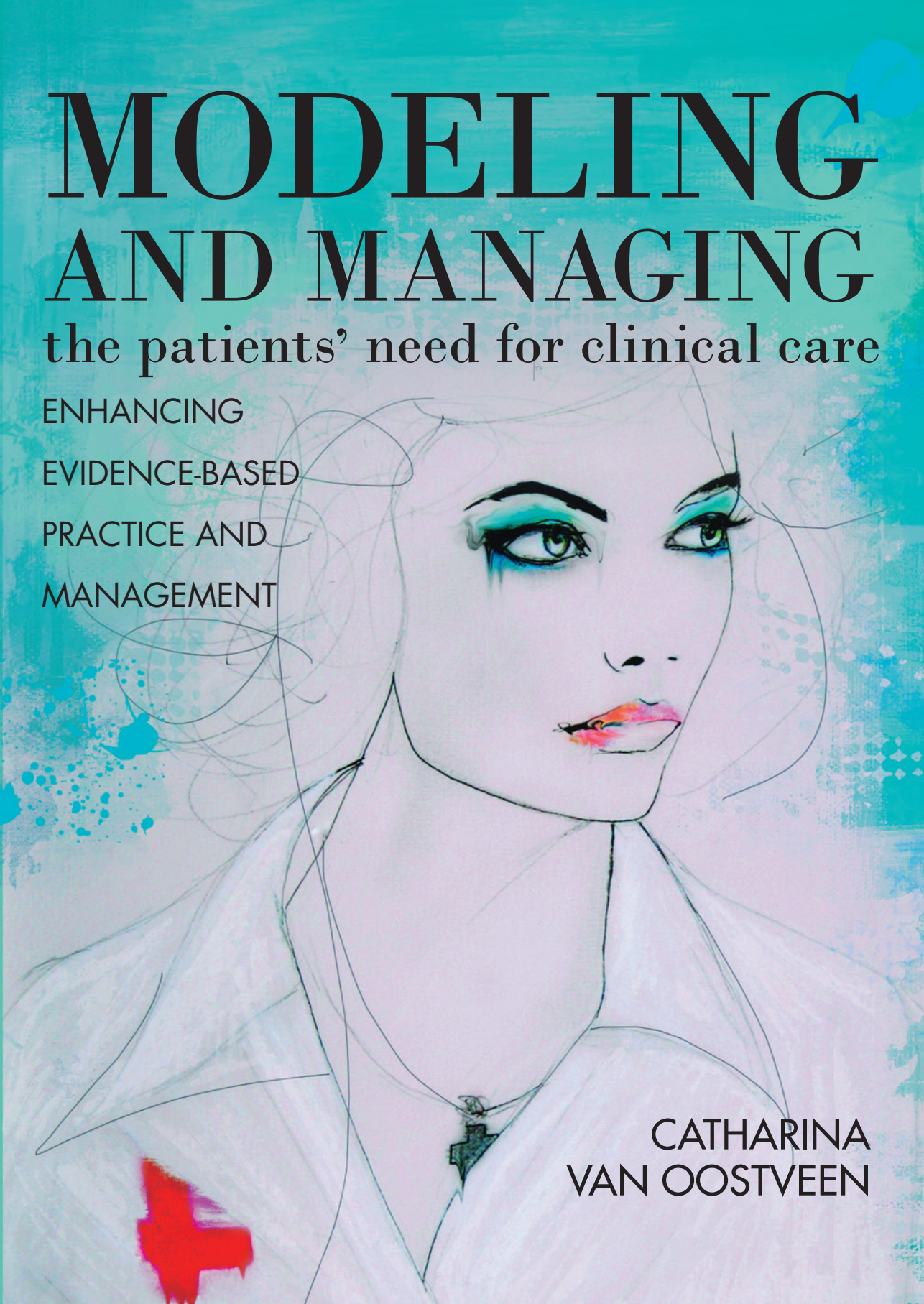
MODELING AND MANAGING

the patients' need for clinical care

ENHANCING EVIDENCE-BASED PRACTICE AND MANAGEMENT



CATHARINA VAN OOSTVEEN

Uitnodiging

Voor het bijwonen van de openbare verdediging van het proefschrift

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Op vrijdag 20 februari 2015 om 11:00 uur in de aula van de Universiteit van Amsterdam, Oude Lutherse kerk, Singel 411 (hoek Spui) te Amsterdam. Receptie na afloop van de promotie aldaar.

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UNIVERSITEIT VAN AMSTERDAM

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ACADEMISCH PROEFSCHRIFT

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GENERAL INTRODUCTION AND OUTLINE OF THIS THESIS

GENERAL INTRODUCTION

Given the current societal developments such as survival to an older age and increasing co-morbidity, the demand for medical and nursing care is expected to increase, while the available number of healthcare professionals is likely to dwindle. In addition, due to expensive technological innovations leading to more treatment options for a wider range of indications, health expenditure will continue to rise. These developments cause a shift from predictable and scheduled clinical care to, for example, outpatient care or home care, while the more complex patients, who need tertiary referral clinical care, stay in hospitals. This causes an increased demand for complex clinical medical and nursing care in these hospitals[1]. This challenges hospitals to provide more complex, effective, and affordable services without lowering the quality. This requires and promotes more evidence-based nursing care (EBN) as well as evidence-based management (EBMgt)[2].

Clinical challenges

Medical directors, nurse directors, policy advisors, physicians and (head) nurses on clinical wards nowadays recognize the changing demography of their patient population and increasing accountability of their hospitals.

Below are some illustrative examples of challenges and questions they are facing:

Medical director, on strategic level; "Which factors are good predictors for the demand for care of my patients? Is it age, the patients' comorbidity or maybe (a combination of) other factors? I need information to substantiate my (top)referral patient population and to negotiate reimbursement issues with insurers…"

Nurse director, on tactic level; "The nurse staffing levels on my wards are critically low. What factors did you (a policy-advisor) use for formulating these levels? Was the patients' care intensity involved? What information can we use to discuss these staffing levels? How can we ensure safe personnel staffing?"

Head nurse, on tactic/operational level; "I have a few unoccupied beds and the patient care intensity per nurse is rather comfortable today. However, I have to discuss new admissions with the ward surgeon as this can have consequences for his operating schedule and our ward production. Which facts do I need to discuss with him? I might also lend some of my staff to another nursing ward with a high care intensity per nurse. However, which ward would need my nurses the most?"

Policy–advisor, on tactic level; "We have some information about safe staffing for nurses. However, this information is based on mainly American or Australian studies. For physicians, safe staffing on general wards is just a black box. What are the optimal nurse and physician staffing levels in the Netherlands?"

Nurse, on operational level; "Today we have 28 patients and 5 nurses. To whom are we going to assign our patients? Should we assign based on the patients' care intensity? Which nurses know which patients? Do some patients need special nursing skills? Can all nurses be assigned for 100%?"

These everyday clinical scenarios expose information gaps about:

1. factors influencing or predicting the patients' demand for care,
2. the consequences of the resulting care intensity for staffing and
3. how to organize care on clinical wards.

Medical directors, nurse directors, policy advisors, physicians and (head) nurses are in want of evidence-based parameters and tools enabling them to efficiently organize and manage their hospitals and wards, including interdisciplinary communication and negotiation.

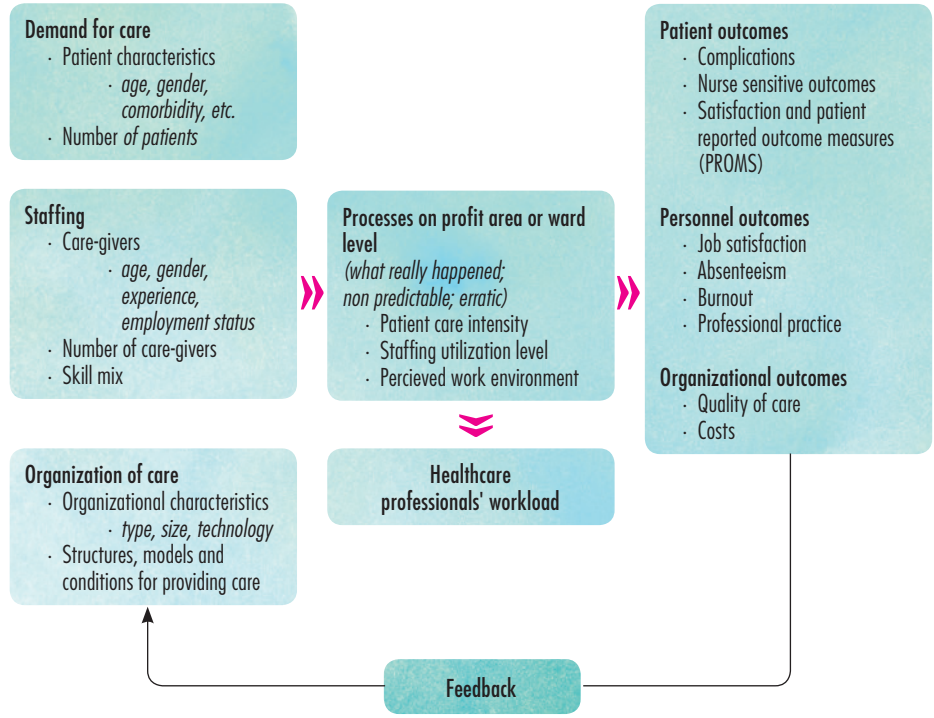
Applying EBMgt in health care; A theoretical framework

Generally, efficient and high-quality hospital care and inherent costs are determined by three aspects. First, the number of patients treated and their disease severity[3]; second, the size and skill mix of the medical and nursing staff[4,5]; and third, the organization of care[6], in other words; *demand for care*, *staffing* and *organization of care*.

These aspects have effect on how hospital care is provided on clinical wards, on workload, and on outcomes in terms of quality and costs of care. How these aspects are interrelated is illustrated by the Patient Care Delivery Model (PCDM; Figure 1)[7]. Here, the original model was adapted by using terms identifiable in this thesis to be applicable to our research purposes.

This model was originally developed in the mid-nineties to link the nursing work environments and care processes to outcomes[8]. The theory behind delivering patient care is that causal factors, such as the characteristics of patients, personnel and organization, are transformed by processes on the work floor into patients' care intensity, perceived work environment, and staffing utilization level. In turn, this results in outcomes that provide feedback to the system. This transformative process from the three determining aspects of hospital care to the outcomes of care is influenced by many factors and events: leadership, social support, unanticipated disruptions, delayed events, and distractions[9]. All factors involved in this transformative process

Figure 1 Hospital care delivery model



Adapted from O'Brien-Pallas et al., J Clin Nurs. 2011;20:1640-1650

determine the healthcare professionals' workload.

The PCDM offers hospital managers a conceptual framework based on empirical evidence to inform decision-making and to promote systematic approaches as to the scenarios described earlier. To start with demand for care; patients enter the hospital with a certain demand for care, which is determined by the patient's characteristics[8] (e.g., age, gender, comorbidity, or diagnosis). These characteristics subsequently influence the outcomes of the patient[10], the personnel[11], as well as the organization. For example, increased age and severity of illness are associated with poor patient outcomes and higher hospitalization costs[12,13].

Second, the association of personnel staffing and organizational characteristics with outcomes is supported by a number of publications: patients receiving insufficient care due to high workload are at risk for higher morbidity and mortality rates[14-16]; higher proportions of Registered Nurses (RNs) are associated with lower mortality rates[17,18]; a higher workload has a significant impact on job satisfaction as nurses in hospitals with higher nurse-patient ratios are more likely to suffer from

burn-out and job dissatisfaction[16]; the larger the size of the hospital unit, the fewer nurses were satisfied[19]; a functional nursing care model (i.e. with few highly educated nurses and little support for innovation and nursing professionalization) is, in contrast to a professional nursing care model (i.e. an organization model with a highly educated nursing staff in a supportive practice environment), associated with an increase in medication errors, patient falls, pressure ulcers, and pneumonia[6].
Third, factors directly influencing the healthcare professionals' work and work environment, for example leadership, social support, delayed events and distractions, have an indirect effect on healthcare outcomes as they interact with patients' demand for care, personnel staffing and the organization of care. For instance, when implementing a better hand hygiene among nurses, strong leadership has significant influence on the incidence of post-operative wound infections[20], while interruptions during the medication administration process cause more medication errors[21]. Both examples are common measures of hospital care quality[22].

AIM AND OUTLINE OF THIS THESIS

Taking the scenarios and the PCDM into account, the overall aim of this thesis is to give insight in the relation between patients' demand for care, patients' care intensity, and personnel staffing. We therefore investigated:

1. Which patient characteristics predict the demand for medical and nursing care? (part I)
2. What is the impact of the patients' care intensity on physicians and nurses? (part II)
3. How can we ensure optimal staffing levels on clinical wards? (part III)

PART I: DEMAND FOR CARE

As described in the first scenario, it is important to know trends in the demand for care and to have information on cost issues. In order to support hospital directors in their substantiation and negotiation, insight in the (sets of) factors influencing or explaining the demand for care is highly desirable. We conducted a systematic review (SR) to identify these (sets of) factors and to appreciate their capability to explain the demand for clinical hospital care (Chapter 2).
Based on the factors found in this SR we developed a set of explanatory factors for the demand for care, in the first place for the demand for care by clinical surgical patients (Chapter 3). To test the applicability of this set to other clinical specialties, we investigated the set in a wider clinical patient population; described in Chapter 4.

PART II: PATIENT CARE INTENSITY

Subsequently, knowledge about the impact of the demand for medical and nursing care (i.e. the patients' care intensity) would help managers plan the number and skill mix of healthcare professionals. Nowadays, the staffing of physicians and nurses in Dutch hospitals tends to be mainly determined by historical production data, financial arguments and process optimization (i.e. optimization rather than care intensity). Therefore the risk physicians and nurses run to experience a high workload and resource shortage is high, particularly at times when clinical patients need a complex and large amount of care[23]. Patients' care intensity is a well-known concept in nursing care, but is less known to physicians. To obtain insight in the factors influencing the patients' care intensity according to physicians and nurses on the wards, and possible perception differences, we conducted a conjoint analysis (Chapter 5).
No empirical information is available about the perceptions of nurses about the current patient care intensity and the impact on providing nursing care on the wards. In Chapter 6 we describe a study exploring the current sentiments regarding the use of a patient care intensity measure for managing nursing care on operational level and tuning the demand for nursing care and nursing resources offered.

PART III: STAFFING ON CLINICAL WARDS

Physicians and nurses are the key healthcare professionals in the hospital setting. Hence, adequate physician and nurse staffing has become critical to ensure efficient and affordable high-quality care[6,14-18,24-26]. In Chapter 7 we conducted a study to check whether an evidence-based patient classification instrument (RAFAELA; of Finnish origin) would lead to reliable and valid measures of the patients' care intensity, and whether this measure would be valuable to achieve more adequate nurse staffing levels.
If we are able to quantify the patients' care intensity, this measure can also lead to daily practical staffing applications on the wards, i.e. automatic patient assignment based on the patients' care intensity (Chapter 8). Such an instrument would help efficiently organize nursing care and balance the nursing workload on the wards over a longer period of time.
Finally, Chapter 9 presents a summary and future challenges that put the findings of the studies in this thesis into a broader context.

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Part I

DEMAND FOR CARE

FACTORS AND MODELS

ASSOCIATED WITH THE AMOUNT OF HEALTHCARE SERVICES AS DEMANDED BY HOSPITALIZED PATIENTS: A systematic review

Catharina J van Oostveen, Dirk T Ubbink, Judith G Huis in het Veld, Piet JM Bakker, Hester Vermeulen

Plos One. 2014;9:e98102.

ABSTRACT

BACKGROUND: Hospitals are constantly being challenged to provide high-quality care despite ageing populations, diminishing resources, and budgetary restraints. While the costs of care depend on the patients' needs, it is not clear which patient characteristics are associated with the demand for care and inherent costs. The aim of this study was to ascertain which patient-related characteristics or models can predict the need for medical and nursing care in general hospital settings.

METHODS: We systematically searched MEDLINE, Embase, Business Source Premier and CINAHL. Pre-defined eligibility criteria were used to detect studies that explored patient characteristics and health status parameters associated to the use of hospital care services for hospitalized patients. Two reviewers independently assessed study relevance, quality with the STROBE instrument, and performed data analysis.

RESULTS: From 2,168 potentially relevant articles, 17 met our eligibility criteria. These showed a large variety of factors associated with the use of hospital care services; models were found in only three studies. Age, gender, medical and nursing diagnoses, severity of illness, patient acuity, comorbidity, and complications were the characteristics found the most. Patient acuity and medical and nursing diagnoses were the most influencing characteristics. Models including medical or nursing diagnoses and patient acuity explain the variance in the use of hospital care services for at least 56.2%, and up to 78.7% when organizational factors were added.

CONCLUSIONS: A larger variety of factors were found to be associated with the use of hospital care services. Models that explain the extent to which hospital care services are used should contain patient characteristics, including patient acuity, medical or nursing diagnoses, and organizational and staffing characteristics, e.g. hospital size, organization of care, and the size and skill mix of staff. This would enable healthcare managers at different levels to evaluate hospital care services and organize or reorganize patient care.

KEYWORDS: PATIENT CHARACTERISTICS; USE OF HOSPITAL CARE SERVICES; NURSING INTENSITY; HOSPITAL COSTS; (MULTIPLE) REGRESSION ANALYSIS; SYSTEMATIC REVIEW

INTRODUCTION

As health expenditures continue to rise, hospitals are challenged to provide more efficient and affordable services without compromising on quality. Efficient and high-quality hospital care is generally determined by three aspects. First, the size and educational level of the medical and nursing staff[1,2]; second, the organization of care[3]; and third, the number of patients treated and their disease severity[4].

Because healthcare costs and consequently its affordability are related to the severity of a patient's condition (need for health care), and to the services requested (demand for health care), it is important for hospital managers to identify the factors that determine the demand[5]. If these factors could be identified, managers would be able to generate information on cost issues and substantiate trends in the demand for hospital care services over time. Furthermore, university hospitals could better define their top-referral patient populations and plan for capacity and capability through staff levels and facility planning.
At present, it is still unclear which individual, and preferably objective, patient characteristics are associated with the demand for hospital care services and their inherent costs. In recent attempts to reveal these characteristics, the focus was on specific patient populations[6], or different reference standards were used for analysing the characteristics and produced conflicting results[7].

When searching for associations between patient characteristics and the demand for hospital care services, it is necessary to define 'demand for hospital care services' or the product of this demand, i.e., 'use of hospital care services'. Although the WHO defines 'demand for health services' as: The health care expectations expressed by individuals or communities, a more detailed interpretation of the term is lacking. For the purpose of this review, we further define the term 'demand for hospital care services' as the need for medical treatment and nursing care (i.e. personnel costs for medical and nursing staff as well as costs for therapeutic and diagnostic interventions), as determined by the individual patient's diagnosis and wishes.
During the nineteen-eighties and nineties, researchers put effort into matching the demand for hospital care services with nursing supplies. This was fuelled by economic pressures (i.e. nursing shortages[8] and the knowledge that the amount of nursing care needed varies substantially between diagnosis-related groups (DRGs)[9]). The above resulted in various definitions for 'nursing care' as well as various ways of predicting the demand for, or the measurement of nursing care actually given[10]. Clinical nursing care is most clearly expressed as 'nurse hours per patient day'

(NHPPD)[11]. It is also customary to use the term for the product of the demand for care, i.e., 'nursing care intensity' or 'workload' as measured with a range of patient classification systems (PCS)[10-12]. In addition, other methods have been proposed, such as DRG nurse costing models or nurse-patient ratios[13]. Although these methods are commonly used, they have been criticized because nurses do not perceive them as a reflection of the 'real' nursing workload and these methods do not take into account changes in practice, e.g., a rise in care complexity or nursing care intensity[13,14]. In addition, NHPPD, DRG costing models, and nurse-patient ratios are merely a proxy for the nursing care offered (personnel staffing) with the underlying assumption that all patients and all patient days are equal in terms of the use of health services.

In the medical world, the use of hospital care services is generally measured by costs for care as determined by DRG costing models[7], or length of stay (LOS)[15]. However, it is widely known that the intensity of patient care, and therefore the utilization of health services, increases as the LOS is shortened. Furthermore, LOS is substantially influenced by non-medical, for example, organizational factors[16,17] and therefore not useful as an expression of the demand for medical services.
In the most favorable case scenario, the utilization of clinical hospital care services is defined as costs made during hospitalization, including the costs incurred for medical, nursing, diagnostic and therapeutic services. However, considering the variety of the measures and the shortcomings of some of them, we decided to study the use of hospital care services by using hospitalization costs, nursing workload and nursing care intensity. We therefore conducted a systematic literature review to search for associations between factors or models and the patient's demand for medical and nursing hospital care services in non high-care hospital wards.

METHODS

This systematic review was conducted according to the PRISMA Preferred Reporting Items for Systematic Reviews and Meta-analysis-statement[18].

Eligibility criteria

Articles were eligible if they: 1) explored associations between health status parameters or patient characteristics and the demand for hospital care services; 2) focused on hospitalized patients on general wards; and 3) used regression or correlation analyses to explore possible associations.

We applied no restrictions on study design, but excluded other reviews including systematic reviews and original studies that merely described relative measures such as staffing levels, health outcomes, or length of hospital stay.

Literature search and information sources

MEDLINE, Embase, CINAHL and Business Source Premier were searched from inception through June 2013 to find articles that predicted or explained the demand for hospital care services; there were no limits regarding publication status, date or language. The complete search strategy for each database is given in Appendix 1 (MEDLINE), 2 (Embase) and 3 (for CINAHL and Business Source Premier). The search was designed and conducted with the help of a clinical librarian.

Study Selection

Eligible articles were independently selected by two reviewers (HV and DU) based on the relevance of their titles and abstracts as retrieved by the search. If articles met the inclusion criteria, full-text versions of the articles were obtained and further scrutinized for eligibility by CO and JHV. Authors were contacted for irretrievable articles. HV and DU also made the final selection of articles to be included. CO was involved in any cases of disagreement where consensus was reached through discussion. The reference lists of included articles were checked to detect any potential additional studies. Also, experts in healthcare services research were asked for potentially eligible studies.

Study quality appraisal

The STROBE statement for cohort studies was used to assess the methodological quality of the included studies[19]. This standard contains general methodological aspects that are important and applicable to the studies included. Appraisal was undertaken by two reviewers independently (CO and JHV) and cross-checked afterwards. Quality items were judged as '-' (not described) or '+' (described) as according to the definition in the STROBE statement. Items scoring '+/-' were partially present, e.g., when the study population was described in terms of the medical diagnosis rather than the patient characteristics.

Data extraction and data items

Data extraction was performed by using a predefined, structured data-abstraction sheet and was double-checked during the process by CO and JHV. The following data were extracted: author, year of publication, setting, research design, sample size and specialty, (resource) reference standard, possible associated factors, measures of association with the demand for hospital care services, expressed as correlation coefficient (ρ), beta-coefficient (β) of a linear regression analysis, or odds ratio

(OR) as derived from a logistic regression analysis, including their p-values and 95% confidence intervals (CI). We also documented whether the associations given had been corrected for other factors by means of a multivariable analysis. Where there was some uncertainty about the data, CO and JHV contacted the authors by e-mail.

