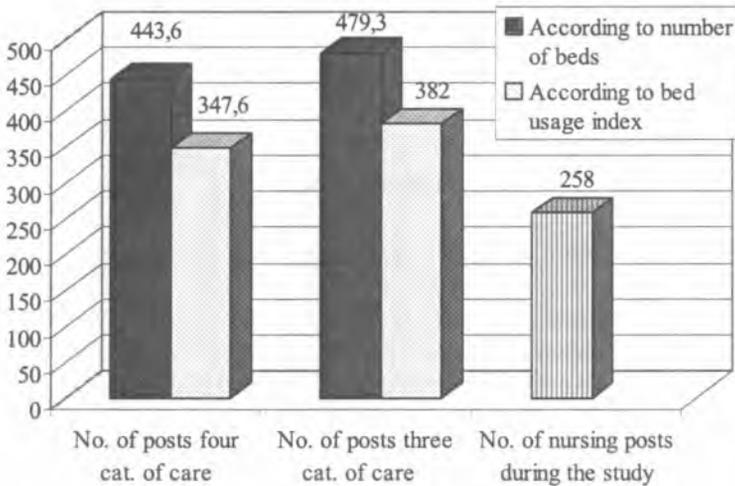


Fig. 5. Demand for nursing posts according to the number of beds and bed usage index in classification of patients into three and four categories of care in military hospitals in general

In management practice, the methods which simplify the problem examined and are less time consuming during their application will be more valued. The own, verified method of nursing staff scheduling proposed, referring the  $T_{dir}$  time to three categories of care and not requiring in practice arduous calculations of standard deviations due to low SD values may constitute a considerable help for practitioners. This method may be especially helpful in those hospitals which are not familiar with the problem of staff scheduling according to the demand for nursing care according to PCS method, and are faced by the necessity to improve services and determine the number of staff according to patients' needs.

The choice of a method for the determination of the auxiliary time ( $T_{aux}$ ), however, is of primary importance for defining the number of nursing posts on an annual scale. If the number of beds is preferred – the number of posts increases. Hence, the method for the determination of  $T_{aux}$  time considering bed usage index is closer to the real values.

## CONCLUSIONS

1. No statistically significant differences were observed in the determination of the direct nursing time according to the methods with four and three categories of direct care.

2. Statistically significant differences appear, when the number of beds and not the index of their usage are considered while calculating the auxiliary time. The selection of the first option causes overestimation in the number of staff with reference to the actual patients' demand.

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## STRESZCZENIE

Analiza porównawcza zapotrzebowania na opiekę pielęgniarską wyznaczoną według metod klasyfikacji pacjentów wykazała, że nie ma różnic istotnych statystycznie w liczbie etatów pielęgniarskich, gdy pacjentów przydziela się do trzech lub czterech kategorii opieki bezpośredniej. Różnice są znaczące, kiedy przy obliczaniu czasu pomocniczego bierze się pod uwagę liczbę łóżek, a nie wskaźnik ich wykorzystania.