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Determining Optimal Nursing Resources in Relation to Functions During the Oulu University Hospital Nurse Staffing Management Project

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> Abstract. The Oulu University Hospital's staffing management project sought information on the number of nursing staff in relation to treatment days and visits, using existing indicators to describe the activities involved. The retrospective data obtained was compared to human resources and the personnel structure. On this basis an optimal number of staff was determined for the units, taking account of a range of explanatory indicator data. The project made use of the computational model for nurse staffing and the World Health Organisation's (WHO) Workload Indicators of Staffing Need (WISN) method. The project provided extensive information on human resources issues within the units. Its results indicated the differences between wards with respect to the number and structure of resources. In addition, the nurse administrators lacked skills in gathering and using data from administrative datasets. This information will provide support for the further development of nursing operations and nursing management decision-making.

> Keywords. Nursing staff, personnel staffing and scheduling, workload, WISN-model, management information systems

1. Introduction

The ageing population, new technology and demand for higher quality of care, combined with shrinking budgets and nursing shortages are creating new challenges for health care. In Finland, as in other high-income countries, we have an ageing nursing workforce caring for increasing numbers of elderly [1]. On the other hand, higher staffing levels and a richer skills mix improve patient outcomes, for instance in relation to falls, medication errors, surgical wound infections, pressure injuries, pneumonia, upper gastrointestinal bleeding, sepsis and even deaths [2, 3, 4]. Such studies also argue that the staffing level and skills mix affect nurses' wellbeing [5] and intention to leave [6]. This makes it particularly important to find the optimal staffing level for promoting

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quality of care and nurse and patient satisfaction, and to prevent nurses from wishing to leave the profession.

The nurse staffing project in Oulu University Hospital (OUH) in Finland sought to provide information on the number of nursing staff in relation to treatment days and visits, using indicators from the management information system to describe the operations concerned. The information obtained was compared to human resources and the personnel structure, on the basis of which an optimal number of staff were determined for the units in question while taking account of various explanatory indicator data. Nurse staffing levels were also calculated for Kuopio University Hospital (KUH) in East Finland [7], but without evaluating all nursing units.

2. Methods

The project involved the use of the computational model for nurse staffing developed during the Nurse Staffing Management Development project as part of a broader project for designing a new building for the KUH [7, 8]. The WHO's WISN-tool [9] was also used to gather existing data from information systems in the organisation.

The data was collected retrospectively from all 111 independent or related units of the OUH in which nursing staff with a range of professional titles work. Nursing staff include registered nurses, midwives, assistant head nurses (if not wholly administrative), physiotherapists, occupational therapists, radiographers, dental hygienists and licensed practical nurses. The study covered all of the hospital's current specialties. The final sample consisted of information on 142,193 treated patients, 302,650 in-patient care days, 627,304 outpatient visits and 34,631 operations in 2013, and administrative information (workload, posts, divisions of tasks, absences) on 2,518 nurses. The WISN tool was used to compute the available working time of nurses; for one nurse it averaged 1,542.24 hours per year, excluding various types of absences (public holidays, annual leave, vacations, sick leave and other leave) in OUH. For both subjects, patients' care needs and nursing resources were converted into hours. The basic formula for the unit's computational nurse staffing need (CNN) was:

$$CNN = \frac{Patients' care needs in hours * NP (nurse-to-patient)-ratio}{available working time of one nurse}$$

Patients' care needs were based on registered data on the units' day-to-day functions and the time needed. On the hospital wards, the patient day lasts 24 hours, so the need for care calculation formula is: *(number of in-patient days (ipd) in one year * 24 hours)*. Outpatients' visits and time spent in the operating theatre can vary from a few minutes to several hours. Account should also be taken of other essential activities that require nursing resources.

The NP-ratio indicates the nurse-to-patient ratio [10] and is calculated as follows: [1/ (average in-patient days in one week/nurse workload)]. For example: in one surgical ward there are 158 in-patient days in one week and the nurse workload is $28 \rightarrow 158 / 28 = 5.6$ in-patient (=treatment) days per one nurse workload, i.e. 5.6 patients per one nurse per day. To obtain the NP-ratio, you need to calculate: 1/5.6 = 0.18. This is the ratio for each nurse workload per day receivable per patient. The NP-ratio varied between in-patient units: from 2.0 for ICU patients (two nurses to one patient) to 0.08

for postpartum mothers with newborns (one nurse cared for an average of 12.5 mothers or newborns each day). In internal medicine and surgical units, the NP-ratio ranged