Data analysis

All models and factors in the included studies that were investigated for their association with the use of hospital care services were summarized. Associations were judged significant if P <0.05 or their CI did not enclose the value of 0 or 1.
Meta-analysis was intended if study designs, reference standards, and outcomes were homogeneous. Otherwise, the findings are described and categorized by the various models and factors found.

FINDINGS

Study selection and characteristics

The search identified 2,168 studies from the four databases. After removing the duplicates and reviewing the titles and abstracts, 125 studies remained that met the inclusion criteria. Based on the full texts, a further 109 studies were excluded. Most of these studies (n=83; 76%) did not report patient characteristics. For nine studies, all dissertations, the researchers received no reply to their queries for more information. Two authors replied to questions about their statistical analyses, but no extra data were obtained. One study was included after checking the references of one included publication. Another study was included because it was known by the researchers. Eventually, 17 studies were identified for this review (Figure 1).

The studies included (Table 1) were published between 1983 and 2013. Twelve out of the 17 studies (70%) had a retrospective design, while five studies (30%) were prospective cohort studies. Ten studies (59%) were conducted in the United States, five in Europe (30%) and two in Canada (11%). Data were taken from hospital sources including hospitalizations on different wards e.g. pulmonary, medical, surgery, obstetrics and gynecology, intensive care, pediatrics, orthopedics, geriatrics, and cardiology units. Study sizes ranged from 206 to 298,691 patients.
From the 17 studies, various factors associated with the demand for hospital care services were investigated. These comprised patient characteristics[7,12,20-27], Case Mix Group (CMG), DRG (Appendix 4), nursing diagnoses[7,21,24,28-30] (Appendix 4), severity of illness[9, 22,23,25,26,30-32] (Appendix 5), patient acuity[12,24,30] (Appendix 5), comorbidities[7,23], complications[7,23,25,26,33] and admission and discharge factors[22]. Three studies[21,23,30] investigated models estimating the demand for hospital care services.

Figure 1 Summary of search strategy

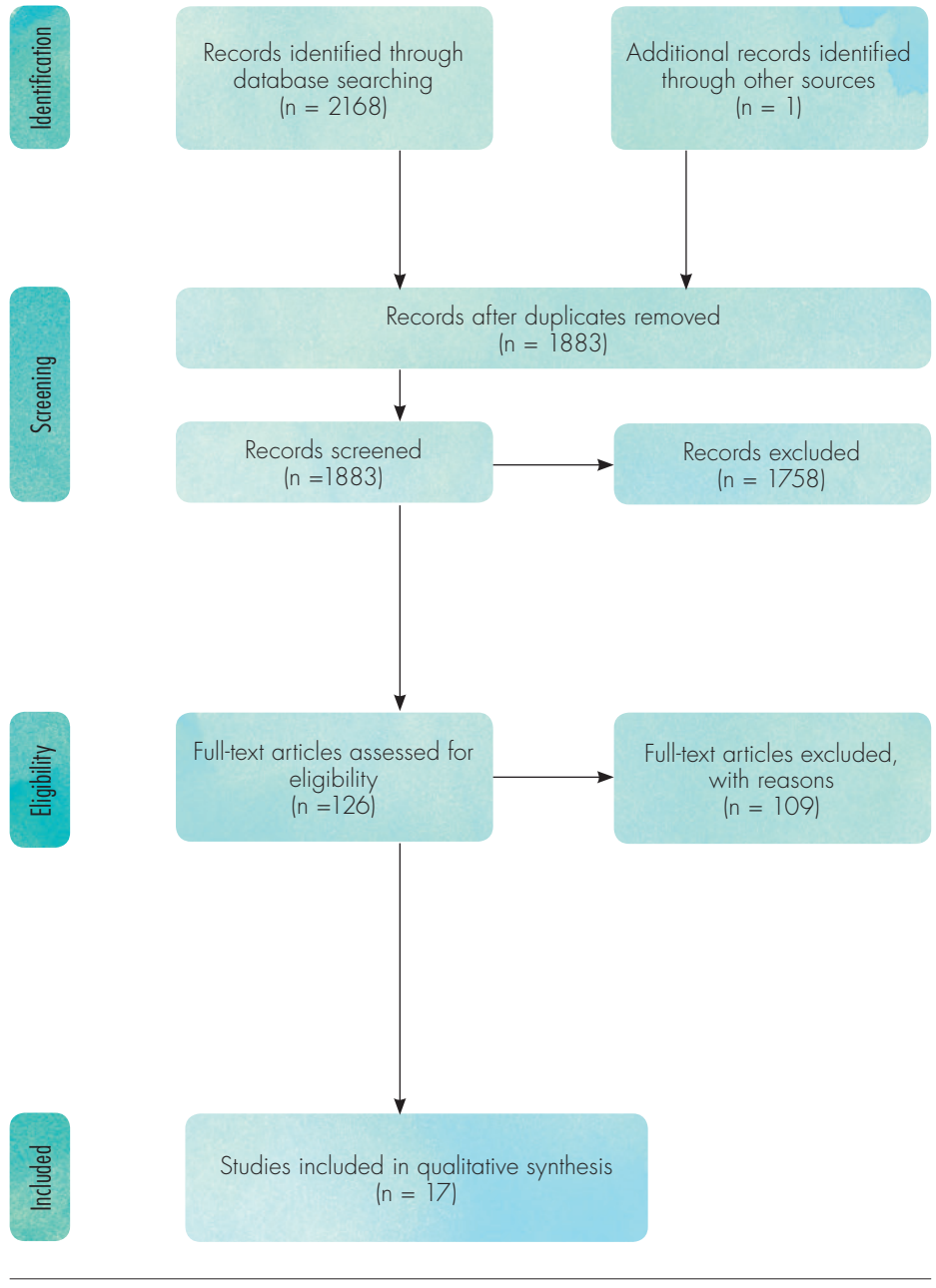

Table 1 Study characteristics ►

STUDY CHARACTERISTICS						STUDY CHARACTERISTICS			
Author	Setting	Design	N, specialty	Resource	Reference standard	Predictive factors	Results	Corrected	Statistical analysis
Bostrom 1991	University hospital, United States, 600 beds	Retro-spective	n = 1,372 patients	Medicus	average daily and total nursing hours per hospital stay	SII per DRG (14, 15, 89, 96, 138, 148, 182, 294, 320, 468)	daily range: r0.27 to r0.53 total range: r0.64 to r0.80	NA	correlation
Bostrom 1994	University hospital, United States, 600 beds	Retro-spective	n = 1,164 patients	Medicus	average daily and total nursing hours per hospital stay	SII per DRG (14, 15, 89, 96, 138, 148, 182, 294, 320, 468)	daily range: $r^2$0.04; NS to $r^2$0.30; p<0.001 total range: $r^2$0.17; p<0.05 to $r^2$0.49; p<0.001	corrected for physician practice	multivariable regres-sion analysis
Campbell 1997	Hospital, United Kingdom	Retro-spective	n = 798 pa-tients, respiratory medicine unit	TEAM-WORK	weekly worked nursing hours	CMG cystic fibrosis	18%	NA	univariable regression analysis
Caterinicchio 1983	8 hospitals (5 teaching), New Jersey, United States, range 155-550 beds	Prospec-tive	n = 2,660 medical-surgical, obstetric-gynae-cologic, psychiat-ric and intensive care units	RNEUSI (grand to-tal minutes corrected for skill level)	nursing resource use	Age	r0.2326; P<0.0001	NA	Pearson correlation analysis
Fagerström 2000	Hospital, Finland	Prospec-tive	n = 19,324 OPC records, on 8 units: 3 internal, 2 surgical, 1 gynecology and 2 pediatric units	PAONCIL	daily nursing workload measure for ward organization	OPC	$r^2$0.37		multivariable regres-sion analysis
						Age per ward	$r^2$0.001; NS $r^2$0.09; p0.0488 $r^2$0.064; p0.0008	corrected for OPC score	
						Gender per ward	$r^2$0.006; p0.37 $r^2$0.000%; NS		
Geissler 2012	712 hospitals, across 10 European countries: Finland, France, Germany, Spain, Sweden, Austria, Ireland, Poland, England and Estonia	Retro-spective	n = 125,698 with hip replacement	national routine patient-level data samples from 2008	hospitalization costs, admission to discharge	Age 1 (1-60) Age 2 (61-70) Age 3 (71-75) Age 4 (76-80) Age 5 (>80) Gender No. of diagnoses Transfer in Transfer out Emergency Deceased CCI 1 CCI 2 Urinary tract infection Wound infection Fracture Partial replacement Revisions of implants	range $r^2$0.068 to r^2-0.004 RC range β0.017 to β-0.082 range β0.051 to β-0.049 range β0.070 to β0.051 range β0.026 to β-0.007 range β0.036 to β-0.013 range β0.114 to β-0.125 range β0.112 to β-0.071 range β0.117 to β-0.053 range β0.346 to β-0.233 range β0.004 to β-0.030 range β0.137 to β-0.060 range β0.178 to β-0.396 range β1.474 to β-0.027 range β0.110 to β-0.06 range β0.019 to β-0.318 range β0.399 to β0.154	corrected for DRG 1-14 (ordered by weight), DRG other, no. of procedures and adverse events	multivariable regression analysis

Table 1 Study characteristics continued ►

Author	Setting	Design	N, specialty	Resource	Reference standard
Halloran 1985	Hospital, United States, 279 beds	Retro-spective	n = 2,560 patients, every adult patient both admitted and discharged to one hospital	Rush-Medi-cus patient classifica-tion	daily nursing workload measure
Mahmoud 2009	196 hospitals, United States	Retro-spective	n = 25,825 patients, adults undergoing elective colon procedures	Premier Perspective database	mean daily hospital costs (>US $15,000) (medical/ surgical room and board, pharmacy, nursing, ICU, central supply, laboratory, diagnostic imaging and operating room charges)
McMahon 1992	University hospital, Michigan, United States	Retro-spective	n = 1,920 patients, ICU, general medicine and medical sub-specialty units	RVU (costs without non direct patient costs)	hospital resource consumption
Mion 1988	Cleveland Metropolitan General/ Highland View Hospital, Canada	Prospec-tive	n = 351 pa-tients, 4 general medical units, 28 beds	PAS	total nursing workload score

Predictive factors	Results	Corrected	Statistical analysis
Age	r0.198; p<0.001; <4%		correlation, stepwise multivariable regres-sion analysis
Marital status	NS		
Payer	NS		
Age, sex & race	$r^2$0.043; p<0.001		
DRG (3, 4, 11, 59, 75, 110, 121, 124, 132, 144, 156, 158, 189, 226, 227, 228, 264, 265, 266, 267, 271, 278, 282, 304, 322, 323, 348, 350, 355, 362, 382)	$r^2$0.263; p<0.0001; range β17.855 to β-19.138		
Nursing diagnoses & DRG	$r^2$0.603; p<0.0001		
Nursing diagnoses (37)	$r^2$0.532; range β0.158 to β-0.093		
Surgical Site Infection Age > 65years Female sex Caucasian race BMI >30 High SENIC (risk of infection) score	OR 7.46 (CI 6.47-8.60) OR 1.71 (CI 1.61-1.82) OR -0.87 (CI 0.8-0.93) OR -0.81 (CI 0.75-0.86) OR 1.29 (CI 1.19-1.40) OR 3.30 (CI 3.02-3.70)	corrected for antibiotic regimen	logistic regression analysis
DRG (89, 96, 125, 127, 138, 140, 182, 183, 296, 410, 112, 124, 320)	$r^2$0.10; p<0.0001		stepwise multivariable regression analysis
DRG and FIRST (first APACHE-L in 24hours of admission)	$r^2$0.14; p<0.0001; range $r^2$0.18-$r^2$0.00		
DRG and FIRST WORST (worst APACHE-L in 24 hours)	$r^2$0.18; p<0.0001; range $r^2$0.23-$r^2$0.00		
DRG and WORST (value having highest APACHE-L weight during admission)	$r^2$0.25; p<0.0001; range $r^2$0.38-$r^2$0.00		
PSI Age Gender Race Marital status Admission source Discharge disposition	r0.60; p<0.0001 $r^2$0.48; p<0.0001 r0.25; p0.0001 p<0.30 p<0.30 p<030 r0.35, p0.0001 r0.54, p0.0001	corrected for LOS	Pearson's correlation, stepwise multivariable regression analysis

Table 1 Study characteristics continued ►

Author	Setting	Design	N, specialty	Resource	Reference standard
O'Brien-Pallas 1989	University hospital, Canada, 1,000 beds	Prospec-tive	n = 206 patients, diagnoses for dis-eases and dis-orders of the nerv-ous system and circulatory system	GRASP; Medicus; PRN	daily and aver-age nursing hours
van Oostveen 2013	Academic medical center, The Netherlands, 1,000 beds	Pros-pective	n = 174 patients, surgical wards	time and motion research, hospital database	hospitalization costs (costs for physician services, nurse services, paramedics, all diagnostic tests, therapeutics, sur-gical procedures)

Predictive factors	Results	Corrected	Statistical analysis
CMG, LOS, age and sex			multivariable regression analysis
· PRN	$r^2$0.58; p<0.0001		
· Medicus	$r^2$0.56; p<0.0001		
· GRASP	$r^2$0.57; p<0.0001		
Age	β0.004; CI 0.001-0.007; p0.004		univariable regression analysis, stepwise multivariable regres-sion analysis
Gender (males)	β-0.015; CI -0.118-0.87; p0.767		
Number of co-morbidities	β0.000; CI -0.031-0.030; p0.978		
Number of complications	β0.221; CI 0.144-0.299; <p0.000		
ASA-class			
· 1	RC		
· 2	β0.168; CI 0.057-0.279; p0.003		
	RC		
· 3	β0.234; CI 0.081-0.387; p0.003		
	β0.067; -0.071-0.204; p0.339		
BMI at admission	β-0.006; CI -0.015-0.003; p0.189		
Nutritional status	β0.018; CI 0.010-0.026; <p0.000		
Number of medications during hospitalization	β0.031; CI 0.022-0.040; <p0.000		
Admission type	β-0.210; CI -0.360-0.061; p0.006		
Surgical specialty			
· Trauma surgery	RC		
· Urology	β0.776; CI 0.511-1.042; <p0.000		
· Short Stay surgery	β0.758; CI 0.505-1.012; <p0.000		
· Orthopedics	β1.152; CI 0.900-1.405; <p0.000		
· Gastro-Intestinal surgery	β0.644; CI 0.368-0.920; <p0.000		
· Plastic surgery	β0.622; CI 0.381-0.943; <p0.000		
· Vascular surgery	β0.786; CI 0.502-1.071; <p0.000		
· Oral and Maxillofacial surgery	β0.679; CI 0.380-0.977; <p0.000		
Age, number of comorbid-ities, number of complica-tions, number of medication during hospitalization, surgical specialty	$r^2$0.562; p<0.000 - β0.002; CI 0.000-0.005; p0.072/ β-0.038; CI -0.064-0.012; p0.005/ β0.072; CI 0.005-0.139; p0.036/ β0.013; CI 0.004-0.023; p0.007/ range β1.005 to β0.610; p<0.001		

Table 1 Study characteristics continued ►

Author	Setting	Design	N, specialty	Resource	Reference standard
Sermeus 2008	115 acute hospitals, Belgium	Retrospective	n = 298,691 patients, ICU, surgical, internal medicine, geriatric and mixed surgical and internal medicine wards units	B-NMDS hospital financing and nurse staffing decisions	Prinqual 1; nurse care intensity
Shukla 1992	84 community hospitals, United States, average 196 beds ranging between 50 and 670 beds	Retrospective	n = 84 community hospitals, medical-surgical units	actual staffing and skill mix data using standard hourly wages GRASP	nursing costs by staffing/ skill mix per ward per day Patient acuity
Titler 2007	One academic medical center, United States	Retrospective	n = 523 patients, >60 years older adults (568 hospitalizations) admitted for treatment for hip fracture or elective hip procedure	medical record database multiplied by cost to charge ratio hospital costs corrected for the fiscal year	hospital costs (general services, ICU/ special care, pharmacy, laboratory, radiology, operating room, supplies and ancillary services)

Predictive factors	Results	Corrected	Statistical analysis
SJ Hospital type, hospital size, age, department type, DRG, severity of illness, DRG*severity of illness	$r^2$0.70 $r^2$0.40		multivariable regression analysis
SJ, hospital type, hospital size, age, department type, DRG, severity of illness, DRG*severity of illness	$r^2$0.78		
Patient acuity (GRASP)	r0.18; p0.19	NA	correlation
CMI Age CMG	r0.38; p<0.01 r0.26; p<0.05 r0.12; p0.37		
Total number of medications	β0.0197; p<0.0001 (US$287,32 more costs)	corrected for nursing unit characteristics, medical treatments, individual treatments, individual medications, individual nursing interventions (fluid management, bathing, tube care and surgical preparation)	correlation, multivariable regression analysis - *only significant results given with direction of result of the correlation analysis
Depression	B-0.0943; p0.0078 (US$1299,59 lower costs)		
Patient characteristics*			
· Gender	p0.2306		
· Age	p0.0003+		
· Religion	p0.7334		
· Race	p0.4908		
· Marital Status	p0.5109		
· Occupation	p0.0630		
· Severity of illness	p<0.0001+		
Medical diagnoses*			
· Non traumatic joint disorders	p<0.0001-		
· Complications of device, implant or graft	p<0.0001+ .		
Comorbidities*			
· Congestive heart failure	p0.0271+		
· Arrhythmias	p0.0137+		
· Valvular disease	p0.0043+		
· Pulmonary circulation disease	p0.0088+		
· Paralysis	p0.0098-		
· Other neurological disorders	p0.0077+		
· Diabetes	p0.0155+		
· Peptic ulcer disease without bleeding	p0.0404+		
· Lymphoma	p0.0409+		
· Metastatic cancer	p0.0189+		
· Coagulopathy	p0.0043+		
· Obesity	p0.0791-		
· Weight loss	p<0.0001+		
· Fluid and electrolyte disorders	p0.0102+		
· Chronic blood loss anemia	p<0.0001+		
· Deficiency anemia's	p0.1055+		
· Depression	p0.1263-		

Table 1 Study characteristics continued ►

Author	Setting	Design	N, specialty	Resource	Reference standard
Titler 2008	Academic medical center in the Midwest, 843 beds	Retro-spective	n = 1,075 patients, >60 years older heart failure patients (1,435 hospitali-zations)	medical record database multiplied by cost to charge ratio hos-pital costs corrected for the fiscal year	hospital costs (costs for general services, ICU/ special care, pharmacy, labo-ratory, radiology, operating room, supplies and other ancillary services)
Wang 2010	United States, dataset Market-Scan Commercial Claims and Encounters inpatient	Retro-spective	n = 23,216 heart failure related hospitalizations	dataset Market Scan Com-mercial Claims and Encounters inpatient	hospitalization costs (costs for physician servic-es, all diagnostic tests, therapeu-tics, supplies and room fees)

Predictive factors	Results	Corrected	Statistical analysis
Age	NS	corrected for nursing unit characteristics, multidisciplinary treatments, individual medications and nursing interventions	correlation, generalised estimate equations
Gender	NS		
Ethnicity	NS		
Marital status	NS		
Religion	NS		
Occupation	NS		
Primary diagnosis			
· Heart failure without · hypertension	NS		
· Acute myocardial infarction	NS		
· Other cardiac conditions	NS		
· Conduction disorders	NS		
· Peripheral vascular disease	NS		
· Non-cardiac circulatory diseases	NS		
· Comorbidities	β0.0500; p0.483 (US$536.00 more costs)		
· Deficiency anemia	β-0.0318; p0.6355 (-US$327.22 lower costs)		
Severity of illness			
· Severe	β-0.0062; p0.9187		
· Major	(-US$64.62 lower costs)		
· Moderate	β-0.0840; p0.1699 (-US$842.29 lower costs)		
· Minor	RC		
· Total number of different medications	β0.017; p<0.0001 (US$179.24 more costs)		
Age		corrected for urban, region, LOS and secondary diagnosis	multivariable regression analysis
· 18-39 years	US$388; p0.689		
· 40-54 years	US$962; p0.038		
· 55-64 years	RC		
· Gender	US$4316.7; p<0.001		
· CCI	US$229.5; p0.047		

B-NMDS = Belgium Nursing Minimal Data Set; BMI = Body Mass Index; CCI = Charlson Comorbidity Index; CMG = Case Mix Group; CMI = Case Mix Index; DRG = Diagnose Resource Group; GRASP = Grace Reynolds Application and Study of PETO; LOS = Length of Stay; NANDA = North American Nursing Diagnosis Association; NA = not applicable; NS = not significant; OPC = Oulu Patient Classification; OR = Odds Ratio; PAS = Patient Acuity Scale; PAONCIL = Professional Assessment of Optimal Nursing Care Intensity Level; PRN = Project Resource Nursing; Prinqual 1 = self-care (dependency level); PSI = Patient Severity Index; RC = reference category; RNEUSI = Registered nurse equivalents Units of Service index; RVU = relative value unit; SENIC = Study of the Efficacy of Nosocomial Infection Control; SII = Horn's Severity of Illness index; SJ = San Joaquin

Different outcomes were used to determine the amount of hospital care services demanded: five studies used nursing hours spent[9,28,29,31], two studies used resource consumption[20, 32], three studies used nursing workload[12] or nursing workload as measured by a PCS[21,22], Sermeus et al.[30] only used nursing care intensity, and seven studies used hospitalization costs[7,23,24,25-27,33]. Physician services, if investigated at all, were done so only indirectly.

As a result, only factors tested in multivariable analyses and individual factors (i.e. univariable and correlation analyses) are described. For the results of all univariable analyses and correlations between the utilization of hospital care services and associated factors please see Table 1. Because of large range of definitions of demand for health care services, we refrained from doing a meta-analysis.

Methodological quality of studies

Overall, the methodological quality of the included studies was moderate to good (Table 2). Rationale, participants, variables and level of measurement, sample size and statistical methods were clearly reported. However, only eight (47%) studies mentioned their study design and provided an informative abstract. As most studies used large databases, the assessment of bias was hardly possible and limited to the data validation as reported by the investigators. Only six studies (35%) explained how missing data were handled, and in eight (56%) studies the characteristics of study participants were described. Seven studies that described the number of DRGs included, scored this as 'partially present' (31%). The precision of adjusted and unadjusted estimates was given in eight studies (47%).

Models

Three models were found that could predict the use of hospital care services to a certain extent[21,23,30]. Halloran[21] reported a model comprising the patient's age, gender, and race, which explained only 4.3% of the nursing workload. In addition, Halloran described a model with nursing diagnoses and DRGs that explained 60% of the nursing workload as measured by a PCS. More than 20 years later, Sermeus et al.[30] could explain 78.7% of nursing care intensity as measured by a Nursing Minimal Data Set (NMDS) Prinqual 1, including hospital type, hospital size, department type, patient's age, San Joaquin system scores, DRG, and the interaction between DRG and severity of illness. By removing the San Joaquin scores, the model explained only 40.8% of nursing care intensity. Recently, van Oostveen et al.[23] reported a model comprising age, medication during hospitalization, complications, co-morbidity and medical specialty, explaining 56.2% of hospitalization costs for surgical patients.