or newborns each day). In internal medicine and surgical units, the NP-ratio ranged between 0.18 and 0.22 (4.5–5.5 patients per nurse per day). We also used a higher value of 0.5 for the highest intensity in-patient days. Nursing intensity was measured using the Oulu Patient Classification (OPCq), part of the RAFALA patient classification system [11] which has been systematically used in OUH for over 15 years. For outpatient clinics and operational theatres the average nursing time was calculated for various patient functions and visits. Below is an example of a calculation for one surgical in-patient unit:

$$CNN = \frac{8000 \text{ ipd}^{*}24 \text{ hours } * 0,20(\text{NP-ratio}) + 100 \text{ high intensity ipd}^{*}0,5}{\text{available working time of one nurse}} = \frac{38 400 \text{ h}+50 \text{ h}}{1542.24 \text{ h}} = 24.9$$

The computational nurse staffing need (CNN = 24.9) was then proportioned to the unit's number of nurse vacancies (N=30) and the resulting ratio (24.9/30 *100 % = 83%) provided information on the usage level of nurse resources in care processes [7]. In addition to the units' actual nurse staffing volume, much information had been published on work intensity and issues affecting staff workloads, such as the number of students, division of labour, transfer and cancellation of nursing time, the ratio between registered nurses and licensed practical nurses, and the percentage of emergency treatment periods.

3. Results

3.1. Computational results

The ratio between the computational nurse staffing need and the posts in each unit was calculated. This ratio provided information on the usage level of nurse resources in care processes [8]. Within the units, the ratio of nurse staffing needs to vacancies varied between 55 and 129%. When the ratio was between 80 and 90 %, the unit's nurse staffing was considered adequate, at optimal level, but at 90–100% it indicated a need for process development. If the ratio was over 100% and no other results were



Figure 1. Nurse staffing situation in relation to functions in different sectors of OUH.

indicative of understaffing, there was an obvious need for additional resourcing. If it was under 80%, in terms of current nursing functions the resources available can be deemed excellent.

3.2. Results of explanatory factors

The number of students varied greatly. In general, there were more students in wards than in outpatient clinics. Nurses had many non-nursing duties such as cleaning, clerical work and service provision (meal, logistics and transfer). Providing advice to others (mainly doctors and support workers) was very common in almost every unit. Much time was also spent transferring and cancelling outpatient visit times. During 2013, around 80,000 outpatient visits were transferred and cancelled, involving an annual workload equivalent to that of 12 nurses or clerical workers. The ratio between registered nurses and licensed practical nurses varied between 71% and 100% in wards and 45% and 100% in outpatient clinics.

4. Discussion

The nurse staffing project provided the units with a tool for allocating the correct number of nurses to different teams. It also helped in directing development at the right issues and provided staff with information on the content of work and the time devoted to various tasks. In itself, the ratio between the computational nurse staffing need and vacancies changes nothing, but it does provide transparent and comparable information for the planning, follow-up and evaluation of nurse staffing [8]. An enormous range of data is produced within health care organisations, which could also be used for managerial purposes [9, 12]. The project revealed that nurse administrators lack the uniform competencies and information literacy required to use management information systems. This need for further education has been identified on previous occasions [12]. There is an essential need for nurse informaticists in healthcare to support and educate with different kind of information systems and data capturing [13].

Most of the data was collected by two researchers, but all phases of the study were analysed together with the units studied. A major reliability factor was the nurse-topatient ratio, which decreased as the number of patient episodes increased in a situation with unchanging resources. Within certain limitations, the NP-ratio needed to be standardised for this reason.

The results indicated that the staff situation in in-patient care units is fairly good on the whole, but there are differences between wards with respect to the number and structure of resources. Account should be taken of the poorer nursing staff resource situation in outpatient clinics and other open care units when rectifying staff shortages and beginning new open-care operations. In the current economic situation, there is a great temptation to reduce staffing in units with optimal or better resources, but many other issues affecting staff workloads should considered. On the basis of the results, the clearest staffing deficiencies were rectified immediately between hospital division areas, since increases in the workloads of nurses 'are associated with serious medical events' [2]. Less acute shortcomings could be addressed by developing the occupational division of labour, renewing operational processes and distributing staff evenly between the responsible units. Sensible resourcing could be supported by

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introducing new technology and improving nursing practices. The development of new IT systems enabling patients to reserve and cancel visits online and provide pre-surgery information has begun. Staffing calculations within the units should be updated if operations change substantially or processes are developed in a manner that enables the release of staff resources. It will soon be necessary to assess the impacts of measures taken in relation to patient care outcomes.

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