Individual patient characteristics

Five studies reported different results on the association between age and the use of hospital care services. Geissler et al.[7] reported a significant association between age and hospitalization costs (younger patients <61 years were more costly), while Mahmoud et al.[33] found older patients (> 65 years) more likely to account for hospitalization costs over USD 15.000. Fagerström et al.[12] and Wang et al.[27] found that age contributed slightly but significantly to nursing workload and hospitalization costs. The study by van Oostveen et al.[23] reported that age had no significant influence on hospitalization costs.

Three studies investigated the association of gender, race and BMI with costs. Geissler et al.[7] found lower costs for women than for men in three out of the seven countries investigated. This result was confirmed by Mahmoud et al.[33] and Wang et al.[27]. Additionally, Mahmoud et al.[33] found a decrease in costs for Caucasian patients and a cost increase for patients with a higher BMI score (>30).

Diagnosis, DRG, CMG, Case Mix Index & Nursing diagnoses

DRGs and CMGs contributed 10% to hospital resource consumption[32] 18% to nursing hours[28], and 26.3% to nursing workload as measured by a PCS[21]. Sermeus et al.[30] performed a regression analysis including DRGs and a possible interaction between DRGs and severity of illness, but no significant interaction was found.

DRGs and nursing diagnoses together explained 60% of the variance for nursing workload as measured by a PCS. Nursing diagnoses alone contributed 53.2%[21].

One study[7] reported significantly more costs for hip replacement in patients with fractures (in three out of seven countries studied), lower costs in patients receiving a partial replacement (4/7 countries) and higher costs for revision of a hip implant (7/7) (Table 1). Van Oostveen et al.[23] found that the surgical specialties urology, orthopedics, gastro-intestinal surgery, short-stay surgery, plastic surgery, vascular surgery and oral and maxillofacial surgery, as proxies for diagnosis, were more costly than trauma surgery. All specialties together explained 46% of the variance for hospitalization costs.

Severity of illness/ Physical health status

Severity of illness as measured by Susan Horns' Patient Severity Index (Appendix 5) contributed 48% to nursing workload as measured by a PCS[22]. The contribution of severity of illness to nursing hours varied widely per DRG (total range 17% to 49%)[31]. McMahon et al.[32] also found wide ranges for laboratory measurements, as a proxy for severity of illness, in the different DRGs. Although Titler et al.[26] showed a significant correlation between severity of illness and costs, they found no further significant differences in costs in their final model between different levels of severity.

Patient acuity

Sermeus et al.[30] found the San Joaquin scores could explain most of the variance (70%) of nursing intensity, while Fagerström et al.[12] found their PCS contributed only 37% to nursing workload.

Comorbidity and Complications

Two studies assessed comorbidity via the Charlson comorbidity index (CCI) in association with hospitalization costs[7,27]. One of these studies found contradictory results[7] whereas Wang et al.[27] found an increase in hospitalization costs of USD 229.50 per index shift in the CCI. Patients with hip fractures and depression as comorbidity had reduced hospital costs by an average of USD 1299.59[25]. In heart failure patients, only one comorbidity (deficiency anemia) was associated with higher hospital costs (USD 536.00)[26]. The quantity of different medications being used by patients were also related to hospital costs[25,26]. Geissler et al.[7]

revealed higher costs for the total number of diagnoses as well as for urinary tract complications or wound infection. Van Oostveen et al.[23] reported significant effects of the total number of comorbidities -9%, complications +18%, and quantity of medications -3%, on hospitalization costs. For patients with high SENIC risk scores (Appendix 5) for surgical wound infections, the chance of costs rising above USD 15.000 was three times higher than in patients with low or moderate scores[33].

Correlation

In five studies factors in their univariable or correlational analyses were used without testing them in multivariable analyses. Mion et al.[22] and van Oostveen et al.[23] reported a significant association between admission type (elective and emergency) and the hospital care services used. Mion et al.[22] also found a significant positive relationship for the type of discharge. Four research teams tested marital status[21,22,25,26], religion and occupation[25,26] as possible influencing factors, but no significance was found. The payer was also found not to influence nursing workload significantly[21].

The American Society of Anesthesiologists (ASA)-class was used by van Oostveen et al.[23] to measure the physical health status of patients. They found only two categories (1-2/ 1-3) of ASA-classes significantly associated with hospitalization costs. Fourteen out of 30 specific comorbidities recorded in patients diagnosed with hip fractures were positively associated with hospital costs[25], while three comorbidities, i.e. depression, paralysis and obesity, showed a negative correlation. Primary diagnoses in heart failure patients were found not to influence hospital costs significantly[26].

Table 2 Methodological quality assessment *Page 41* ↻►

METHODOLOGICAL QUALITY ASSESSMENT																					
STROBE items*	1	2	3	4	5	6[a]	7	8	9	10	12[a]	12[b]	12[c]	14[a]	16[a]	17	18	19	20	21	22
Bostrom, 1991	-	+	+	-	+	+	+	+	+/-	+	+	+	+	+/-	+/-	-	+	-	+	+	-
Bostrom, 1994	-	+	+	-	+	+	+	+	+	+	+	+	-	+/-	+	+	+	+	-	+	-
Campbell, 1997	+	+	+	+	+/-	+	+	+	+	+	+	+	+	-	-	-	+	+	+/-	+	-
Caterinicchio, 1983	+	+	+	+	+	+	+	+/-	+	+	+	+	+	+	+	+	+	-	-	+	+
Fagerström, 2000	+	+	+	+	+	+	+	+	+	+	+	+	+/-	NA	+/-	+	+	+	+/-	-	-
Geissler, 2012	+/-	+	+	+	+	+	+	+	-	+	+	+	-	+/-	+	+	-	+	-	-	-
Halloran, 1985	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+/-	+	+	+	-	+	+
Mahmoud, 2009	+/-	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	-	+
McMahon, 1992	+/-	+	+	+	+	+	+/-	+	+	+	+	+	-	-	+/-	+	+	+	-	-	+
Mion, 1988	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+/-	+	+	-	+	+	-
O'Brien-Pallas, 1989	+/-	+	+	+	+	+	+	+	+	+	+	+	-	-	+/-	+	+	+	+	+	-
van Oostveen, 2013	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sermeus, 2008	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+/-	+	+	+	+	+	+
Shukla, 1992	+/-	+	+	+	+/-	+	+	+	-	-	+	+/-	-	+/-	-	+	+	+	+	+	-
Titler, 2007	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+
Titler, 2008	+	+	+	+	+	+	+	+	+	+	+	+	-	+/-	+	+	+	+	+	+	+
Wang, 2010	+/-	+	+/-	+	+	+	+	+	+/-	+	+	+	-	+	+	+	+/-	+	+	-	+
Percentage positive judgments	47%	100%	94%	88%	88%	100%	94%	94%	71%	88%	100%	94%	35%	56%	47%	88%	88%	82%	59%	65%	53%

1. title and abstract; 2. background; 3. objectives; 4. study design; 5. setting; 6. participants; 7. variables; 8. data sources/measurement; 9. bias; 10. study size; 11. quantitative variables; 12 statistical methods; 14a. descriptive data; 16a. main results; 17. other analyses; 18. key results; 19. limitations; 20. interpretation; 21. generalizability; 22. funding.

Items 12d, 12e, 13, 14 b, 14c, 15, 16b en 16c were not applicable for assessing the included studies. + = *present;* +/- = *partially present;* - = *not present; NA = not applicable*

DISCUSSION

This systematic review of 17 studies shows that the use of hospital care services is both defined and composed (i.e., financial components) differently across countries, disciplines and studies. Both organization-related and patient-related factors contribute to the use of hospital care services. In particular, age, gender, medical diagnosis, nursing diagnosis, severity of illness, patient acuity, comorbidity, and complications have been investigated the most and have been found to be associated significantly with the use of hospital care services.

The best combination of factors, explaining nearly 80% of the nursing care intensity, contained hospital type, hospital size, department type, age, severity of illness, DRG, and the San Joaquin system score[30]. However, this model contains patient characteristics as well as organizational factors, and explains nursing rather than medical services used. The second best model[23], containing only patient characteristics, explained 56.2% of the use of hospital care services. This implies that a combination of patient characteristics, including patient acuity, and organizational factors, results in the best model for explaining the use of hospital care services.
All models found examined individual patient characteristics as explanatory factors for the use of hospital care services, which suggests that these characteristics are important predictors for care demand. The characteristics found in this review can be used as predictors if they are known prior to a patient's admission, or as explanatory factors if they occur during admission, for example, to monitor trends in time regarding the demand for care. Therefore, the results of this review may be integrated into a practical dashboard for healthcare managers and policy-makers to manage and (re)organize their delivery of clinical hospital care at operational, tactic and strategic levels of decision-making. This will help substantiate their top-referral patient population, reorganize patient care, up-scale wards, planning budgets, capacity and capability, and evaluate the hospital care services themselves.
CMGs, DRGs and medical specialty[7,23,28,30,32] indicators for the medical diagnosis, were better suited for predicting the demand for hospital care services than the patient characteristics. Consequently, these indicators appear to be more suitable for explaining the use of hospital care services than individual diagnoses – apparently because the aggregate of this predictor corrects for variation at individual patient level. Nursing diagnoses[21] and the San Joaquin score for patient acuity[30], predicted the use of hospital care services even better than the indicators for the medical diagnosis. This seems plausible because nursing diagnoses and patient acuity scores contain similar elements regarding a patient's condition and aspects of nursing[21]. However, this characteristic cannot be derived easily from hospital databases, which poses difficulties to its practical application.

Contradictory results were found for factors like comorbidities and complications[7,23,25-27,33]. In another review, Gijsen et al. stated that some negative associations found between comorbidity and the use of hospital care services may be due to the fact that the severity of the various comorbidities was not weighed in these studies[34]. Furthermore, less severe comorbidities may have been managed easily and less expensively with medication, while patients with more severe comorbidities may have had more expensive treatments.

One of the three models also addressed some organizational factors concerning hospital structure (e.g. hospital size, department type)[30]. Although the individual predictive values of most organizational factors were either not reported or small, they do determine efficient and high-quality hospital care[3]. Hence, these factors have to be included in any explanatory or prediction model for the use of hospital care services. This also holds for the size and educational level of the medical and nursing staff[1,2,35], but none of the studies in this review investigated these factors.
The limitations of this review are firstly, the heterogeneity of the reference standard 'use of hospital care services'. Because hospitalization costs are defined differently in different countries, hospital databases are also set up differently resulting in the study aims being different. Hence, it is impossible to pool data and hardly possible to provide a clear result for each predictor. Secondly, the reference standard provides information on the amount of care delivered, which can be based on revenues rather than on the needs of patients[35]. Furthermore, the methodological quality of the included studies was fairly good, but 50% of the studies were somewhat dated. For instance, confidence intervals came into use during the nineteen-nineties[36] and were rarely reported earlier. Potential sources of bias and funding were also poorly reported, which may have flawed the validity of the results.

CONCLUSION

This systematic literature review has revealed several patient characteristics that are significantly associated with the need or demand for healthcare services in the hospital setting. The most prominent characteristics were age, gender, medical diagnosis and nursing diagnosis, severity of illness, patient acuity, comorbidity, and complications, most of which can be derived from hospital databases. Complete models that explain the use of hospital care services should contain patient characteristics, including patient acuity, medical or nursing diagnoses, organizational factors and staffing characteristics, as these factors do determine efficient and high-quality hospital care, and therefore the costs of care. These models appear useful for healthcare managers and policy-makers as predictors or to monitor trends in time regarding the demand for care.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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APPENDIX I SEARCH MEDLINE

P

(("Patients/classification"[Mesh] OR "Patients/statistics and numerical data"[Mesh] OR patient[tiab] OR inpatient*[tiab] OR "Inpatients/classification"[Mesh] OR "Inpatients/statistics and numerical data"[Mesh] OR "Inpatients/psychology"[Mesh])

I→AND

("health status" [Mesh] OR "severity of illness index" [Mesh] OR "workload" [Mesh] OR workload measurement [tiab] OR care intensity [tiab] OR "Nursing Care/classification"[Mesh] OR "Nursing Care/organization and administration"[Mesh] OR "Nursing Care/statistics and numerical data"[Mesh] OR "Health Services Needs and Demand/classification"[Mesh] OR "Health Services Needs and Demand/statistics and numerical data"[Mesh] OR "Needs Assessment/classification"[Mesh] OR "Needs Assessment/organization and administration"[Mesh] OR "Needs Assessment/statistics and numerical data"[Mesh] OR patient dependency[tiab] OR patient acuity[tiab] OR patient characteristic*[tiab] OR health service use[tiab] OR patient clinical characteristic*[tiab]OR care requirement*[tiab] OR patient dependency level*[tiab])

O→AND

("Classification/ methods"[Mesh] OR patient classification*[tiab] OR casemix[tiab] OR "Nursing Records/classification"[Mesh] OR "Nursing Records/statistics and numerical data"[Mesh] OR "Nursing Care/classification"[Mesh] OR "Nursing Care/organization and administration"[Mesh] OR "Nursing Care/statistics and numerical data"[Mesh] OR "Nursing Staff, Hospital/statistics and numerical data" OR "Health Services/statistics and numerical data"[Mesh] OR "Patient Care Planning"[Mesh] OR "Diagnosis-Related Groups/classification"[Mesh] OR "Diagnosis-Related Groups/statistics and numerical data"[Mesh] OR "Diagnosis-Related Groups/organization and administration"[Mesh] OR "Medical Records/classification"[Mesh] OR "Medical Records/statistics and numerical data"[Mesh] OR "Personnel Staffing and Scheduling"[Mesh] OR "Data collection"[Mesh] OR "Health Manpower"[Mesh] OR medical staffing[tiab] OR nurse staffing[tiab] OR physician staffing[tiab] OR requirement planning[tiab] OR workload measures[tiab] OR nursing hours per patient day[tiab] OR nursing workforce[tiab] OR physician workforce[tiab] OR nurse-patient ratio[tiab] OR patient-nurse ratio[tiab] OR nurse to patient ratio[tiab] OR patient to nurse ratio[tiab] OR physician to patient ratio[tiab] OR patient to physician ratio[tiab] OR physician-patient ratio[tiab] OR patient-physician ratio[tiab] OR "Medicare Assignment"[Mesh])

AND

(patient classification system [tiab]OR patient classification instrument* [tiab] OR "Nursing Assessment/methods"[Mesh] OR patient data management*[tiab] OR patient administration system [tiab] OR "Hospitalization/statistics and numerical data"[Majr] OR "Database Management Systems"[Mesh] OR "Hospital Information Systems"[Mesh] OR "Nursing Informatics/statistics and numerical data" [Mesh] OR "Medical Informatics/statistics and numerical data" [Mesh] OR "Forecasting" [Mesh] OR "Nursing Administration Research/statistics and numerical data" [Mesh]OR "Personnel Staffing and Scheduling Information Systems"[Mesh])

AND

("Validation Studies "[Publication Type] OR "Prospective Studies"[Mesh] OR Retrospective studies[Mesh] OR "Reproducibility of Results"[Mesh] OR "Task performance and analysis "[Mesh] OR "Regression Analysis"[Mesh] OR "Predictive Value of Tests"[Mesh] OR "Discriminant Analysis"[Mesh] OR "Costs and Cost Analysis"[Mesh] OR time management[tiab] OR work sampling[-tiab]

NOT

("Treatment Outcome"[Mesh] OR "Outcome Assessment (Health Care)"[Mesh] OR "Hospital mortality"[Mesh])

NOT

("Critical care"[Mesh] OR "Intensive care"[Mesh] OR "Intensive care units" [Mesh] OR "Psychiatry"[Mesh] OR acute care[tiab] OR emergency department[tiab] OR recovery[tiab] OR psychiatry[tiab] OR dialysis[tiab]))

APPENDIX II SEARCH EMBASE

.tw=text word
.ti.ab=title and abstract
.pt=publication type

P

hospital patient/
aged hospital patient/
hospital$ adjusted patient$.tw
(hospitalized patient OR hospitalized patient).ti.ab

I→AND

health status/
health status indicator/
disease severity/
workload/
workload.ti.ab
care intensity.tw
nursing care/
health care need/
(health care use OR healthcare use OR health service$ use OR health services needs and demand).tw
exp.needs assessment/
(patient dependency OR care requirement$ OR patient dependency level$).tw
patient acuity/
(patient characteristic* OR patient clinical characteristic*).ti.ab

O→AND

nursing classification/
clinical classification/
patient coding/
casemix.ti.ab
diagnosis related group/
nursing care/
medical record/
nursing staff/
exp.hospital personnel/
health care manpower/
(nursing service$ OR physician service$ OR nursing service$, hospital).tw
(nurse staff$ OR medical staff$ OR requirement planning OR physician staff$ OR hospital staff$ OR personnel staffing and scheduling).tw
health care delivery/
workload measures.ti.ab
(nursing hours per patient day OR nursing workforce OR physician workforce OR nurse-patient ratio OR patient-nurse ratio OR nurse to patient ratio OR patient to nurse ratio OR physician to patient ratio OR patient to physician ratio OR physician-patient ratio OR patient-physician ratio).ti.ab

AND

(patient classification system OR patient classification instrument).ti.ab
nursing assessment/
(patient data management OR patient administration system$ OR
electronic medical record/
medical information system/
hospital information system/
nursing administration research/
exp.medical informatics/
exp.prediction and forecasting/

AND

health care cost/
hospitalization costs/
nursing costs/
exp.economic evaluation/
predictive value/
task performance/
exp.regression analysis/
discriminant analysis/
validation study/
prospective study/
retrospective study/
reproducibility/

NOT

exp.treatment outcome/
exp.mortality/

NOT

exp.intensive care/
exp.psychiatry/
psychiatric ward/
emergency ward/
(emergency care OR recovery OR dialysis).ti.ab

APPENDIX III SEARCH EBSCO

(CINAHL & Business Source Premier)

P

- MH Inpatients /CL /SN

I →AND

- MH Health status+
- MH Workload
- MH Workload Measurement
- TX Care intensity
- MH Nursing Care+ /AM /CL /EC /SN
- MH Health Services Needs and Demand+ / CL /EC /SN
- MH Needs Assessment +/CL
- MH Nursing Assessment+ /AM /CL /SN
- TI patient dependency OR AB patient dependency
- MH Patient Classification+ /AM /CL /SN
- TI patient acuity OR AB patient acuity
- TI patient characteristic* OR AB patient characteristic*
- TI care requirement* OR AB care requirement*
- TI patient dependency level* OR AB patient dependency level*

O → AND

- MH Classification+ /MT
- MH Patient Classification+ /AM /CL /SN
- MH Patient Classification+ /MT /ST
- TI casemix OR AB casemix
- MH Medical Records+ /CL /SN
- MH Nursing Care+ /AM /CL /SN
- MH Medical Staff, Hospital+ /SN
- MH Nursing Staff, Hospital+ /SN
- MH Diagnosis-Related Groups+ /AM /CL /SN
- MH Medical Records+ /CL /SN
- MH Personnel Staffing and Scheduling+
- MH Workload Measurement+ /CL/ EV /MT
- TI medical staffing OR AB medical staffing
- TI nurse staffing OR AB nurse staffing
- TI physician staffing OR AB physician staffing
- TI requirement planning OR AB requirement planning
- TI nursing hours per patient day OR AB nursing hours per patient day
- TI nursing workforce OR AB nursing workforce
- TI physician workforce OR AB physician workforce
- TI nurse to patient ratio OR AB nurse to patient ratio
- TI patient to nurse ratio OR AB patient to nurse ratio

AND

- MH Patient Classification+ /MT /ST
- MH Workload Measurement+ /CL/ EV /MT
- MH Nursing Assessment+ /MT
- MH Computerized Patient Record+
- MH Hospitalization+ /SN
- MH Management information systems+
- MH Hospital information systems+
- MH Health informatics+
- MH Nursing administration research/ SN
- TI patient data management OR AB patient data management
- TI patient administration system OR AB patient administration system

AND

- MH Instrument validation
- MH Non experimental studies+
- MH Task performance analysis+
- MH Reproducibility of results
- MH Retrospective design
- MH Regression+
- MH Predictive value of tests
- MH Discriminant analysis
- MH Cost and cost analysis
- MH Cost control

NOT

- MH Outcomes (Health care)+
- MH Hospital mortality

NOT

- MH Critical care+
- MH Intensive care units+
- MH Psychiatry+
- TI acute care OR AB acute care
- TI emergency department OR AB emergency department
- TI recovery OR AB recovery
- TI psychiatry OR AB psychiatry
- TI dialysis OR AB dialysis
-

APPENDIX IV DRG -EXPLANATION

AUTHOR	DRG	DESCRIPTION	N	NURSING DIAGNOSES
Bostrom 1991	14	Specific cerebrovascular disorders except TIA	210	NA
	15	TIA & precerebral occlusions	52	
	89	Simple pneumonia & pleurisy age >17 with c.c.	196	
	96	Bronchitis & asthma. 17 with c.c.	98	
	138	Cardiac arrhythmia & conduction disorders with c.c.	133	
	148	Major small & large bowel procedures with c.c.	207	
	182	Esophagitis/ gastroenteritis & miscellaneous digestive disorders age >17 with c.c.	148	
	294	Diabetes age >35	58	
	320	Kidney and urinary tract infections age >17 with c.c.	79	
	468	Extensive operating room procedure unrelated to principal diagnosis	191	
Bostrom 1994	14	Specific cerebrovascular disorders except TIA	NR	NA
	15	TIA & precerebral occlusions	NR	
	89	Simple pneumonia & pleurisy age >17 with c.c.	NR	
	96	Bronchitis & asthma. 17 with c.c.	NR	
	138	Cardiac arrhythmia & conduction disorders with c.c.	NR	
	148	Major small & large bowel procedures with c.c.	NR	
	182	Esophagitis/ gastroenteritis & miscellaneous digestive disorders age >17 with c.c.	NR	
	294	Diabetes age >35	NR	
	320	Kidney and urinary tract infections age >17 with c.c.	NR	
	468	Extensive operating room procedure unrelated to principal diagnosis	NR	
Halloran 1985	3	Infectious disease without secondary diagnosis	22	Altered level of consciousness
	4	Infectious disease with secondary diagnosis	23	Less nutrition than required
	11	Cancer of the GI system with surgery	17	Impairment of mobility
	59	Benign tumor of the Uterus, Ovary with surgery	22	Decreased cardiac output
	75	Diabetes without surgery with major secondary diagnosis	23	Altered self-concept: body image
	110	Disease of the eye with surgical procedure	20	Depletion of body fluids
	121	Disease of the heart- AMI	32	Thought process impaired
	124	Disease of the heart, ischemia (except AMI) without surgery with major secondary diagnosis	54	Bowel constipation
Halloran 1985	132	Disease of the heart failure without surgery	73	Severe anxiety
	144	Brain hemorrhage (Stroke) without surgery with major secondary diagnosis	28	Alteration of urinary pattern
	156	Inflammation of the veins, blood clot without secondary diagnosis or with minor secondary diagnosis	21	Dysrhythmia of sleep-rest activity
	158	Hemorrhoids	20	Actual Impairment of skin integrity
	189	Upper GI disease except stomach ulcer without surgery with secondary diagnosis	21	Urinary incontinency
	226	Disease of the gall bladder and the bile duct with surgery with age >50	28	Bowel impaction
	227	Disease of the gall bladder and the bile duct with surgery without secondary diagnosis	17	More nutrition than required
	228	Disease of the gall bladder and the bile duct with surgery with secondary diagnosis with age <65	21	Discomfort
	264	Disease of the female reproductive system with surgical procedures without secondary diagnosis	34	Potential Impairment of skin integrity
	265	Disease of the female reproductive system with surgical procedures with secondary diagnosis	77	Respiratory dysfunction
	266	Disease of the female reproductive system with surgery	65	Excess body fluids
	267	Benign breast tumor, chronic cystic disease without secondary diagnosis	13	Diarrhoea
	271	Abortion without secondary diagnosis	45	Altered ability to perform hygiene
	278	Delivery without surgery or with surgery assisting delivery	228	Noncompliance
	282	Delivery with complications with Cesarean Section	67	Urinary retention
	304	Backache, diffuse disease of connective tissue without surgery with secondary diagnosis	22	Pain
	322	Indications of nervous, respiratory circulatory system disease without surgery without secondary diagnosis	28	Mild anxiety
	323	Convulsions, fainting, nosebleed, chest pain without surgery with secondary diagnosis	25	Bowel incontinency
	348	Fracture with major surgery	18	Altered composition of body fluids
	350	Dislocation, sprains without surgery	42	Acute grieving
	355	Internal injury of the skull, other organ without surgery with secondary diagnosis with age <41	20	Delayed grieving

APPENDIX IV CONTINUED

AUTHOR	DRG	DESCRIPTION	N	NURSING DIAGNOSES
Halloran 1985	362	Open wound, multiple injuries without surgery with secondary diagnosis	24	Manipulation
	382	Special admission with surgical procedure	17	Potential nutritional alternation Confusion Moderate anxiety Panic Anticipatory grieving Sensory perceptual alternations Altered ability to perform self-care
McMahon 1992	89	Simple pneumonia and pleurisy, age >70 with complication and/ or comorbidity	120	NA
	96	Bronchitis and asthma, age >70 with complications and/ or comorbidity	53	
	112	Vascular procedures except major reconstruction without pump	710	
	124	Circulatory disorders, excluding AMI with cardiac catheterization and complex diagnosis	144	
	125	Other circulatory disorders, cardiac catheterization	59	
	127	Health failure and shock	148	
	138	Cardiac arrhythmia and conduction disorders with c.c.	68	
	140	Angina Pectoris	68	
	182	Esophagitis/ gastroenteritis & miscellaneous digestive disorders age >17 with c.c.	95	
	183	Esophagitis/ gastroenteritis & miscellaneous digestive disorders age 18-69	23	
	296	Nutritional and miscellaneous metabolic disorders age >17 with c.c.	107	
	320	Kidney and urinary tract infections age >69 and/ or c.c.	88	
	410	Chemotherapy	256	

AMI = Acute Myocardial Infarction; c.c. = comorbid conditions or complications; GI = Gastro-Intestinal; NA = not applicable NR = not reported; TIA = Transient Ischemic Attack

APPENDIX V SCORE EXPLANATION

AUTHOR	SCORE	ITEMS	RESPONSE CATEGORIES
Bostrom 1991 & 1994	SII	· stage of principal diagnosis · complications of the principal condition · concurrent interacting conditions · dependency on hospital staff · extent of non-operating room procedure · rate of response to therapy or rate of recovery · remaining impairment after therapy	1 (least severe) to 4 (most severe)
Fagerström 2000	OPC	· planning and coordination of care · breathing, blood circulation and symptoms of disease · nutrition and medication · personal hygiene and secretion · activity/ movement, sleep and rest · teaching/ guidance in care/ follow-up care and emotional support	1 (least workload) to 4 (greatest workload)
Mahmoud 2009	SENIC	operating room >2hours >3 discharge diagnoses abdominal surgery	1 point/ 1 (low risk) 1 point/ 2 (moderate risk) 1 point/ 3 (high risk)
McMahon 1992	APACHE-L	· Hematocrit · Serum creatinine without ARF · Serum creatinine with ARF · Serum BUN · Serum Na+ · Serum albumin · Serum bilirubin · Serum glucose · pCO2 · pH	Extracted from the original APACHEIII
Mion 1988	PAS	· feeding · bathing, grooming and dressing · mobility · elimination · dressings and treatments · medication · mental status and behavior · special needs ·	1 (least workload) to 5 (greatest workload)
	PSI	· stage of the principal diagnosis · complications from the disease or from treatment · interactions of other illnesses · level of physical dependency · procedures · level of response to therapy · resolution of acute symptoms	1 (low severity) to 4 (high severity)
Sermeus 2008	SJ	Care relating to hygiene	No assistance, supportive assistance, partial assistance, complete assistance
		Care relating to mobility	No assistance, supportive assistance, partial assistance, complete assistance
		Care relating to elimination	No assistance, supportive assistance, partial assistance, complete assistance
		Care relating to feeding	No assistance, supportive assistance, partial assistance, complete assistance

APACHE-L = Acute Physiology and Chronic Health Evaluation-laboratory; OPC = Oulu Patient Classification; PAS = Patient Acuity Score; PSI = Patient Severity of Illness; SENIC = Study of the Efficacy of Nosocomial Infection Control; SII = Horn's severity of illness index; SJ = San Joaquin

□

EXPLAINING THE AMOUNT OF CARE

NEEDED BY HOSPITALIZED SURGICAL PATIENTS:

A prospective time and motion study

Catharina J van Oostveen, Hester Vermeulen, Dirk J Gouma, Piet JM Bakker, Dirk T Ubbink

BMC Health Serv Res. 2013;13:42.

ABSTRACT

BACKGROUND: Hospitals provide care for patients with a variety of diseases, co-morbidities and complications. The actual amount of care these patients need is unclear. Given the recent developments such as ageing, multi-morbidity and budgetary restraints, a practical explanatory model would avail healthcare professionals and managers in determining the demand and costs for clinical care.

METHODS: Six surgical wards in a Dutch university hospital participated in this prospective time and motion study. Surgeons, nurses and paramedics recorded the time spent on patient care 24/7 by means of PDAs. The investigators extracted possible determining characteristics from a previous systematic review and expert focus group. Total amount of care needed by the patients was expressed as costs involved in medical and nursing time, surgical interventions and diagnostics. Afterwards the investigators applied linear regression analysis to detect significant independent characteristics.

RESULTS: 174 Surgical patients were monitored during their hospital stay. Characteristics significantly influencing the consumed amount of care were: medication during hospitalization, complications, co-morbidity, medical specialty, age, as well as undergoing surgery and length of stay. Median costs for care were €8.446 per patient admission.

CONCLUSIONS: The investigators developed a model that explains the total demand and costs of care needed for surgical patients in a university hospital. The input for this instrument can be derived from readily available data in hospital databases. This makes it a relatively easy instrument to help healthcare professionals and managers appreciate the amount of care needed on (surgical) wards and may be used to appreciate trends in time.

KEYWORDS: PATIENT CHARACTERISTICS; WORKLOAD; TIME AND MOTION RESEARCH; (MULTIPLE) REGRESSION ANALYSIS

BACKGROUND

Given the recent societal developments such as survival to an older age, increasing multi-morbidity and stagnating growth of the working population, it is expected that the demand for medical and nursing care will increase substantially[1]. Hospitals are nowadays more and more confronted with budget cuts and accountable to substantiate their costs spent on highly specialized, top referral care. Therefore it is important for professionals and managers to identify the factors determining the (trends in the) demand and costs for care. Surgical wards of university hospitals in particular recognize the changing demography and increasing accountability, as they rely heavily on expensive facilities like operating theatres, ICUs, and diagnostic imaging.

Demand for care is defined as the needs of individual patients in terms of the sum of (para)medical and nursing resources used[2]. One of the seminal systems to measure and classify this demand for care from nursing resources is the Therapeutic Intervention Scoring System (TISS)[3]. This instrument helps classify the workload for nurses in the intensive care unit (ICU) by registering and weighing therapeutic nursing interventions. On general hospital wards, similar instruments are used as Patient Classification Systems (PCS). These instruments rely on subjective and clinical observations by nurses, give information about nursing care already given, and help with the staffing of nursing wards[4]. These instruments, however, cannot predict the demand for care, particularly from physicians and paramedics, and are not based on objective measures, such as patient characteristics.

Few studies have investigated objective influencing factors for nursing workload[2,5-14]. Although these studies applied the demand for care as a reference standard, they used different definitions for this entity[15,16]. This led to invalid and unreliable PCSs and systematic under- and overestimation of the demand for care, while the explored characteristics per se were poorly associated.
The investigators therefore aimed to develop an explanatory model, based on readily available clinical patient characteristics from hospital databases for the use of (para)medical and nursing resources by surgical patients. A practical explanatory model would avail healthcare professionals and managers in determining the demand and costs for clinical care and use this information for policy making, i.e., budget planning.

METHODS

The conduct and description of this study was done according to the Suggested Time And Motion Procedures (STAMP) checklist[17].

Setting

Six general surgical wards in a university hospital in the Netherlands contributed to this study. These 24-bed wards provide standard and specialty surgical care, i.e. general, vascular, plastic, orthopedic, and trauma surgery. On each ward approximately 30 nurses, three auxiliary nurses, one resident, two surgeons, one physical therapist, one social worker, and one dietician were involved during the study.

Design

In this prospective time and motion study medical, nursing and paramedical personnel continuously (24/7) recorded the patients' care process during admission. The investigators recorded data on diagnostic and surgical procedures, intensive care stay, total length of hospital stay, and time spent on patient care by all healthcare professionals (physicians, nurses and paramedics). Time recordings comprised direct patient contact or indirect care (i.e. patient-related telephone calls, planning and administrative activities, inter-professional consultations, multidisciplinary meetings, etc.). These data were used as reference standard to develop the desired explanatory model.

Potentially predicting patient characteristics

A set of 17 potentially predictive characteristics (Table 1) was defined based on suggestions made by a local expert panel (consisting of head nurses, nursing managers and clinicians), and a systematic literature review not yet published. These characteristics could be extracted from the medical and nursing files and hospital databases and therefore did not need any additional registration effort.

Co-morbidities were counted if requiring treatment with drugs or medical devices (e.g. prosthesis).

Patient characteristics were collected and checked by two investigators independently during admission and after discharge from the hospital. Only co-morbidities requiring medication or a medical device were recorded. Missing data were retrieved from medical and nursing files or asked directly from the patients during their hospitalization or, after discharge, by phone.

Table 1 Potentially predictive patient characteristics

CHARACTERISTIC	RANGE OF POSSIBLE VALUES
Surgical intervention	0= yes or 1= no
Age	0 to ∞
Gender	0= woman or 1= man
Number of co-morbidities	0 to ∞
Number of complications	0 to ∞
ASA-classification	1, 2, 3 or 4
BMI at admission	NA
Nutritional status (weight loss in past 6 mo.)	NA
Delirium during hospitalization	0= no or 1= yes
Pressure ulcer during hospitalization	0= no pressure ulcers, or grade 1 through 4 ulcers
Isolated care during hospitalization	0= no, 1= barrier or 2= strict isolation
Survival during hospitalization	0= yes OR 1= no
Number of different medications during hospitalization	0 to ∞
Admission type	0= home or 1= emergency
Discharge type	0= home, 1= other
Length of hospital stay	number of days
Surgical specialty	· TRAUMA Trauma surgery · URO Urology · SHORT Short Stay surgery · ORTHO Orthopedic surgery · ABDO Gastro-Intestinal surgery · PLAST Plastic surgery · VASC Vascular surgery · ORAL Oral and Maxillofacial surgery

ASA = American Society of Anesthesiologists; BMI = Body Mass Index; NA = not applicable

Patient sample

To define a patient sample representative for those regularly admitted to surgical wards, the investigators used the latest available update of the national medical registry (LMR) of admission diagnoses. To develop an explanatory model with up to 17 predefined characteristics, the investigators decided to collect a sample of at least 170 patients in a three-month period. The numbers of patients with a certain diagnosis to be included was commensurate with the ranking based on a top-12 of admission diagnoses for each ward (Table 2). Patient inclusion stopped when a sufficient number of patients with these diagnoses was reached.

Study conduct

For continuous time and motion research the investigators used Personal Digital Assistants (PDAs) (Palm One Tungsten E2; Palm Inc., Sunnyvale, CA, USA). A dedicated software program was developed for this purpose (I-V-O: Web development, scripting, hosting & consultancy, Alkmaar, The Netherlands). This allowed recording of the date, duration of direct and indirect time spent per patient, type of professionals involved, and wards and patients involved (Figure 1). Data thus collected were downloaded daily from the PDAs to a central computer database. The PDAs were distributed during every shift to the professionals involved on each ward. Consulting professionals visiting an included patient made use of an additional PDA placed at the patients' bedside. All professionals contributing to the study were informed about its purpose and the use of the PDAs by instructive posters and meetings.

Eight investigators distributed the PDAs and were available for support seven days a week from 7AM to midnight. Recording errors were as much as possible recognized directly by means of a logbook and corrected and evaluated afterwards. Recorded time data were checked and analyzed twice a week for exceptional and missing values. Such recordings were replaced by an average, based on similar situations in the same patient. To check the reliability of the data the investigators frequently asked, and randomly shadowed, the professionals involved regarding their recording behavior.

Time and motion method

To obtain a single measure for demand for care, information about wards, patient characteristics, professionals involved, date, time, and duration of care were converted into the costs involved. Standard costs for wages of the various professionals were used for day, evening, night, and weekend shifts, whenever applicable. Costs of surgical interventions were based on the gross time needed for the surgical procedure and the associated salary costs of the professionals present. The costs of diagnostic procedures and ICU and recovery stays were added to arrive at the

Table 2 Patient samples per surgical specialty

Specialty	Top 12 admission diagnoses	Estimated diagnosis incidence	Planned patient inclusion	Realized patient inclusion
		PATIENT SAMPLES PER SURGICAL SPECIALTY		
URO SHORT	· Diseases of the genitourinary system	406 (50.1%)	23	(47.8%) 11
	· Diseases of the digestive system	113 (14%)	7	(57.1%) 4
	· Neoplasms	301 (37.2%)	17	(82.4%) 14
	· Additional inclusions			4
Total		810 (100%)	47 (100%)	(71.7%) 33 (19%)
VASC PLAST	· Diseases of the circulatory system	208 (55.8%)	12	(66.7%) 8
	· Diseases of the skin and subcutaneous tissue	24 (6.4%)	1	(100%) 1
	· Diseases of the genitourinary system	28 (7.5%)	2	(100%) 2
	· Diseases of the musculoskeletal system and connective tissue	54 (14.5%)	3	(66.7%) 2
	· Factors influencing health status and contact with health services	59 (15.8)	4	(75%) 3
	· Additional inclusions			7
Total		373 (100%)	22 (100%)	(100%) 23 (13.2%)
ABDO	· Neoplasms	204 (63%)	12	(125%) 15
	· Diseases of the digestive system	106 (32.7%)	6	(133.3%) 8
	· Factors influencing health status and contact with health services	14 (4.3%)	1	(200%) 2
	· Additional inclusions			2
Total		324 (100%)	19 (100%)	(142.1%) 27 (15.5%)
ABDO ORAL	· Neoplasms	153 (58.8%)	10	(160%) 16
	· Diseases of the digestive system	83 (32%)	5	(300%) 15
	· Injury, poisoning and certain other consequences of external causes	24 (9.2%)	1	(300%) 3
	· Additional inclusions			4
Total		260 (100%)	16 (100%)	(237.5%) 38 (21.8%)
TRAUMA	· Injury, poisoning and certain other consequences of external causes	311 (88.1%)	18	(66.7%) 12
	· Diseases of the musculoskeletal system and connective tissue	42 (11.9%)	2	(150%) 3
	· Additional inclusions			9
Total		353 (100%)	20 (100%)	(120%) 24 (13.8%)
ORTHO	· Injury, poisoning and certain other consequences of external causes	124 (27.2%)	7	(57%) 4
	· Diseases of the musculoskeletal system and connective tissue	286 (62.7%)	16	(113%) 18
	· Neoplasms	46 (10.1%)	3	(133.3%) 4
	· Additional inclusions			3
Total		456 (100%)	26 (100%)	(111.5%) 29 (16.7%)
OVERALL TOTAL			**150 (100%)**	**(116%) 174 (100%)**

TRAUMA = Trauma surgery; URO = Urology; SHORT = Short Stay surgery; ORTHO = Orthopedic surgery; ABDO = G-I surgery; PLAST = Plastic surgery; VASC = Vascular surgery; ORAL = Oral and Maxillofacial surgery

total costs of the demand for care for each patient during their admission period. The total costs were used as the dependent variable in the explanatory model.
To account for the possible influence of the availability of resources on the amount of care given, the investigators also observed the relation between available Full Time Equivalents (FTE) and bed occupancy rates per ward.

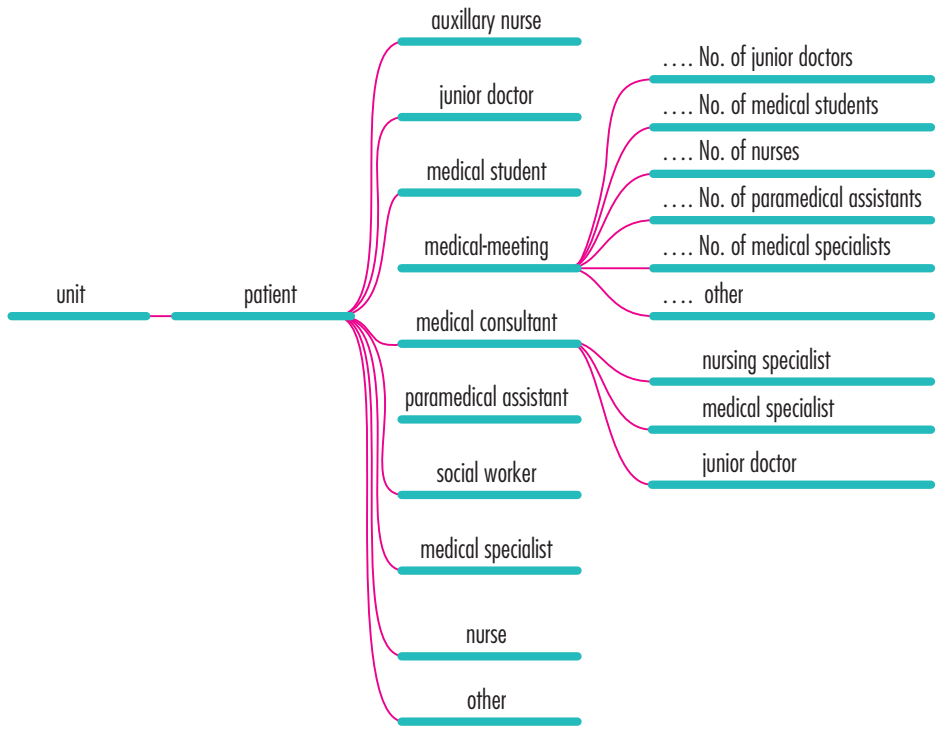
Statistical analysis

Data were imported into the Statistical Package for the Social Sciences v. 16 (SPSS Inc., Chicago, IL, US). Categorical data are presented as proportions. Continuous variables are summarized as means with standard deviations. After exploration of the association between the various characteristics and the costs of the demand for care in a univariable analysis, significant predictive characteristics were detected in a multiple backward linear regression analysis. Additionally, each non-significant factor was added one by one to the model found by the multiple backward analysis to check whether they contributed significantly to the model.
To distinguish patient characteristics and organizational factors, we analyzed these in different models. For all analyses the significance level was set at $P<0.05$. B-values were calculated with their 95% confidence intervals. Log-transformation of the dependent variable total costs of demand for care was performed because of its non-normal distribution.

Ethical issues

Our local medical ethics review board (Academic Medical Center, Amsterdam, The Netherlands) approved the study but waived the need for written informed consent, as the study had no effect on the patient's treatment or psychological wellbeing. Yet, all included patients received an explanation about the study and gave verbal consent.

Figure 1 Menu structure of Personal Digital Assistants



RESULTS

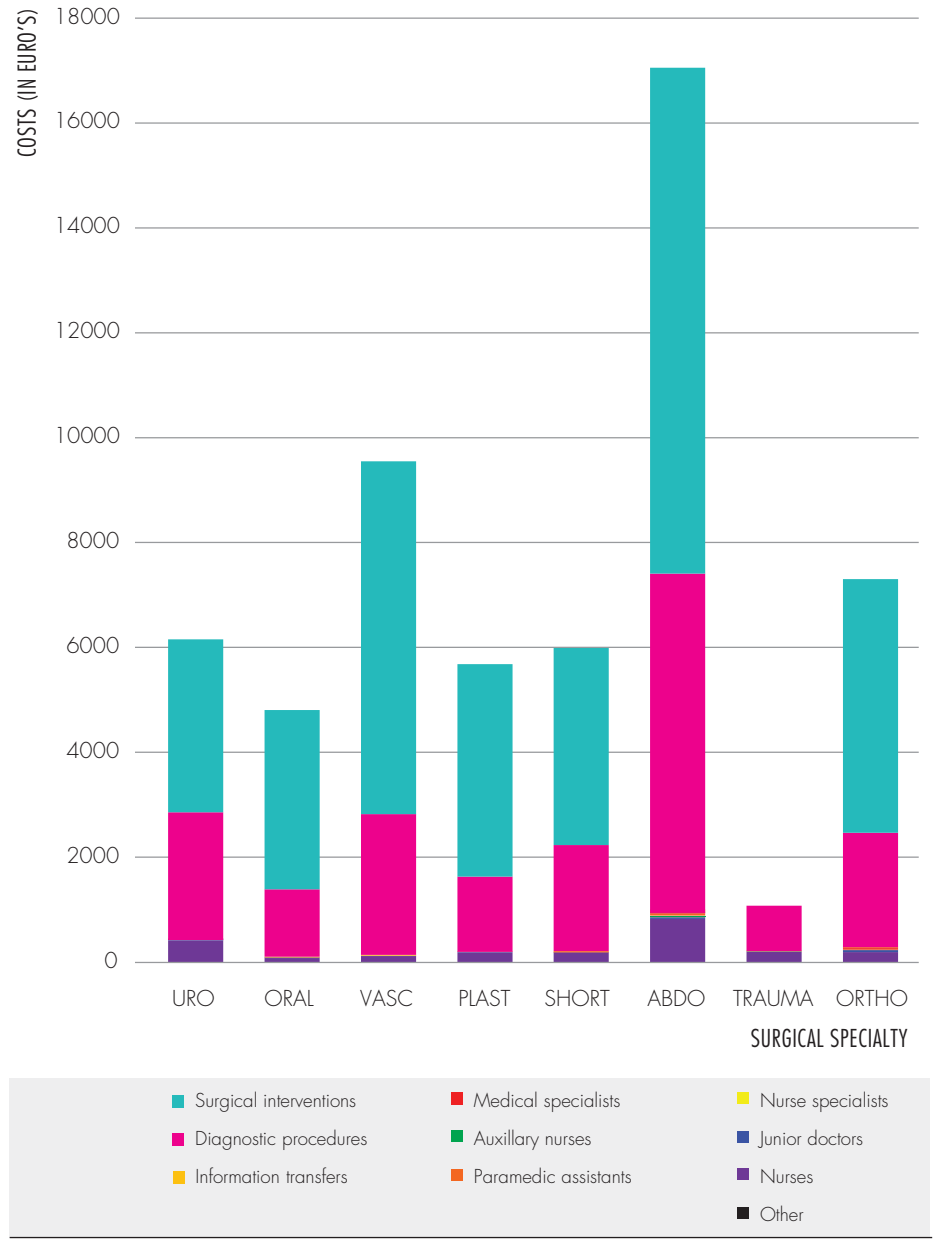
From February to April 2010, 174 consecutive patients were included, both elective and emergency admissions. One patient declined participation in the study. Demographics of included patients are summarized in Table 3.
Median total costs of the demand for care per patient were €8,446 and varied from €815 for trauma patients to €82,780 for G-I surgical patients (Figure 2). Surgical and diagnostic interventions contributed most to these costs. Nursing costs formed the largest part (76%) of the personnel expenses; €308, vs. physicians €56, and paramedics €2.70 per patient, excluding the personnel costs for the surgical intervention. Median costs for surgical interventions were €5,286 (range: €0 – €21,111). Median costs for diagnostic procedures were €2,699 and varied from €372 to €74,567 (Figure 3).

In the univariable analysis, age, number of complications, ASA-class, nutritional status, admission type, number of medications during hospitalization, and surgical specialty were significantly associated with the costs of demand for care (Table 3), as opposed to gender, number of co-morbidities, and BMI. Delirium and isolation during hospitalization, pressure ulcers, admission type, and mortality did not contribute significantly, likely because they occurred rarely. A total of 153 valid cases from the initial 174, i.e. without any missing values, could be used to complete the multivariable regression analysis. Although not significant in the univariable analysis, number of co-morbidities was also used in the multivariate analysis because of the allegedly high clinical relevance of this characteristic.

The best model of patient characteristics to predict the total costs of the demand for care contained the number of medications during hospitalization, number of co-morbidities, number of complications, age and surgical specialty.
This model explained 56.2% of the variance in the demand for care in terms of costs. The set of dummies for surgical specialty effectuate 49% of this variance. Total costs increased with 18% per additional complication (95% CI 1 to 38%; p=0.036), while an additional medication caused a 3% increase in costs (95% CI 1 to 5%; p=0.007). Per increasing year in age the costs increased with 0.5%, but this was not statistically significant (95% CI 0 to 1%; p=0.072). Unexpectedly, an additional co-morbid condition lowered the costs with 9% (95% CI -16 to -3%; p=0.005; Figure 3). In addition, in a separate model of organizational factors surgical intervention and length of hospital stay were also found to be significant factors of total costs of care. This model explained 54% of the demand for care. Undergoing a surgical procedure nearly tripled total costs (292%; 95% CI 194 to 440%; p<0.001), while an extra day of hospitalization increased the costs with 8% (95% CI 6 to 9%; p<0.001).

Bed occupation as proportion of the total number of available beds varied among wards from 53.2 to 70.5%, while the percentage of optimum staffing in FTEs per ward ranged from 93.4 to 96.6% (Table 4). The investigators did not find any relation between a higher FTE occupancy or lower bed occupancy and more time spent on care. Hence, we could not detect a substantial influence of the availability of resources on demand for care.
From our random checks of the completeness of data recordings the investigators appreciated that nurses recorded 59 to 96% of their times spent per patient. Physicians stated a registration of between 45 to 100% of their activities.

Figure 2 Median costs (in Euros) per patient of the demand for care per surgical specialty



TRAUMA = Trauma surgery; URO = Urology; SHORT = Short Stay surgery; ORTHO = Orthopedic surgery; ABDO = G-I surgery; PLAST = Plastic surgery; VASC = Vascular surgery; ORAL = Oral and Maxillofacial surgery

Table 3 Univariable and multivariable linear regression analysis of possible predictive characteristics ►

				UNIVARIABLE			MULTIVARIABLE		
Characteristic	N (%)	Mean (SD)	Range	Estimate (B)	CI 95%	P- value	Estimate (B)	CI 95%	P- value
Age		57.20 (16.60)	19–87	0.004	0.001–0.007	0.004	0.002	<0.000–0.005	0.072
Surgical Intervention performed	167 (96)			0.594	0.351–0.837	<0.000	0.466	0.288–0.643	<0.000
Gender (males)	99 (56.90)			-0.015	-0.118–0.870	0.767			
Number of co-morbidities		1.47 (1.68)	0–9	<0.000	-0.031–0.030	0.978	-0.038	-0.064–0.012	0.005
Number of complications		0.21 (0.60)	0–4	0.221	0.144–0.299	<0.000	0.072	0.005–0.139	0.036
ASA-class									
· 1	41 (26.80)			RC	0.057–0.279	0.003			
· 2	89 (58.17)			0.168, RC	0.081–0.387	0.003			
· 3	23 (15.03)			0.234, 0.067	-0.071–0.204	0.339			
BMI at admission		26.43 (5.37)	17.2–53.6	-0.006	-0.015–0.003	0.189			
Nutritional status		2.28 (5.78)	0–50	0.018	0.010–0.026	<0.000			
Delirium during hospitalization	3 (0.70)								
Pressure ulcer acquired during hospitalization									
· Grade 1	0								
· Grade 2	1 (0.60)								
· Grade 3	1 (0.60)								
· Grade 4	0								
Isolation									
· Barrier	2 (1.15)								
· Strict isolation	0								
Survival	174 (100)								
Number of medications during hospitalization		8.51 (5.07)	0–26	0.031	0.022–0.040	<0.000	0.013	0.004–0.023	0.007
Admission type				-0.210	-0.360–-0.061	0.006			
· Home	152 (87.36)								
· Emergency	22 (12.64)								
Discharge type									
· Home	163 (93.70)								
· Other	11 (6.32)								
Length of Stay		8.11 (6.85)	1–45	0.034	0.028–0.039	<0.000	0.032	0.027–0.037	<0.000
Surgical specialty									
· TRAUMA	4 (2.30)			RC					
· URO	21 (12.07)			0.776	0.511–1.042	<0.000	0.760	0.500–1.021	<0.000
· ORTHO	49 (28.16)			0.758	0.505–1.012	<0.000	0.706	0.461–0.950	<0.000
· ABDO	55 (31.06)			1.152	0.900–1.405	<0.000	1.005	0.755–1.255	<0.000
· SHORT	14 (8.05)			0.644	0.368–0.920	<0.000	0.623	0.350–0.896	<0.000
· PLAST	12 (6.90)			0.622	0.381–0.943	<0.000	0.610	0.339–0.882	<0.000
· VASC	11 (6.32)			0.786	0.502–1.071	<0.000	0.738	0.456–1.020	<0.000
· ORAL	8 (4.60)			0.679	0.380–0.977	<0.000	0.664	0.383–0.946	<0.000

RC = reference category; SD = standard deviation; B = beta; CI = confidence interval; ASA = American Society of Anesthesiologists; BMI = Body Mass Index; TRAUMA = Trauma surgery; URO = Urology; SHORT = Short Stay surgery; ORTHO = Orthopedic surgery; ABDO = Gastro-Intestinal surgery; PLAST = Plastic surgery; VASC = Vascular surgery; ORAL = Oral and Maxillofacial surgery

Figure 3 Box plots of median costs (in Euros) per patient of the demand for care per number of co-morbidities

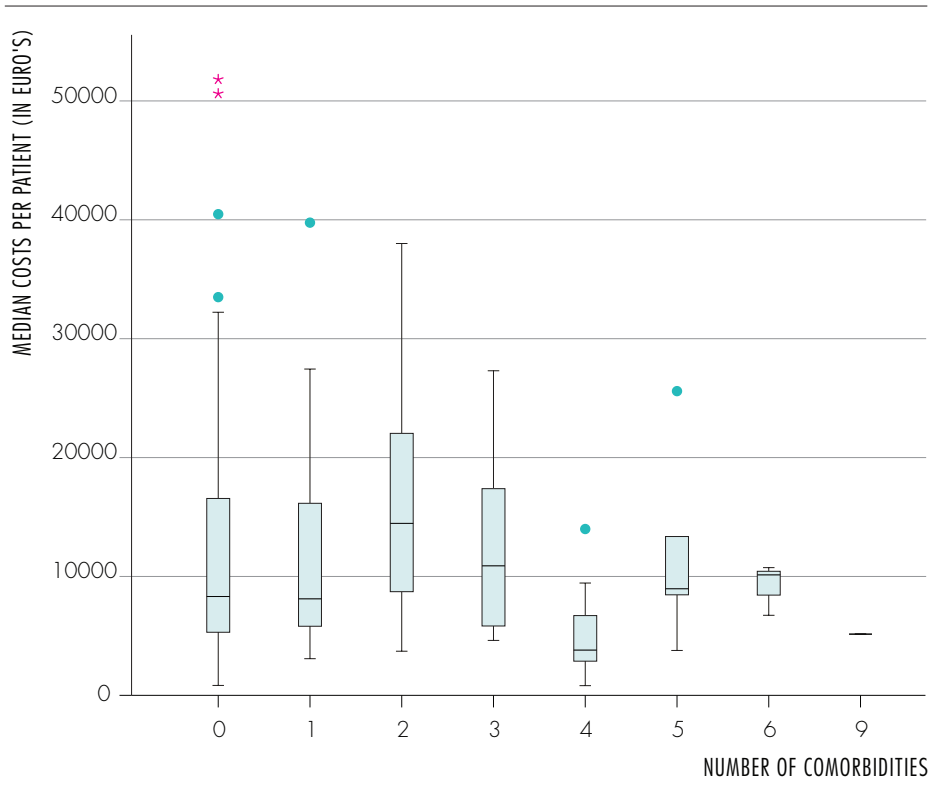


Table 4 Bed occupation and available Full Time Equivalents (FTEs) during data collection

UNIT	BED OCCUPATION %[1,2]	FTE[2,3]	TIME[4]
Short stay & Urology	60.29	95.08%	32:19:06
Vascular and Plastic surgery	56.63	93.62%	29:53:37
Gastro-Intestinal surgery	65.86	94.85%	67:44:50
Gastro-Intestinal surgery and Oral & Maxillofacial surgery	70.53	93.44%	63:12:02
Trauma surgery	53.20	96.58%	30:03:24
Orthopedic surgery	62.09	93.55%	35:29:41

1: Bed occupation (realized/available beds) during study period;

2: Mean of February and March 2010;

3: 100% (optimum personnel staffing) minus absence;

4: Mean total time spent per patient during hospitalization

DISCUSSION

A model was developed to explain the demand for care based on readily available patient characteristics. Number of medications during hospitalization, number of co-morbidities, number of complications, age, surgical specialty, as well as undergoing a surgical intervention and length of stay significantly contributed to an increased demand for care. It is likely that these results are generalizable to other specialties because these are blanket factors, applicable to a broad patient population.

No significant associations were found between the patient's ASA class, nutritional status, admission type and their demand for care. This is partially in agreement with the results from other investigators[10], a weak but significant correlation ($r=0.35$ $p<0.0001$) between admission type and nursing workload. For ASA class and nutritional status, no comparable evidence is available. ASA class appeared to be a promising influencing factor in the univariable analysis, but was found not significant in the multivariable analysis. Probably too few patients belonged to ASA class 3, because we found significant associations between ASA classes 1 and 2, and between 1 and 3, but not between classes 2 and 3. Also delirium, pressure ulcers, patient isolation, and in- hospital mortality were not significantly associated with demand for care. This is likely because their incidence was quite low in our study, but not unusual for these wards. Furthermore, these factors are less useful as factors predicting the demand for care because they occur during hospitalization and are not known beforehand. If they would contribute significantly to the model, they can still be useful as a managerial tool to monitor amount of care on a more aggregate level on wards to detect trends in time as to patients' demand for care.

Some nursing care models have found the case-mix groups (CMG) or Diagnosis Related Groups (DRGs) to be explanatory factors for the demand for nursing care[6,9,11-13]. In this study the investigators categorized the medical diagnoses at a more abstract level, i.e., surgical specialty, because of the large variety in diagnoses present. This specialty appeared relevant as it showed to be an important significant factor, explaining 49% of the variance in the demand for care in terms of costs.

The number of complications during hospitalization also had a large influence on the demand for care. This number is likely to be related to co-morbidity and medication. Therefore, this number seems a sensitive indicator for the complexity of care and the following demand for care. Complexity is an important concept in research as to the demand for nursing care[12,14]. In the nursing realm, complexity has been measured by parameters like severity of illness[10] nature of nursing tasks[12,18]

and nursing diagnoses[9,12]. These variables had similar predicting values. The impact of complications on the demand for care was mainly due to the costs for diagnostic or therapeutic interventions, such as (redo) surgery to treat complications, and mostly occurred in patients undergoing gastro-intestinal surgery. This may be exemplary for the tertiary referral hospital in which this study was conducted.
The number of medications used during hospitalization had less influence on the demand for care. No comparable evidence is available but this limited influence is possibly caused by the fact that medication is principally given to cure, and therefore associated with an increase in the demand for care. Also 'age' had less influence on the demand for care. This parameter nearly reached statistical significance (P=0.072) in the multivariable model and was added because of its clinical relevance. Such poor associations were also found by other researchers[8,9,12].
The negative association found between co-morbidity and demand for care may be because the severity of the various co-morbidities was not weighed in this study. Less severe co-morbidities may have been managed through medication, while patients with more severe co-morbidities were less likely to undergo surgery. This is confirmed by the study of Gijsen et al.[19]. They proposed the Charlson Co-morbidity index (CCI) to operationalize the severity of the co-morbidity.
Also, undergoing a surgical intervention and length of hospital stay were significant factors associated with the demand for care. This seems obvious, given the additional costs of surgery and of each extra day spent in the hospital. Previous studies have shown this is likely to be related to the severity of the patient's illness and therefore their demand for care[2,10,12].

Some limitations of this study should be discussed. First, the investigators calculated and modelled the care the patients received, which may not be commensurate with what they needed. We did check that the results of our study represented demand for care rather than the mere usage of personnel and resources. The delivered care was independent of bed occupancy and available personnel. This suggests that indeed the demand for care was measured instead of offered resources. In retrospect, the investigators might also have appreciated whether the care given had met the patient's expectations and had cured or relieved their disorder.
Second, the investigators used a diversity of input, structure, process, and outcome variables in the model. As mentioned earlier, variables occurring during hospitalization are unknown beforehand and therefore not useful as predictive factors. It seems plausible to use input variables for the explanatory model and use process and structure variables as specialty-specific or center-specific characteristics, e.g. undergoing a surgical intervention, level of education[7,8], or organizational factors[12,13], in an additional model. Furthermore, the success of the care given could also have been estimated, e.g. by measuring outcome variables as the number of complications or readmissions within 30 days after dismissal or by appreciating the quality of care[8]. This was beyond the possibilities of the present study, but will be incorporated in a recently started follow-up study among Dutch top-clinical hospitals.
Third, the investigators took for this study an innovative approach to measure the demand for care by time and motion research. This method was performed with rigor to collect data on individual patient contacts by professionals. Otherwise, continuous time and motion research provides precise results only if the professionals involved are willing to accurately record the time spent. The investigators found under-recording of time data, predominantly among physicians, resulting in an under-reporting of the total costs involved. Although this will have weakened the power of our model to predict demand for care, there was no reason to suspect selective under-recording that would have influenced the ability to detect predictive characteristics. It may explain, however, that the demand for care in our model appeared determined by the costs of the surgical and diagnostic interventions rather than the costs of personnel outside the operating theatre. As the investigators could not incorporate all costs at the same level of detail (e.g. overhead cost on wards or surgical interventions were not taken into account), a representative estimate was used of the costs for (para)medical and nursing care during admission. However, the overhead costs are likely to be proportional to the personnel costs we measured and therefore not influencing the outcome of our model.
Fourth, by expressing the demand for care as costs, the contribution of unpaid medical trainees to the patient care was not taken into account, although they deliver a substantial contribution to patient care in university clinics and affiliated hospitals. In addition, costs for overhead, patient transport, medication, material costs for surgical procedures in the operating theatre or on the nursing ward were not taken into account, while costs for ICU- and recovery stays were entered as fixed costs. Finally, no additional charges were included for surgical interventions during weekends, evenings and nights. Further detailing of these costs was beyond our possibilities but it is doubtful whether this would have had a major impact on the general outcome of our study.

CONCLUSION

A practical model was developed to explain the total demand and costs of care for surgical patients in a university hospital. The input for this model, age, number of co-morbidities, number of medications during hospitalization, number of complications, surgical specialty, and length of hospital stay, can be derived from readily available data in hospital databases. The time and motion approach to estimating costs potentially provides an accurate assessment of the demand for care. This approach can be applied more broadly to the same ends.

It is worthwhile to explore this model in different populations and healthcare organizations. The results needs to be further explored, but can combined with population projections potential allow healthcare professionals and managers in policy making, i.e. informed planning and budgeting.

COMPETING INTERESTS

The authors declare that they have no competing interests.

ACKNOWLEDGEMENTS

The investigators thank the many physicians, nurses, and paramedical personnel of the surgical departments for their effort to record their time spent on patient care, and the patients for participating in this study. The investigators are also grateful to the team that advised and daily supervised the collection of the PDAs and time data on the wards.

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QUANTIFYING THE DEMAND

OF HEALTHCARE SERVICES: A time and motion study

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BMC Health Serv Res. Provisionally accepted

ABSTRACT

BACKGROUND: The actual amount of care hospitalized patients need is unclear. A model to quantify the demand for hospital care services among various clinical specialties would avail healthcare professionals and managers to anticipate the demand and costs for clinical care.

METHODS: Three medical specialties in a Dutch university hospital participated in this prospective time and motion study. To include a representative sample of patients admitted to clinical wards, the most common admission diagnoses were selected from the most recent update of the national medical registry (LMR) of ICD-10 admission diagnoses. The investigators recorded the time spent by physicians and nurses on patient care. Also the costs involved in medical and nursing care, (surgical) interventions, and diagnostic procedures as an estimate of the demand for hospital care services per hospitalized patient were calculated and cumulated. Linear regression analysis was applied to determine significant factors including patient and healthcare outcome characteristics.

RESULTS: Fifty patients on the Surgery (19), Pediatrics (17), and Obstetrics & Gynecology (14) wards were monitored during their hospitalization. Characteristics significantly associated with the demand for healthcare were: polypharmacy during hospitalization, complication severity level, and whether a surgical intervention was performed.

CONCLUSIONS: A set of predictors of the demand for hospital care services was found applicable to different clinical specialties. These factors can all be identified during hospitalization and be used as a managerial tool to monitor the patients' demand for hospital care services and to detect trends in time.

KEY WORDS: PATIENT CHARACTERISTICS; DEMAND FOR HOSPITAL CARE SERVICES; TIME AND MOTION RESEARCH; (MULTIVARIABLE) REGRESSION ANALYSIS

INTRODUCTION

In the upcoming decades the ageing of our population is likely to increase the demand for healthcare services, while more patients will acquire cancer or chronic diseases[1]. This, together with menacing budgetary restraints, will have its impact on hospital resources and may jeopardize the quality, efficiency, and accessibility of patient care[2]. It is therefore important for hospitals to be able to anticipate the upcoming demand for hospital care services, in qualitative and quantitative terms.

Existing instruments to determine the demand for care rely on subjective and clinical observations by nurses, give information about nursing care already given, and help with the staffing of nursing wards[3]. These instruments, however, cannot predict the medical demand for care, and are not solely based on objective measures, such as patient characteristics, e.g. medical diagnosis, age, ASA-classification, etc. In an earlier study we developed a model for the demand for hospital care services, based on commonly accepted surgical patient characteristics that were readily available from hospital databases[4]. This demand was defined as the costs of (para)medical and nursing resources used by surgical patients during their hospital stay. In this model to predict (trends in) the demand for surgical care, we identified a set of patient characteristics, as well as process and structure variables, i.e.: ASA-classification, number of co-morbidities, polypharmacy during hospitalization, number of complications, surgical specialty, and length of hospital stay (LOS).
To assess the validity of this model in a broader setting, it needs to be tested among other clinical specialties for its usefulness for hospital managers and policy makers. It may then be used on strategic and tactical levels to determine (trends in) the hospital's patient population and referral function, to make managerial choices regarding hospital specialization, or to underpin reimbursement negotiations with healthcare insurance companies.

This prospective time and motion study was conducted to validate an already developed set of explanatory factors for the demand of hospital care services[4] for some of the most representative clinical patient populations (Surgery, Pediatrics and Obstetrics & Gynecology) in a university hospital.

METHODS

The description and conduct of this time and motion study was done according to the Suggested Time And Motion Procedures (STAMP) checklist[5]. The checklist's nine main categories of procedures—intervention, empirical setting, research design, task category, observer, subject, data recording, data analysis, and ancillary data—focus on subject identification, randomization, data collection, and data analysis. We used the STAMP checklist to capture and organize the data collection process.

Setting

The study was undertaken in a tertiary-care university hospital in the Netherlands. Three clinical specialties contributed to the study; five Surgery, four Pediatrics, and three Obstetrics & Gynecology (Ob&Gyn) wards.

On each ward approximately 30 nurses, one resident, and several medical specialists contributed during the study. For pediatric and obstetric patients respectively, clinical educationalists, i.e., coaches for hospitalized children, and midwifes were also involved as they contributed a substantial amount of care.

Design

To estimate the patients' demand for hospital care we applied a hybrid study design[6], consisting of a so-called "continuous observation time and motion study" among nurses[7], and a paper-based sampling of the activities among physicians. The latter approach was preferred as an equally effective[8], but more reliable method, because during a previous study we had detected considerable under-recording by the physicians when clocking their own activities[4].

Data collection

In a six-month time frame, we recorded data on hospital features, patient characteristics, diagnostic and surgical procedures, intensive care stay, time spent on patient care by all healthcare professionals involved, and outcome measures to estimate the provided care. Time recordings included direct patient contact (i.e., washing, wound care, communication, ward rounds, etc.) and indirect care (i.e., patient-related telephone calls, planning and administrative activities, inter-professional consultations, multidisciplinary meetings, etc.). The collected time and resource usage data were used as reference standard for the hospital care needed by the patients in order to validate the set of explanatory factors (Table 1). This set was previously developed based on suggestions made by a local expert panel (consisting of head nurses, nursing managers, and physicians), a systematic literature review[9], and results from a previous exploratory study[4]. The factors could be extracted from the patient files and hospital databases and therefore did not require any additional registration effort. Polypharmacy was defined as using 5 or more medications during admission, being a cut-off point according the Dutch law for Pharmaceutics and commonly used in literature[10]. To identify patient characteristics regarding the amount of care needed, we browsed medical and nursing files, either electronic or paper-based. The Charlson co-morbidity index (CCI) was calculated using a calculation sheet[11]. To assess the severity of complications for all patients in the study we used the Clavien-Dindo classification for surgical complications, which is integrated in the national surgical complication registry[12]. Characteristics were collected and checked by two investigators independently during admission and after discharge from the hospital. Missing data were retrieved from medical and nursing files or, if necessary, asked directly from the patients during their hospitalization.

Table 1 Predictive patient and clinical characteristics investigated.

CHARACTERISTIC	RANGE OF POSSIBLE VALUES
Age	0 to ∞
Ethnicity	0= Dutch, 1= Moroccan, 2= Surinamese, 3= Other Western, 4= Other non-Western
Gender	0= woman or 1= man
Charlson co-morbidity index	0 to 40
Complication severity level	0, 1, 2, 3 or 4
ASA-classification	0, 1, 2, 3 or 4
BMI at admission	NA
Nutritional status (weight loss in past 6 mo.)	NA
Delirium during hospitalization	0= no or 1= yes
Pressure ulcer during hospitalization	0= no decubitus, or grade 1 through 4
Isolated care during hospitalization	0= no, 1= barrier or 2= strict isolation
Survival during hospitalization	0= yes or 1= no
Polypharmacy during hospitalization	0 = <5 or 1= >5
Admission type	0= home or 1= emergency
Discharge type	0= home or 1= other
Readmission within 30 days	0= no or 1= yes
Surgical intervention	0= no or 1= yes
Medical specialty	· Surgery · Pediatrics · Obstetrics & Gynecology

ASA = American Society of Anesthesiologists; BMI = Body Mass Index; NA = not applicable

Patient sample

For this validation study we needed a broad and representative sample of patients admitted to the participating wards. To include a representative sample of patients admitted to clinical wards, the most common admission diagnoses were selected from the most recent update of the national medical registry (LMR) of ICD-10 admission diagnoses in a whole year. The numbers of patients with the diagnoses to be included were proportionate with the top-20 of admission diagnoses for each specialty (Table 2).

Table 2 Patient samples per medical specialty ►

PATIENT SAMPLES PER MEDICAL SPECIALTY					
Specialty	Top 12 admission diagnoses ICD 10*	Planned patient inclusion	Planned patient inclusion	Included diagnoses	Realized patient inclusion
SURGERY (Orthopedics, Urology and Gastro-Intestinal-surgery)	Diseases of the genitourinary system	3	3	· Donor nephrectomy · Hyperplasia of prostate	1 1
	Diseases of the digestive system	1	1	· Perforation of bile duct	1
	Neoplasms	7	7	· Malignant neoplasm prostate · Malignant neoplasm extra hepatic bile ducts · Malignant neoplasm esophagus · Malignant neoplasm pancreas · Secondary malignant neoplasm liver · Malignant neoplasm of thyroid gland · Malignant neoplasm femur	2 2 1 1 1 1 1
	Diseases of the circulatory system	3	3	· Claudication Intermittent, Fontaine stage III · Claudication Intermittent, Fontaine stage IV · Aortic aneurysm	1 1 1
	Injury, poisoning and certain other consequences of external causes	2	2	· Fracture femur	1
	Diseases of the musculoskeletal system and connective tissue	2	2	· Osteoarthrosis · Infection following a procedure after fracture of forearm · Pyogenic arthritis	1 1 1
TOTAL		18 (100%)			19 (106%)
PEDIATRICS	Diseases of the respiratory system		3	· Pneumonia · Emphysema	1 1
	Diseases of the musculoskeletal system and connective tissue		2	· Other disorders of bone development and growth · Pectus Excavatum	1 1
	Neoplasms		4	· Benign neoplasm tonsil · Neuroblastoma · Malignant neoplasm femur · Secondary malign. neoplasm bone and bone marrow · Lymphoid leukemia	1 1 1 1 1
	Diseases of the ear and mastoid process		1		0
	Injury, poisoning and certain other consequences of external causes		2	· Concussion	1
	Diseases of the digestive system		5	· Anal abscess · Constipation · Fistula of urethra to small intestine · Esophageal obstruction · Cholestasis · Acute appendicitis	1 1 1 1 1 1
	Congenital malformations, deformations and chromosomal abnormalities		1	· Hirschsprung's disease	1
TOTAL		18 (100%)			17 (94%)
OBSTETRICS & GYNECOLOGY	Neoplasms		7	· Malignant neoplasm of vulva · Malignant neoplasm of cervix · Malignant neoplasm of ovary · Secondary malignant neoplasm of perineum · Benign neoplasm of ovary · Leiomyoma of uterus	1 1 2 1 1 1
	Diseases of the genitourinary system		3	· Prolapse of vagina wall	1
	Pregnancy, childbirth and the puerperium		9	· Maternal care for (suspected) damage to fetus by drugs · Maternal care for other known or suspected fetal problems · Preterm labor without delivery · Vaginal delivery following previous cesarean section · Single spontaneous delivery · Labor and delivery complicated by fetal stress	1 1 1 1 1 1
TOTAL		19 (100%)			14 (74%)
OVERALL TOTAL		**55 (100%)**			**50 (91%)**

**International Statistical Classification of Diseases and Related Health Problems 10th Revision*

Study conduct

Time and motion

All contributing healthcare professionals were informed about the study purpose and the use of the PDAs for the time recordings through instruction briefings, a study website, and a YouTube clip[13]. We continuously monitored the patients' care process during the whole admission period.

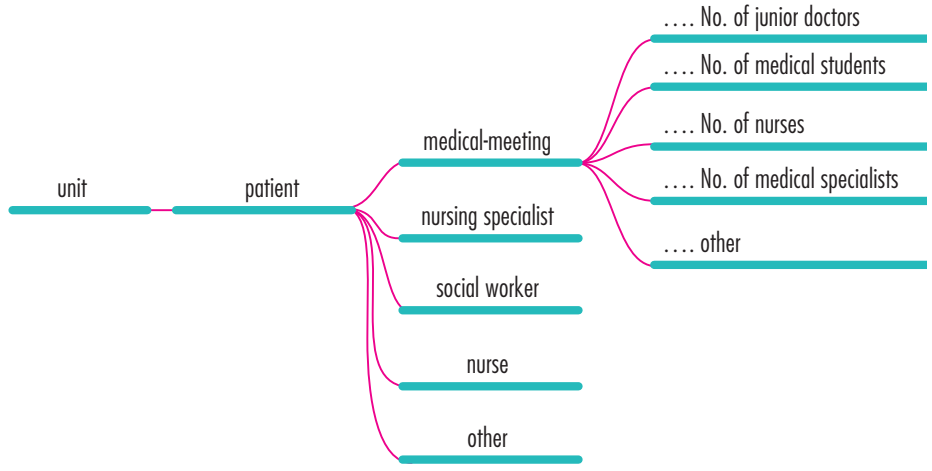
For the continuous time and motion recordings by nurses, Personal Digital Assistants (PDAs) (PalmOne Tungsten E2; Palm Inc., Sunnyvale, CA, USA) were used. These PDAs were equipped with a dedicated software program (I-V-O: Web development, scripting, hosting & consultancy, Alkmaar, The Netherlands). This enabled the recording of the date, duration of direct and indirect time spent per patient, types of healthcare professionals involved, and wards and patients involved (Figure 1). The different activities were not discerned in the recordings. Many of the nurses were familiar with the time clocking procedure as they had participated in the previous study as well. The researchers distributed the PDAs and supported the nurses' recording activities. Two PDAs were placed at the patients' bedside, one of which was placed in a charger. The nurse taking care of an included patient was to carry one of the PDAs and use it as a stopwatch to clock the time (s)he spent on that particular patient and hand it over to the next colleague at the end of their shift, seven days a week for 24 hours a day, until the patient was discharged from the hospital. If another nurse would visit the patient, (s)he could use the other PDA at the patients' bedside. Data collected in the PDAs were downloaded into the database after the patient's discharge.

Physicians were instructed to record the time they spent on the included patients on a daily documentation form, distributed by the coordinator. This form was used to record the date, patient study number, and minimum and maximum estimates of the direct and indirect time spent per patient. The researchers contacted the physicians on average every other day by phone, e-mail, or face to face, to fill out the documentation form if not yet done so.

To avoid measurement errors, nurses and physicians were allowed to measure the time spent for a maximum of 3 patients simultaneously. Time data recorded by nurses were checked and analyzed after the patients' discharge for outliers or missing values. Patients were excluded from the analysis if the time recordings covered less than 50% of their hospital stay. To check the reliability of the data we frequently monitored and asked the healthcare professionals involved regarding their recording behavior.

To evaluate whether the patients felt their demand for care was met during their admission, patient satisfaction with physicians' and nurses' attention and knowledge was asked by means of a short questionnaire, on their day of discharge. Additionally, to account for a possible influence of the availability of personnel resources on the amount of care given, we also assessed the proportion of rejected patients on the contributing wards during the study period. Reasons for rejection were maximum bed occupation and unavailability of necessary resources.

Figure 1 Menu structure of Personal Digital Assistants



Time and costs as measure of the demand for hospital care services

The demand for hospital care services was based on the time spent by the healthcare professionals on the one hand, and costs of diagnostic and therapeutic interventions on the other. To produce a single measure for the demand for care, we also converted these time data into costs and added them to the intervention costs. Standard 2012 salary costs of the various healthcare professionals involved were used for day, weekend, and night shifts, according to the national manual for research on hospital costs[14]. Costs of surgical interventions were based on the gross time spent on the surgical procedure and the associated salary costs of the healthcare professionals present. For costs of diagnostic and therapeutic procedures, ICU and recovery stays, standard tariffs were extracted from the hospital ledger. These costs represent material and overhead costs for procedures and additional personnel costs for ICU and recovery stays. The overhead costs of indirectly involved personnel (for example managers, administrative personnel, patient transport officers) were not taken into account.

The sum of the costs for the time spent by healthcare professionals and the costs for diagnostic and therapeutic procedures, ICU and recovery stays represent direct patient costs and were taken as a measure for the demand for hospital care

services for each patient's hospital stay. The contributing parts of these costs were presented in stacked bar graphs as percentages of the total costs, normalized at 100%. Subsequently, these total costs were used as the dependent variable in the regression analyses.

Data analysis

Data were imported and analyzed in the Statistical Package for the Social Sciences v. 20 (IBM SPSS Inc., Armonk, NY, USA). Categorical data are presented as proportions. Continuous variables are summarized as means with standard deviations, or medians if not normally distributed. A multiple backward linear regression analysis was done with characteristics that were significantly associated with the costs of the demand of care in a univariable analysis. For all analyses the significance level was set at P<0.05. B-values, as a measure of the association with the costs of the demand for care, were calculated with their 95% confidence intervals. Log-transformation of the dependent variable "total costs of demand for care" was performed because of its non-normal distribution.

Ethical issues

Our local medical ethics review board (Academic Medical Center, Amsterdam, The Netherlands) approved the study but waived the need for written informed consent, as the study had no effect on the patients' treatment or psychological wellbeing.

RESULTS

Within the study's time frame from July to January 2013, we included 78 consecutive patients, both elective and emergency admissions. After data validation, 50 valid patient cases remained for analysis (Table 2). Characteristics of included patients are summarized in Table 3. The patients were evenly divided among the medical specialties. Median LOS was 5 days (range: 1-51). Almost 30% of the patients underwent a surgical intervention and more than 30% were re-admitted within 30 days.

Median time spent on the care of patients by physicians and nurses per admission was 15.5 hours and varied from 3.3 hours for a pediatric patient with lymphoid leukemia to almost 4 days for a patient with complications from a malignant neoplasm of the femur. Total time spent by nurses and physicians was 40 days and 6 hours, the majority of which (71%) was spent by nurses. The time spent by physicians did not include the time involved in surgical interventions. Surgeons spent almost half an hour for a tonsillectomy up to almost 12 hours for an extended hemi-pelvectomy with reconstruction in the operating room.

Sum total costs of the demand for care per specialty varied from €127.000 for pediatric patients, €70.500 for Ob&Gyn patients to €206.500 for surgical patients. Surgical and diagnostic interventions contributed most to these overall costs (Figure 2). In the univariable analysis, age, complication severity level, polypharmacy (defined as the use of 5 or more medications during hospitalization), and whether a surgical intervention was performed were significantly associated with the costs of demand for care (Table 3), as opposed to gender, ethnicity, CCI, ASA-class, BMI, nutritional status, readmission within 30 days, and medical specialty. Delirium and isolation during hospitalization, pressure ulcers, admission and discharge type, and mortality did not contribute significantly.

All significant characteristics in the univariable analysis were entered in the multivariable regression analysis (Table 3). Independent factors associated with the total costs of the demand for care were: surgical intervention performed, polypharmacy during hospitalization, and complication severity level. This model explained 55% of the variance in the demand for care in terms of costs. Whether or not patients underwent surgery explained 33.7% of this variance. Undergoing surgery led to a cost increase of 215% (95% CI 65% to 348%; p<0.001). When shifting from no complications to complication severity level 1, total costs increased significantly with 78% (95% CI 19% to 532%; p=0.018), and with 87% (95% CI 61% to 2494%; p=0.001) when moving from no complications to complication severity level 2. Polypharmacy was responsible for a 72% (95% CI 0.6% to 150%; p=0.026) increase in costs.

Approximately 95% of the patients were satisfied with the treatment they received. Nurses' and physicians' competences and the attention patients received from them were also judged as satisfactory. Only 2% of the patients were "moderately satisfied" with the attention from physicians and nurses. Hence, the care provided seemed to be in agreement with the patients' demand for care (Table 4). Rejection rates as a proportion of the total number of admitted patients during the study period varied from 1.2% for surgical wards to 2.8% for pediatric wards. Hence, we assumed that the availability of resources had no meaningful influence on the demand for hospital care services.

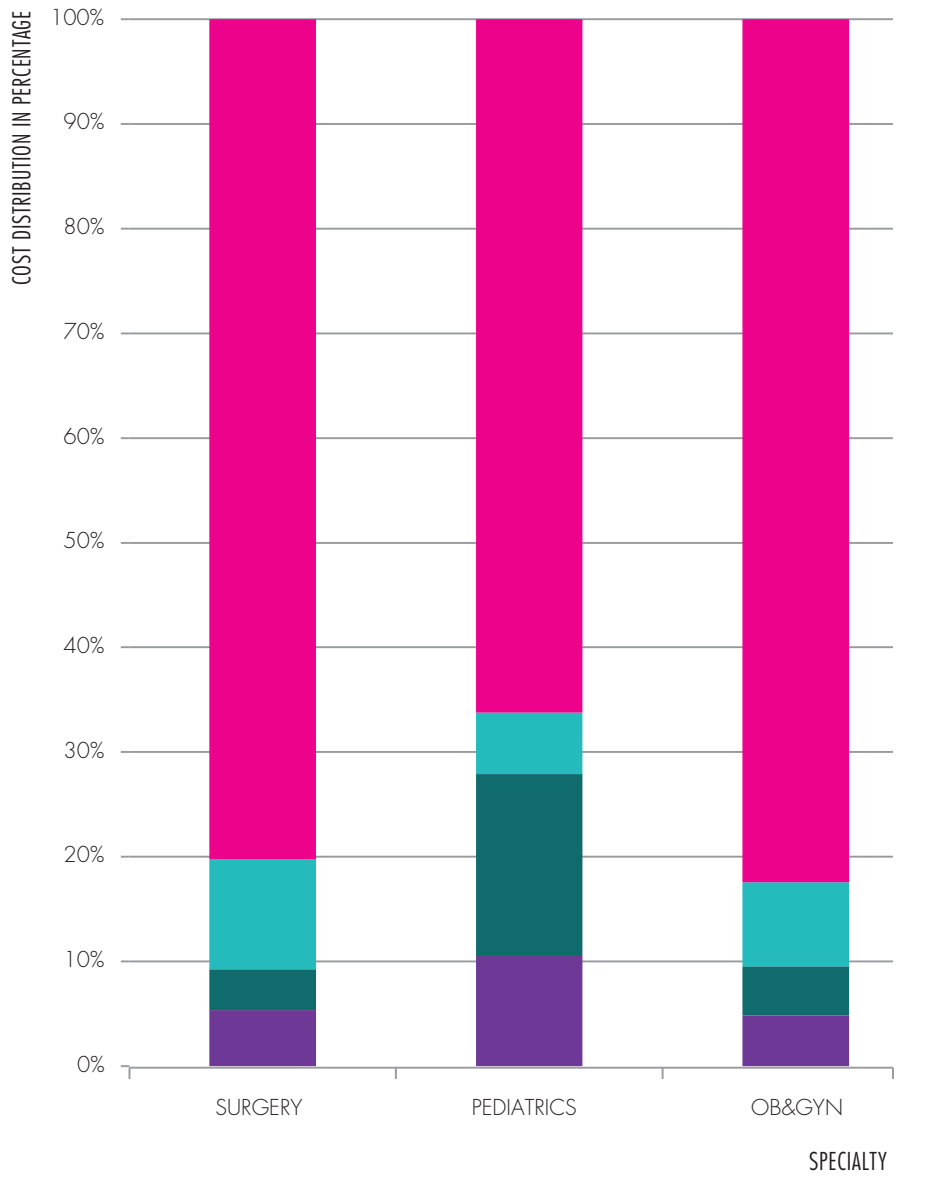
Based on our random checks of the completeness of data recordings physicians appeared to record between 80 to 100% of their activities.

Table 3 Univariable and multivariable linear regression analysis of possible predictive characteristics *Page 92-93* ►

SD = standard deviation; B = beta; CI = confidence interval; BMI = Body Mass Index; ASA = American Society of Anesthesiologists; RC = reference category

CHARACTERISTIC	N (%)	MEAN (SD)	RANGE	UNIVARIABLE B	β	CI	P	MULTIVARIABLE B	β	CI	P
Age		43 (28.90)	1-92	0.004	0.281	0.000-0.008	0.048				
Ethnicity											
· Dutch	39 (78)			RC	-	-	-				
· Moroccan	2 (4)			-0.237	-0.112	-0.861-0.387	0.449				
· Surinamese	2 (4)			-0.068	-0.032	-0.692-0.556	0.827				
· Other Western	3 (6)			-0.020	-0.012	-0.536-0.496	0.938				
· Other non-Western	4 (8)			-0.292	-0.191	-0.744-0.160	0.200				
Gender (males)	19 (38)			0.047	0.055	-0.201-0.295	0.704				
Charlson co-morbidity index											
· No comorbidity	30 (60)			RC	-	-	-				
· 1	4 (8)			0.093	0.061	-0.344-0.530	0.669				
· 2	5 (10)			0.338	0.244	-0.059-0.734	0.093				
· 3	5 (10)			0.492	0.355	0.095-0.888	0.016				
· 4	1 (2)			0.471	0.159	-0.363-1.305	0.261				
· 5	1 (2)			0.081	0.027	-0.753-0.915	0.845				
· 6	4 (8)			0.169	0.110	-0.268-0.606	0.440				
Complication severity level											
· No complication	46 (92)			RC	-	-	-	RC	-	-	-
· 1	3 (6)			0.649	0.371	0.203-1,094	0.005	0.439	0.251	0.077-0.801	0.018
· 2	1 (2)			1.020	0.344	0.265-1.776	0.009	0.811	0.273	0.208-1.414	0.010
· 3	0 (0)			-	-	-	-	-	-	-	-
ASA-class											
· No ASA-class	12 (24)			RC	-	-	-				
· 1	19 (38)			0.479	0.571	0.226-0.732	<0.001				
· 2	14 (28)			0.155	0.130	-0.205-0.516	0.388				
· 3	5 (10)										
BMI at admission		23.16 (6.61)	13.19-42.06	0.015	0.008	-0.002-0.032	0.086				
Nutritional status		0.93 (0.37)	0.00-10.00	0.053	0.274	-0.007-0.112	0.083				
Delirium during hospitalization	0 (0)										
Pressure ulcer acquired during hospitalization	0 (0)										
Isolation											
· Barrier	1 (2)										
· Strict isolation	0										
Survival	50 (100)										
Polypharmacy		7.80 (4.90)	0-21	0.309	0.341	0.061-0.556	0.015	0.213	0.235	0.027-0.399	0.026
Admission type											
· Home	47 (94)										
· Emergency	3 (6)										
Discharge type*											
· Home	48 (96)										
· Other	2 (4)										
Surgical Intervention performed	14 (28)			0.537	0.581	0.318-0.755	<0.001	0.461	0.499	0.271-0.651	<0.001
Medical specialty											
· Surgery	19 (38)			RC	-	-	-				
· Pediatrics	17 (34)			-0.340	-0.389	-0.608--0.073	0.014				
· Obstetrics & Gynecology	14 (28)			-0.046	-0.050	-0.328-0.236	0.745				

Figure 2 Cost distribution of the demand for care per specialty



OB&GYN = Obstetrics & Gynecology

Table 4 Results of the questionnaire evaluating provided care

QUESTION	ANSWER OPTIONS	N (%)
Satisfied with treatment	· Very satisfied	33 (66)
	· Satisfied	14 (28)
	· Fairly satisfied	3 (6)
	· Moderately satisfied	0 (0)
	· Dissatisfied	0 (0)
Satisfied with nurse attention	· Very satisfied	30 (60)
	· Satisfied	18 (36)
	· Fairly satisfied	0 (0)
	· Moderately satisfied	1 (2)
	· Dissatisfied	1 (2)
Satisfied with nurse competence	· Very satisfied	34 (68)
	· Satisfied	14 (28)
	· Fairly satisfied	2 (4)
	· Moderately satisfied	0 (0)
	· Dissatisfied	0 (0)
Satisfied with physician attention	· Very satisfied	32 (64)
	· Satisfied	13 (26)
	· Fairly satisfied	4 (8)
	· Moderately satisfied	1 (2)
	· Dissatisfied	0 (0)
Satisfied with physician competence	· Very satisfied	41 (82)
	· Satisfied	8 (16)
	· Fairly satisfied	1 (2)
	· Moderately satisfied	0 (0)
	· Dissatisfied	0 (0)

DISCUSSION

This time and motion study shows that the previously found set of independent factors explaining the surgical patients' demand for hospital care services are also applicable to various other clinical specialties. This set comprises patient characteristics that become apparent during hospitalization, i.e., polypharmacy during hospitalization, complication severity level, and whether a surgical intervention was performed. This implies that the demand for hospital care can be assessed during and after the patient's hospitalization rather than predicted in advance. This makes the set of characteristics useful as a managerial tool to retrospectively assess the (trends in the) demand for care on various wards within a clinical specialty. For this purpose, these characteristics should be recorded and readily available in hospital databases.

The effect on costs of polypharmacy during hospitalization as found here is larger than in two previous studies[4,15], probably due to the more expensive medical treatments included in this study, e.g. chemotherapy and the fact that the effect found represent 5 or more medications instead of one. This may be exemplary for the university hospital in which this study was conducted.
Complications occurring during hospitalization had a large effect on costs, as opposed to our previous study. In the present study the complication severity level was used rather than the number of complications, as chosen in our previous study[4]. By doing so, fewer complications were taken into account as patients could have more complications within the same severity level. Hence, the incidence of complications, especially in the higher levels, was quite low. Age was not found as an independent factor, which corresponds with the findings in other studies[4,15,16].
The weighted Charlson measure for co-morbidity (CCI), was not found to be an independent characteristic. This is in contrast with other studies[17,18], although these did not find large effects on care costs. This discrepancy could be caused by the fact that these studies used more homogeneous patient groups in protocol-based care pathways, i.e. after hip replacement[18], or with heart-failure[17], while the CCI was originally designed for adult populations[19]. Furthermore, healthcare professionals may be reluctant to treat patients with a high co-morbidity with invasive therapies, e.g. surgery, which obviously increases hospital costs.
The influence of several possible factors, for example, delirium and isolation during hospitalization, pressure ulcers, admission and discharge type, and mortality, could not be appreciated because of their low incidences. Hence, these are not likely to substantially influence the total costs of care for this patient population.

One of the strengths of this study is that we were able to reliably record the time spent by physicians. Earlier, we found an under-recording by physicians[4]. We therefore adapted our data collection method for this discipline, resulting in completeness of the data recorded. Thus, a more exact estimation of the factors associated the demand for hospital care (services) by physicians. Also, the cost estimation of diagnostic and therapeutic procedures, including surgical interventions, could be performed more precisely by using cost prices including overhead and material costs instead of mere personnel costs. On the other hand, it was not feasible to take into account the costs for overhead, patient transport, and medication on the nursing wards, and to correct for the additional charges for physicians during weekends, evenings and nights. This might explain why the costs for diagnostic and therapeutic procedures contributed most to the overall cost estimation of the demand for hospital care.

Limitations of this study are, in the first place, the observed high re-admission rate, which might seem a sign of a poor outcome. However, a considerable part of our patient population was treated for neoplasms by means of radiotherapy or chemotherapy, which explains the frequent re-admissions. Furthermore, patient satisfaction was high and rejection rates were low for every specialty involved. This suggests that the demand for care was measured rather than the care that could be offered, which could have been limited by available resources and personnel.
Second, we started this study as a multicenter validation study to obtain a larger set of representative patients from various clinical specialties. Unfortunately, it turned out to be impossible to collect reliable data in other hospitals because of logistic problems, motivational problems and financial issues in times of budget restraints. As a result, the study population was limited to our own hospital. This limited the number of factors to be tested and the precision of our results. Also, no organizational factors, which may differ among hospitals, could be included. However, in our univariable regression analysis only three factors were found to significantly influence the demand for hospital care services. Therefore, the number of included patients was sufficient to test all three factors in the multivariable analysis, which are in keeping with the previously found set[4].
Third, we were not able to include all major clinical specialties, like internal medicine. Therefore, the outcomes of our study are applicable to a large proportion, but not all of the clinical hospital population. Furthermore, because of the university hospital population under study, the outcome is limited to the more complex patients of these specialties.
Fourth, in obstetric patients we started measuring the care given to one, but after delivery to two (or even more) subjects. As patient characteristics of only the mother were included, this could have had impact on our study outcomes. However, this is the actual way how mother & child care is organized in the Netherlands. Thus, managers and policymakers should take this into account when interpreting these findings.

CONCLUSION

To assess the demand for hospital care as given by various clinical specialties, a set of patient characteristics could be defined, based on a previous model developed in surgical patients. This set of factors comprise polypharmacy during hospitalization, complication severity level, and whether a surgical intervention was performed. These can be obtained during hospitalization and can be used as a managerial tool to monitor the amount of care on a more aggregate level on wards to detect trends in time as to patients' demand for hospital care services. A practical implication could be the integration of these factors in a management information dashboard. This information allows managers and policy makers on strategic and tactic levels in evaluating, planning and budgeting on real data, i.e. to make choices regarding hospital specialization, to substantiate the hospitals (top)referral character and to support negotiations with healthcare insurers. On the other hand, assessment of the demand for hospital care as a predictive tool before patient admission remains difficult.

COMPETETING INTERESTS

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Part II

PATIENT

CARE

INTENSITY

FACTORS DETERMINING

THE PATIENTS' CARE INTENSITY FOR SURGEONS AND SURGICAL NURSES: A conjoint analysis

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Submitted

ABSTRACT

BACKGROUND: Surgeons and nurses sometimes perceive a high workload on the surgical wards, which may influence admission decisions and staffing policy. Yet, it is unclear what the relative contribution is of various patient and care characteristics to the perceived patients' care intensity and whether differences exist in the perception of surgeons and nurses.

METHODS: We invited surgeons and surgical nurses in the Netherlands for a conjoint analysis study through internet and e-mail invitations. They rated 20 virtual clinical scenarios regarding patient care intensity on a 10-point Likert scale. The scenarios described patients with 5 different surgical conditions: cholelithiasis, a colon tumor, a pancreas tumor, critical leg ischemia, and an unstable vertebral fracture. Each scenario presented a mix of 13 different attributes, referring to the patients' condition, physical symptoms, and admission and discharge circumstances.

RESULTS: A total of 82 surgeons and 146 surgical nurses completed the questionnaire, resulting in 4560 rated scenarios, 912 per condition. For surgeons, 6 out of the 13 attributes contributed significantly to care intensity: age, polypharmacy, medical diagnosis, complication level, ICU stay and ASA-classification, but not multidisciplinary care. For nurses, the same six attributes contributed significantly, but also BMI, nutrition status, admission type, patient dependency, anxiety or delirium during hospitalization, and discharge type. Both professionals ranked 'complication level' as having the highest impact.

CONCLUSIONS: Surgeons and nurses differ in their perception of patients' care intensity. Appreciation of each other's differing interpretations might improve collaboration between physicians and nurses and may help managers to match hospital resources and personnel.

KEY WORDS: CONJOINT ANALYSIS; PHYSICIAN INTENSITY; NURSE INTENSITY; SURGERY; SURGICAL WARDS; PATIENT CARE INTENSITY; HOSPITALIZATION; VIGNETTES; CLINICAL SCENARIOS; HOSPITAL RESOURCES; DOCTORS; NURSES; SURGEONS; PHYSICIANS; QUESTIONNAIRE; DEMAND FOR CARE.

BACKGROUND

Western European and North American hospitals are forced to improve efficiency while using limited available resources. This increases pressure on the overall quality of patient care, but also on the healthcare professionals involved. Physicians and nurses form the main body of healthcare professionals in the hospital setting. Hence, optimum staffing of physicians and nurses is crucial for patient safety, staff working conditions, retention and hospitalization costs[1,2]. Patients receiving insufficient care due to high workload because of insufficient staffing, are at risk for higher morbidity and mortality rates[3-5]. A high workload also has a significant impact on job satisfaction[6].

Nowadays, financial arguments mainly determine the staffing of physicians and nurses in European hospitals[7,8]. Subsequently, many physicians and nurses perceive a high workload[9,10] and inefficient teamwork, as their perceived workload seems different and not transparent[11]. However, it is hard to substantiate this with objective measures that are intelligible for both disciplines as well as managers.
The healthcare professionals' workload is generally determined by the demand for care, personnel characteristics and organizational characteristics[12]. Several studies searched for predictors of the demand for medical and nursing care. In a recent systematic review no accurate models were found, although some separate predictors appeared useful[13]. However, these predictors explained the demand for care in terms of required resources and hospitalization costs rather than physician or nurse staffing or workload[14]. For nurses, attempts have been made to match the patients' demand for nursing care with nurse staffing supplies, for instance by measuring patient-related workload. This workload is the result of the demand for nursing care, and is defined here as (nursing) care intensity[15]. Little is known about the care intensity physicians perceive and which factors they believe influence care intensity. It is also unclear whether clinicians, in particular physicians and nurses, perceive this care intensity in the same way, as they are involved in other aspects of hospitalized patient care.

Workload is of particular importance for physicians and nurses working on surgical wards, because more than 50% of adverse events are related to surgical procedures[16]. Therefore the risks of direct harm and high hospitalization costs are substantial for surgical wards. Hence, we investigated the perceptions of surgeons and nurses working in clinical settings regarding determining factors of care intensity. For this purpose we used a conjoint analysis, presenting the clinicians 20 scenarios of hospitalized patients with five surgical conditions. In doing so, we

attempted to detect the relative contribution of various patient and care characteristics to the perceived patients' care intensity and possible differences in appreciation between surgeons and nurses.

METHODS

The conduct and description of this study was done according to the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) checklist for conjoint analysis (CA) applications in healthcare research[17]. Our local medical ethics review board (Academic Medical Center, Amsterdam, The Netherlands) approved the study but waived the need for ethical approval as the study had no effect on the participants' wellbeing.

Design

We performed a conjoint analysis (CA) study in which participants were to appraise the caring intensity of fictional hospitalized patient scenarios ("vignettes"). These scenarios share the same set of so-called attributes (e.g., age), but the levels (e.g., below or above 65 years) of each attribute vary across the different scenarios. Originally, CA is a method of eliciting consumer preferences in marketing research, and allows estimation of the relative importance of different characteristics (attributes) for the valuation of rate descriptions of a good. This method has also been applied successfully in the realm of healthcare[18].
Each scenario described a patient admitted to a surgical ward and characterized by thirteen attributes. These attributes represent various patient and care characteristics, e.g., age, polypharmacy, complication level, and ASA-class (Table 1). Possibly relevant attributes were derived from a systematic review and a pilot study on the use of hospital care services of surgical patients[13,14].

All attributes were divided into an appropriate number of levels, e.g., ASA classes 1, 2 and 3. However, the number of levels within each attribute was kept to a minimum in order to limit the number of scenarios required to present a representative range of different scenarios.
Subsequently, a small group of 6 surgeons and 8 surgical nurses (with different specialty and experience) were invited to a single Delphi round[19], in order to generate a set of apparently influencing characteristics. The contents of the final scenarios were generated by the Orthogonal design in SPSS (Statistical Package for the Social Sciences v. 20; IBM SPSS Inc., Armonk, NY, USA).

Table 1 Attributes used in the scenario's

ATTRIBUTE	LEVELS	N*
Age	0 = <65	10
	1 = >65	10
BMI	0 = <30	14
	1 = >30	6
Nutrition status	0 = no	12
	1 = yes	8
Polypharmacy	0 = <5	10
	1 = >5	10
Medical diagnosis	· Cholelithiasis	4
	· Colon tumor	4
	· Pancreas tumor	4
	· Critical leg ischemia	4
	· Unstable vertebral fracture	4
Admission type	0 = planned	13
	1 = emergency	7
ASA-classification	· 1	4
	· 2	6
	· 3	9
Patient dependency	0 = ADL independent	6
	1 = partially ADL dependent	11
	2 = totally ADL dependent	3
Complication level	0 = no complication	5
	1 = any deviation from the normal postoperative course	6
	2 = requiring pharmacological treatment	5
	3 = requiring surgical, endoscopic or radiological intervention	4
Anxiety or delirium	0 = no	14
	1 = yes	6
ICU stay	0 = no	15
	1 = yes	5
Multi-discipline treatment	0 = no	8
	1 = yes	12
Discharge type	0 = home	12
	1 = other	8

**N = number of times used in vignettes; BMI = Body Mass Index; ASA = American Society of Anesthesiologists; ADL = Activity of Daily Living; ICU = Intensive care Unit*

Setting and participants

Surgeons and surgical nurses from university centers, teaching hospitals and community hospitals in the Netherlands were invited to the questionnaire. Surgeons, including residents, belonging to the regional surgical resident teaching program educational area of the Academic Medical Center were invited via e-mail. A total of two reminders were sent to reach a response rate of 60%.

A random sample of surgical nurses was approached by advertising in three Dutch nursing journals (both paper and web pages), a call on a LinkedIn forum, Twitter, Facebook, and the science webpage of one of the teaching hospitals.

Conjoint analysis questionnaire

The researchers eventually selected 20 plausible scenario's for data collection. This is an ample number as compared to current literature[20,21]. Examples of the composition of the scenarios is given in Table 2, and a full example of a scenario is given in the Appendix. A pilot study was conducted among four surgeons and two nurses to test whether any vital information in the 20 scenarios was missing. This was corrected if necessary.

By means of a digital questionnaire (www.Surveymonkey.com), the surgeons and surgical nurses were asked to score the care intensity of the 20 scenarios on a 10-point Likert scale, ranging from 0 ("very low intensity") to 10 ("very high intensity"). In addition surgeons and nurses were asked to state their top-5 of attributes contributing most to care intensity.

Statistical analysis

Continuous variables regarding the respondents' characteristics and scenario scores were expressed as means and standard deviations (SD). The relative importance of each of the attributes as to the perceived care intensity was determined by means of a fixed effect linear multi-level analysis to account for the multilevel structure of the scenarios (level 1) as rated by surgeons and nurses (level 2).

The effect size of each attribute was expressed as a β-coefficient with its 95% confidence interval (CI). β-coefficients above or below 0 indicate the attribute contributes to a higher or lower care intensity score, respectively. The attribute top-five for surgeons and nurses was assessed based on their mean rating scores per attribute. P-values <0.05 were considered significant.

RESULTS

A total of 82 surgeons and 146 surgical nurses completed the questionnaire, resulting in 4560 rated scenarios, 912 per condition. Characteristics of the responding

Table 2 Example of the composition of five scenarios and the levels of each attribute used

		ATTRIBUTES											
Vignette number	Diagnosis	Age	Polypharmacy	Complication level	ASA class	BMI	ICUstay	Nutrition status	Admission type	Discharge type	Patient dependency	Anxious or delirious	Multi-disciplinary treatment
1	Cholelithiasis	1	1	3	3	0	1	0	0	0	1	0	1
5	Critical leg ischemia	1	1	2	3	1	0	0	0	0	1	0	1
9	Colon tumor	0	0	3	2	0	1	0	0	1	1	0	1
13	Pancreas tumor	1	0	1	2	0	0	1	0	0	2	1	0
17	Unstable vertebral #	0	0	2	2	0	0	0	1	1	1	1	1

The contents of the levels corresponding with numbers 1-3 are shown in Table 1

ASA = American Society of Anesthesiologists; ICU = Intensive Care Unit

Table 3 Characteristics of participants

CHARACTERISTICS OF PARTICIPANTS		
	N (%)	N (%)
Round 2	Nurses (N=146)	Surgeons (N=82)
Gender (male)	12 (8.2)	65 (72.3)
Age	33.3 (range 20-62)	46.4 (range 28-66)
Experience (yrs.)	11.4 (range <1-40)	16.8 (range 1-40)
Hospital		
· Academic	21 (14.4)	18 (22.0)
· Tertiary/educational	69 (47.3)	47 (57.3)
· General	56 (38.4)	17 (20.7)
Specialty		
· Vascular	30 (20.5)	14 (17.1)
· Trauma	43 (29.5)	15 (18.3)
· Gastro-Intestinal	18 (12.9)	33 (40.2)
· General	13 (8.9)	20 (24.4)
· Orthopedic	10 (6.8)	0 (0)
· Plastic	3 (2.1)	0 (0)
· Urology	5 (3.4)	0 (0)
· Other	24 (16.4)	0 (0)

surgeons and nurses are summarized in Table 3. The majority of the surgeons was male, with a mean age of 46.4 (SD 9.7), while the majority of the nurses was female; mean age 33.2 (SD 12.0). Most respondents worked in a tertiary referral hospital and were employed in trauma or gastro-intestinal surgery. No significant associations between surgeons' or nurses' characteristics (i.e., age, gender, surgical specialty of employment, years of experience, or hospital type) and care intensity judgments were observed.

Attribute weights

The overall mean care intensity scores for the 20 scenarios were 6.21 (SD 2.08) among surgeons and 5.76 (SD 2.26) among nurses, which did not differ significantly. Figure 1 shows the contribution to care intensity of the significant attributes as perceived by surgeons and nurses.

Surgeons

According to the surgeons, 6 out of the thirteen attributes significantly influenced care intensity; age, polypharmacy, medical diagnosis, ASA-classification, complication level, and Intensive Care Unit (ICU) stay.

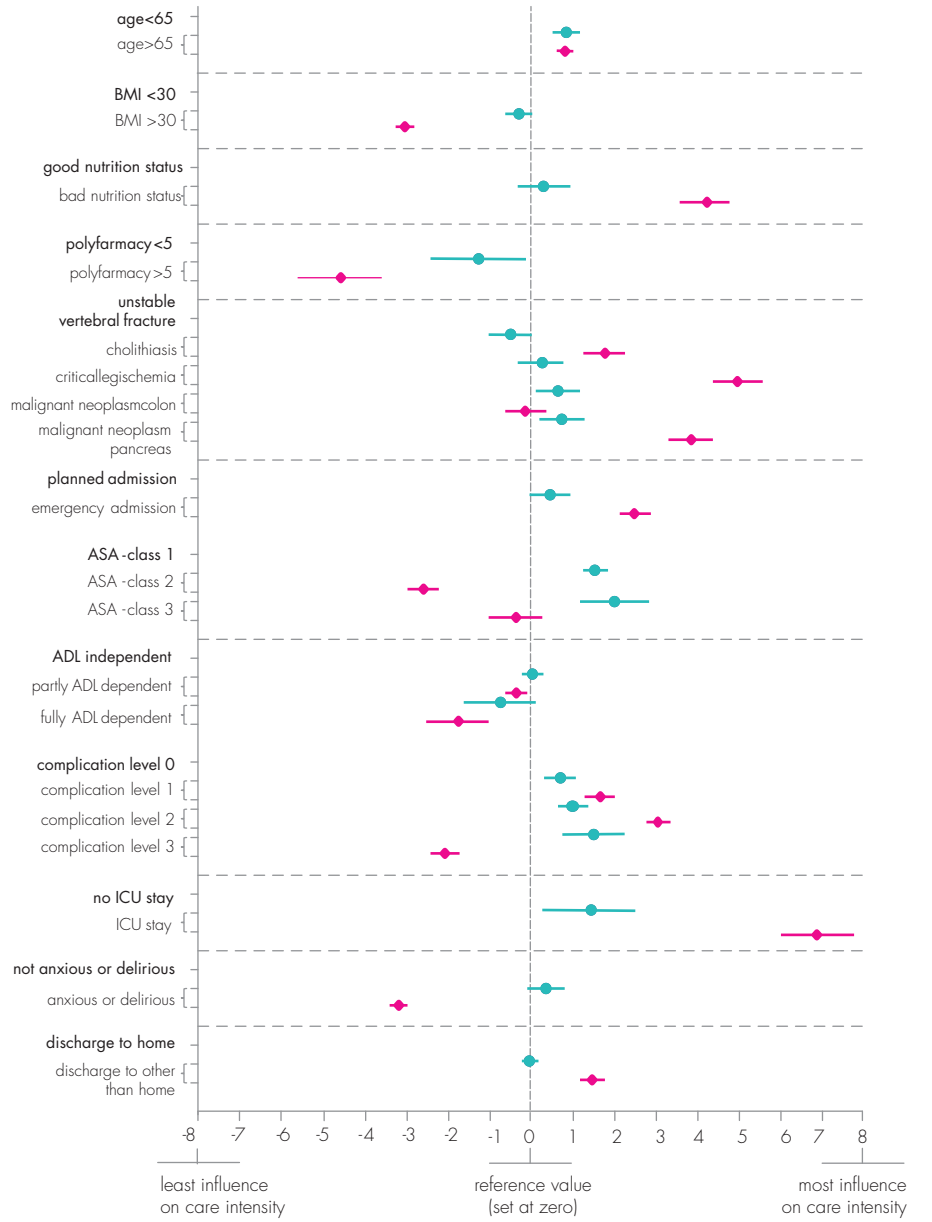
Surgeons assigned significantly more caring intensity to ASA classes 2 and 3 (β1.51; p<0.001, and β2.12; p<0.001, respectively), patients suffering from more severe complications (β1.58; p<0.001), and ICU stay (β1.36; p<0.016). Furthermore, patients using less than 5 medications (β-1.30; p=0.037), patients with medical diagnoses as colon or pancreatic cancer (β0.63; p=0.017 and β0.72; p=0.013), and those above 65 years of age (β0.83; p<0.001) were also perceived as more care intensive.

Nurses

All except one attribute significantly influenced the judgments of the scenarios for nurses. Again, the attribute 'multi-disciplinary treatment' was redundant.

Nurses perceived ICU stay as most care-intensive (β6.92; p<0.001), followed by patients diagnosed with critical leg ischemia (β5.06; p,0.001), a bad nutrition status (β4.23; p<0.001) pancreas cancer (β3.93; p<0.001), a complication at level 2 (β3.11; p<0.001), and an emergency admission (β2.53; p<0.001). Being 65 or older, having a diagnosed cholelithiasis, a complication level 1 (β1.78; p<0.001) and sending home after discharge (β1.39; p<0.001) contributed slightly but significantly more to care intensity. Surprisingly, patients classified as ASA 2 (but not ASA 3) were considered less care-intensive than patients classified as ASA 1. Furthermore, partly or totally dependent patients were perceived as less care-intensive than independent patients (β-0.44; p=0.004, and β-1.79; p<0.001). Patients with complications were assigned higher care intensity. However, patients with the

Figure 1 Contribution to care intensity of each of the attributes as perceived by surgeons and nurses (expressed as beta-coefficients and 95% CI)



CI = confidence interval; BMI = Body Mass Index; ASA = American Society of Anesthesiologists; ADL = Activity of Daily Living; ICU = Intensive Care Unit

most severe complications (apart from mortality), for instance patients with polyneuropathy, were considered to be less care-intensive (β-2.01; p<0.001) as well as anxious and delirious patients (β3.33; p<0.001).

Priority scores

Fifty-nine (72%) surgeons and ninety-four (64%) nurses gave their ranking. Both surgeons and nurses indicated that the occurrence of complications was most influential for care intensity (Table 4). Three out of the top-five of attributes were the same among surgeons and nurses, i.e. medical diagnosis, complication level and ICU stay. However, the mean ratings differed: the surgeons' mean score for medical diagnosis in their top-five was 3.73, as compared to 5.85 for nurses.

Table 4 Top 5 and mean priority scores of attributes

TOP 5 (SURGEONS)	PRIORITY SCORES
1. Complication level	2.05
2. Medical diagnose	3.73
3. ICU stay	4.25
4. ASA-class	5.61
5. Age	6.00
TOP 5 (NURSES)	
1. Complication level	2.94
2. Anxious or delirious	3.46
3. Medical diagnosis	5.85
4. Patient dependency	5.90
5. ICU stay	5.97

ASA = American Society of Anesthesiologists; ICU = Intensive Care Unit

DISCUSSION

This study shows that several attributes contribute to a patient's care intensity according to both surgeons and nurses; age, polypharmacy, medical diagnosis, complication level, ICU stay and ASA-classification. In general, nurses assigned more weight to these attributes than surgeons. In addition, nurses also considered BMI, nutrition status, admission type, patients' physical dependency, anxiety or delirium during hospitalization and discharge type as important factors influencing caring intensity.

The difference between surgeons and nurses as to which attributes contribute to care intensity might be surprising, but easy to explain. Surgeons have a medical background, including technical aspects of their work and primary focus on patient curation and the direct results of the surgical procedure, which involves (multi-specialist) discussions on high risk patients and planning diagnostic or surgical interventions[22]. Nurses on the other hand are more focused on direct patient care, i.e. checking their vital functions, stimulating patients towards self-care, providing wound care and the related documentation[23]. Furthermore, estimating care intensity can be difficult as its concept tends to be confounded with the concept 'care complexity'. As nurses assigned less care intensity to patients classified as ASA II, patients with lasting damage due to a complication (level 3), and patients who were partly or totally dependent or had a delirium, the suspicion rises that nurses appreciated care complexity rather than care intensity, e.g. they only scored highly what they thought was beyond their routine and complex work to perform. Surgeons, in contrast, seemed to focus more on the workload and consequences they anticipate with increasing disease severity (higher ASA-class, more complex surgical interventions, more postoperative complications, more need for intensive care). To our knowledge, this is the first study on the interpretation of the patients' care intensity by surgeons and on the comparison between surgeons and nurses as to the care intensity they perceive. Awareness of the factors contributing to caring intensity is of major relevance to hospital managers who aim at optimizing the care processes on clinical wards. First, because this information helps managers align the surgeons' and nurses' organizational processes and even tailor their personnel and resources. For instance, the finding that more attributes play a role for nurses than for surgeons regarding the patients' care intensity should be an important new criterion for planners of patient admissions, since this apparently depends on several factors that may be different from, and on top of, those perceived by surgeons. Second, knowing these differences may help surgeons and nurses to understand each other's care intensity criteria, and better synchronize their patient care. Understanding, appreciating and respecting each other's work has a positive impact on patient safety and provides learning possibilities for healthcare professionals as well as improving working conditions[24,25].

Some limitations of our study merit discussion. Not all characteristics that influence the patients' caring intensity could be included in the scenarios. For instance, comorbidities or an Early Warning Score (EWS) to account for physical deterioration, could not be taken into account. However, as we conducted a single Delphi round before creating the scenarios, these factors were not considered as influential. Moreover, these attributes are highly correlated with polypharmacy and ICU stay, which are more suitable attributes because they contain fewer levels.

Another suitable attribute would have been the Charlson comorbidity index as a weighted measure for patient comorbidity[26]. However, this measure is, besides in the Hospital Standard Mortality Rate (HSMR), not commonly used for registration in the surgical departments in the Netherlands, and was therefore not included. Furthermore, only the main effects of the attributes could be measured. Possible interactions between main effects are unknown, e.g. between age and ASA-classification, or between age and polypharmacy.
Finally, the healthcare professionals' workload is not only determined by demand for care, but also by personnel and organizational factors[12]. The latter two factors were not included in this study, because too few personnel and organizational factors could be collected to adequately address this issue.

CONCLUSION

According to surgeons and nurses, six patient-related factors influence the care intensity of hospitalized surgical patients, of which 'complication level' ranked highest. Nurses also considered another six factors as important, probably due to the nature of their profession and the way they interpreted care intensity.
Awareness of these factors may help managers optimize the work processes on nursing wards, in terms of staff planning and aligning the activities of surgeons and nurses. Furthermore, surgeons and nurses may better appreciate each other's care intensity. An objective measure for care intensity can foster this and may positively affect patient safety on clinical wards.

COMPETING INTEREST

The authors declare that they have no competing interests.

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APPENDIX

Example of a scenario and care intensity question as presented in the questionnaire Scenario 1

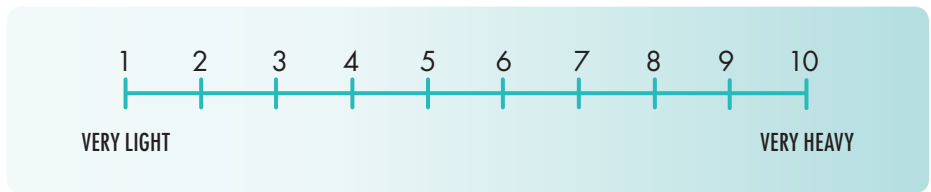
You have admitted a patient electively with clear signs of a cholecystitis. The patient and his admission feature the following attributes:

Patient: 70 years old, slightly overweight (BMI 27), with a normal oral intake suffering from heart failure and COPD, uses beclomethasone, salmeterol, fluticasone, simvastatin, verapamil and furosemide. The anesthesiologist classifies the patient preoperatively as ASA 3.

Surgical procedure and postoperative course: You perform a laparoscopic cholecystectomy. Postoperatively, the patient's abdomen remains tender. Furthermore, his respiration becomes increasingly insufficient, for which he is transferred to the ICU, where the intensive care physician takes over. Because of bile leakage, detected through CT-scanning and an MRCP, a bile drain is placed transcutaneously. Eventually, the patient is transferred to the surgical ward for further recovery.

Discharge: The patient is discharged to his home, where he receives home care for the drain.

How would you rate the care intensity of this patient during hospitalization?
Give the answer that best fits your opinion (1 = very light; 10 = very heavy):



NURSE STAFFING ISSUES

ARE JUST THE TIP OF THE ICEBERG:
A qualitative study about nurses' perceptions of nurse staffing

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Submitted

ABSTRACT

OBJECTIVE: To obtain in-depth insight into the perceptions of nurses in the Netherlands regarding current nurse staffing levels and use of nurse-to-patient-ratios (NPR) and patient classification systems (PCS).

BACKGROUND: In response to rising health care demands due to aging of the patient population and increasing complexity of healthcare, hospital boards have been implementing NPRs and PCSs. However, many nurses at the unit level believe that staffing levels have become critically low, endangering the quality and safety of their patient care.

METHODS: This descriptive phenomenological qualitative study was conducted in a 1000-bed Dutch university hospital among 24 wards of four specialties (surgery, internal medicine, neurology, gynecology & obstetrics and pediatric care). Four focus groups (n=44 nurses) were organized and 27 interviews (20 head nurses, 4 nurse directors and 3 quality advisors) were conducted. Data were collected from September until December 2012. Data-analysis was done by coding.

RESULTS: Nurse staffing issues appear to be merely the 'tip of the iceberg'. Below the surface three underlying main themes became clear – nursing behavior, authority, and autonomy – which are linked by one overall theme: nurses' position. In general, nurses' behavior, way of thinking, decision-making and communication of thoughts or information differs from other healthcare disciplines, e.g. physicians and quality advisors. This results in a perceived and actual lack of authority and autonomy. This in turn hinders them to plead for adequate nurse staffing in order to achieve the common goal of safe and high-quality patient care. Nurses desired a valid nursing care intensity system as an interdisciplinary and objective communication tool that makes nursing care visible and creates possibilities for better positioning of nurses in hospitals and further professionalization in terms of enhanced authority and autonomy.

CONCLUSIONS: The perceived subservient position of nurses in the hospital appears to be the root cause of nurse staffing problems. It is yet unknown whether an objective PCS to measure nursing care intensity would help them communicate effectively and credibly, thereby improving their own position.

KEYWORDS: INTER-PROFESSIONAL RELATIONSHIPS; NURSE STAFF HOSPITAL/ORGANIZATION & ADMINISTRATION; QUALITATIVE RESEARCH; PROFESSIONAL AUTONOMY

INTRODUCTION

Nurses represent the single largest group of healthcare professionals in hospitals, and nursing care consumes a substantial proportion of hospital costs[1-3]. Therefore, it is important that nurses' time is used efficiently and effectively[2]. Cost containment demands and budget restraints underscore the need for adequate nurse staffing to ensure high-quality care in the most economical way[3]. Ideally, the demand for care and personnel staffing match perfectly and influence patient outcomes positively (e.g. nurse-sensitive outcomes and adverse events) as well as personnel outcomes (e.g. job satisfaction and absenteeism). However, nurses have reported that their staffing levels are inadequate to provide high-quality care[4,5]. Indeed, nurse staffing levels and patient outcomes are positively correlated, while in hospitals with high patient-to-nurse ratios (NPRs), higher mortality and failure-to-rescue rates[4,6,7] are reported. Furthermore, nurses are more likely to suffer from burnout experiencing high workload[4,8].

The economic formula to match the demand for care to nurse supply was found far from simple in clinical practice[9]. This explains the many staffing models used on the patient interaction, health care organization, and policy levels. The NPRs in California are an example of a nurse staffing model on the policy level. In 1999, California adopted legislation mandating minimum licensed NPRs, with specific ratios for different types of hospital wards. Since then NPRs have spread to other states in the USA and other countries, even without legislation or policy regulations[10,11]. In Australian hospitals nursing hours per patient day (NHPPD) are generally legislated on the policy level and used on the health care organization level for allocating nursing resources. Twigg & Duffield classified hospital wards based on their patient case-mix into NHPPD categories to allocate resources. Another attempt to match nursing supplies with patient demand was the development of patient classification systems (PCSs)[12]. These instruments consist of objective and subjective critical indicators and nursing tasks regarding patients' health status. Based on this information patients can be categorized and the required nursing resources as well as the number of patients assigned to an individual nurse can be determined[13]. This usage indicates that PCSs are used as a management tool on the patient interaction level. In Finland, the use of a PCS is recommended at the policy level by the Finnish government to determine an optimum staffing ratio[14]. These ratios are based on aggregated administrative data of nursing care intensity measures by a PCS, nursing resource assessment, and a professional assessment of optimal nursing care[9].

In Dutch hospitals, NPRs and PCSs are both frequently used for nurse staffing. However, there is no uniformity in the nurse staffing models used, resulting in

variability within and among hospitals[15]. Policy and guidance for nurse staffing are lacking at the policy and health care organization levels. Due to the current spiraling healthcare costs and economic crisis, frontline nurse staffing in Dutch hospitals is under scrutiny[16], resulting in what is perceived by whistle blowers as "critically low" nurse staffing levels.
Insufficient information exists about the perceptions of nursing directors, their policy advisors, head nurses and frontline nurses concerning the current nurse staffing levels and the use of NPRs and PCSs in (Dutch) hospitals. Thus, decisions at the health care organization and policy level could be made without taking the perceptions and preferences of nurses into account. Insight into these aspects would facilitate a consensus at the health care organization level and could fuel a national discussion on nurse staffing.

To obtain in-depth insight into the perceptions of nursing directors, their policy advisors, head nurses and frontline nurses on the current nurse staffing levels and the use of NPRs and PCSs.

METHODS

Design

We used a descriptive phenomenological approach to reduce individual experiences by describing what participants have in common[17,18]. We organized focus groups of frontline nurses and interviews with nursing directors, their policy advisors and head nurses. Both methods are effective to get rich data from nurses and nurse managers and were held contemporaneously to enable 'cross-pollination' between the two methods. The design and execution of our study complied with the COnsolidated criteria for REporting Qualitative studies (COREQ) checklist[19].

Setting, Organizational structure and Staffing model

The study was conducted in a 1000-bed university hospital in the Netherlands. The hospital board of directors consisted of two medical directors and one financial director. Each specialty division was also managed by a three-person board, a medical officer, a nursing director, and a financial officer. Each division consisted of a number of nursing wards, managed by Chefs de Clinique and head nurses. The medical and financial officers managed the budgets. On the ward level, the Chef de Clinique was formally positioned above the head nurse.
All medical and financial officers and Chefs de Clinique had master's-level qualifications or higher. Nursing directors, quality officers and head nurses were qualified nurses with additional management training. A few held master's qualifications, but this was not a requirement. The nursing skill mix consisted of nurses with bachelor degrees (BSN) and licensed vocational nurses (LVN).

The nurse staffing model is since 2012 formulated by NPRs; 1:4, 1:6 and 1:10 as maximum ratios for respectively the day, evening and night shift. Head nurses use their experiences, gut feeling and self-designed PCSs to allocate nurses and assign nurses to patients on operational level.

Participants

Five general medical specialities (surgery, internal medicine, neurology, gynecology & obstetrics and pediatric care), supported by 24 hospital wards, were involved in this study. A multimethod approach was used for sampling due to the complexity of the nurse staffing process and the different managerial levels involved.
A convenience sample was used to select 44 nurses who participated in four focus groups, stratified by the five specialties involved in this study. These nurses were nominated by their head nurses. They were expected to have a wide range of views on staffing, were both men and women, and had different levels of education and years of working experience.
For the semi-structured, in-depth interviews (n=27), a purposive sample was used. The interviewees included 20 head nurses, 4 nursing directors and 3 policy advisors. This sample maximized the diversity relevant to the research question of this study as all head nurses, nursing directors and policy makers from the five specialties were involved. Two senior nurses who replaced their head nurses were initially selected for participation, but were excluded because they were unable to discuss nurse staffing on the health care organization level.
All participants were informed about the aim of the study and were invited to participate by e-mail.

Data collection

Data were collected between September 2012 and December 2012. In our hospital a model for managing complex changes is used for shaping or screening quality improvement implementations, because of its insightfulness and simple clarification of usual problems with changes. This model is a modification of the model for Managing Complex Change developed by Lippitt (Enterprise management Limited), and describes a straightforward model with a matrix of five requirements for successful complex change: vision, skills, incentives, resources and action plan. The lack of one or more requirements can, for instance, lead to frustration or a false start, i.e. implementation problems.
Because nurses were familiar with this model we used it as underlying framework to obtain insight into nurses' perceptions of changes in nurse staffing. As the

implementation of the staffing model in our hospital had resulted in "critically low" NPRs, we used this model to explore the implementation of this staffing model from the nurses' perspective. Therefore, we asked them about their knowledge of, and experiences with, the current staffing model and about their vision and preferences on nurse staffing according to the requirements in the model.

Focus groups

The focus groups were conducted in the last hour of the nursing day-shift (15:00 to 16:00 PM) and consisted of a brown-paper session (concepts emerging were directly written on a brown-paper during the session) structured by the five requirements of the model for managing complex change. To acquire insight in the perceptions of the attendants each requirement was discussed for 10 minutes with the use of open-ended questions and a topic list, based on available literature (Table 1). Additional topics, found during the focus groups, were added to the topic list and used for the subsequent focus groups and interviews. One researcher (CO) moderated the focus groups and another researcher (HV) observed and took notes. The focus groups were also audio-taped to complete the notes.

Interviews

The interviews, conducted by one researcher (CO), took place at a time and location according to the participants' wishes and took between 30 and 60 minutes. All participants were interviewed once. To get insight into the perceptions of the interviewees, the same open-ended questions were asked as in the focus groups (Table 1). Interviewees were encouraged to describe their lived experiences in nurse staffing. Probes and prompts were used as questioning techniques[17]. The interviews were audio-recorded, and notes were made immediately following each interview. Participants were asked whether they wanted to receive the completed transcript of their interview.
The quality of the interviewer's (CO) technique was judged during the first interview by an interviewing expert (RS) and was found appropriate.

Role of the researchers

The two researchers involved in the process of data collection (CO, HV) can be considered as 'insiders'. HV is a clinical epidemiologist and positioned as assistant professor. She has longstanding experience in research and evidence-based quality improvement in which qualitative research plays a role. CO is a PhD candidate trained in nursing science, in which qualitative research is a substantial part of the curriculum. Prior to their academic careers, they both worked as nurses in the hospital that was the setting for this study.
The focus groups and interviews were conducted with participants the researchers often worked with as a nurse or as a researcher and academic nurse role model. This insider role allowed the researchers more rapid and more complete acceptance by the participants[20]. On the other hand, the participants may have given socially desirable answers. To avoid bias, both researchers set aside their experiences as much as possible[18].

Table 1 Focus group and interview questions and topics structured by current model for managing complex change

		QUESTIONS AND TOPICS
VISION		
1	Q	What do you think the organizational vision on nurse staffing is about?
	T	nurses/ patients/ quality & safety/ evidence-based/ patient centered/ personnel centered
2	Q	How is the organizational vision, regarding nurse staffing, operationalized on your ward, in your profit area, or in the hospital?
	T	nurse patient ratios/ patient classification systems/ nursing care intensity/ nurse sensitive outcomes/ ward policies and tactics/ benefits or disadvantages for organization, nurses and patients
3	Q	What is your personal vision on nurse staffing?
	T	organization/ nurses/ patients/ evidence-based/ quality & safety/ patient centered/ personnel centered
4	Q	What would be the operationalization of your personal vision?
	T	nurse patient ratios/ patient classification systems/ nursing care intensity/ nurse sensitive outcomes/ ward policies and tactics/ benefits or disadvantages for organization, nurses and patients
SKILLS/ RESOURCES (CONSTRAINTS)		
5	Q	Which nursing skills, knowledge and resources are needed to realize that vision or policy?
	T	budget/ nursing habitus: nurses' position, professionalization, behavior/ academic nurse: evidence-based practice, inter-professional collaborator, organizers and quality improvers/ leadership
6	Q	How do you feel about current skills, knowledge and resources?
INCENTIVES		
7	Q	What are the incentives of the current nurse staffing model according to the organization, the head nurse, nurses on the ward, and the patient?
	T	quality of care/ finances/ ward production/ nursing culture/ team culture, behavior/ other disciplines
8	Q	How do you feel about these incentives?
	T	opposite/ equivalent/ empowering/ quality
ACTION PLAN		
9	Q	What do you hope the outcome or continuation of this study will be?
	T	Implementation nurse staffing model/ goal/ vision on nursing/ practical advices: start, actions, best experiences, best practices by nurses, strategies, strategic choices

Q = question; T=topic; vs = versus; irt = in relation to

Data analysis

Four researchers were involved in the process of data analysis (CO, EM, SB, HV) using Colaizzi's analytic method[21]. From December 2012 through June 2013, the interviews were transcribed verbatim and reviewed independently to ensure accuracy. To grasp the context, the transcripts were read several times. Data analysis was conducted in Dutch, using MAXQDA version 11. Each transcript was analyzed independently by two researchers.

The process of data analysis started with breaking down the data into meaningful segments, which were labelled with codes. The codes were based on the words the participants used. Next, the codes were clustered into categories and themes, and finally the themes were integrated into an exhaustive description of the phenomenon. To increase transparency, memos were used in which meanings were written down about the emerging themes. Consensus about the codes, categories, themes and their meanings was reached during joint meetings. Discrepancies were resolved by discussion between the researchers. This process of researcher triangulation was used to increase this study's reliability and validity[18]. The focus groups were directly coded from the notes and statements on the brown papers, following the same process as the interview coding. Audio recordings were used to check the notes and codes. During the process of data analysis, data saturation confirmed that the sample size was sufficient. All nursing directors from the hospital under study, along with two nursing directors from other academic hospitals, were asked to reflect on the investigators' interpretation of the results regarding validity and generalizability. They recognized the results and confirmed that the same themes were applicable to their situation.

Ethical considerations

Our local medical ethics review board (Academic Medical Center, Amsterdam, The Netherlands) approved the study but waived the need for ethical approval as the study had no effect on the participants' or patients' wellbeing.

Permission for this study was obtained from the nursing directors. Participants were given a full explanation of this study prior to the focus groups and interviews and gave oral informed consent and permission for audio-recording. Assurances were given that all data would remain confidential and that the anonymity of the participants was guaranteed by disassociating their names. Data were saved under identification numbers, which were safeguarded by one of the researchers (CO).

RESULTS

The result of the data analysis was that nurse staffing – as tip of the iceberg – comprised three underlying main themes – nursing behavior, authority, and autonomy – which were linked by one overall theme: the nurses' position (Figure 1).

The main themes influenced the nurses' perceived and actual position in a positive or negative way. Several subthemes were identified: narrow vision on high-quality of patient care, nurses' problem solving, different communication style, different work ethic, conflicting interests, nurses' value, quantifying nursing care, and desire for more autonomy (Table 2).

Figure 1 Nurse staffing: the tip of the iceberg

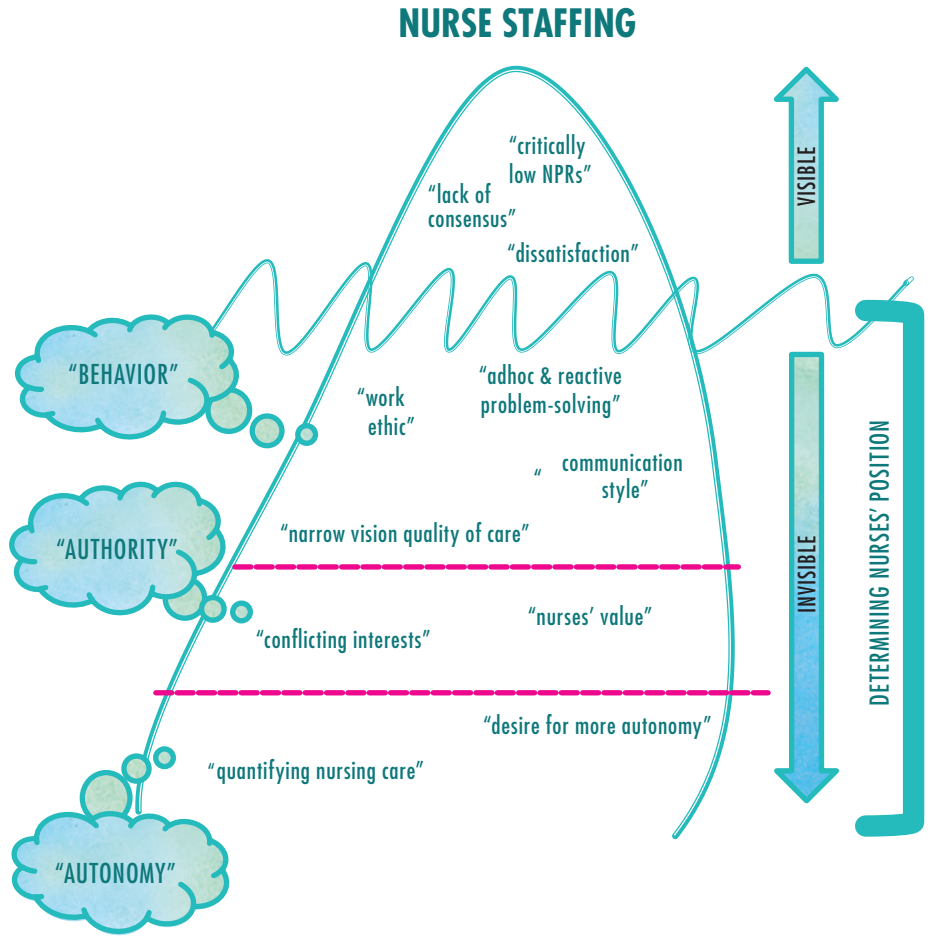

Table 2 Definitions of Main Themes

THEME	DEFINITION
Nursing behavior	Actions and reactions of nurses: · narrow vision on high-quality of care as nurses prefer direct patient-related nursing tasks. Moreover, are inwardly focused and feel administrative tasks to control quality of care and innovation projects keep them away from their patient; · ad hoc behavior; making short term solutions instead of constructive long term solutions (downsizing number of beds, re-scheduling); · reactive behavior as being dependent on other disciplines and processes instead of being proactive and self-controlling (e.g. admission scheduling, innovation projects); · different communication style: feelings and opinions are dominant in nurses' communication, while other disciplines are more sensitive to facts or evidence (e.g. talking about patient's health status, nursing care intensity); · different work ethic: nurses think of themselves as hardworking people, while others think thy spend their time inefficiently (e.g. taking long breaks, taking care of colleagues, return on investment is low on support of developing skills).
Authority	Degree of power and control: · conflicting interests: nurses interests are ignored, lacking arguments for high workload (e.g. admitting patients to wards); · nurses' values: nurses are not involved in decision-making concerning nurse staffing, which makes them feel like they do not matter.
Autonomy	Freedom or privilege to act independently: · difficulties in quantifying nursing care: no measure is available for nurses proving they experience high workload; · desire for more autonomy: nurses suggested a patient classification system is needed to earn autonomy in balancing nurse staffing with nursing care intensity, and eventually earn authority by getting into dialogue and decision-making about nurse staffing with constructive and objective arguments for long-term solutions.

Nurses' professional behavior

Narrow vision on high-quality of care

Quality of patient care appeared to be the driving force with respect to nurse staffing levels for all participants, i.e., nurses, nursing directors, head nurses and policy makers. Nurses viewed this from the perspective of the patients; the patients and their families must be satisfied with the quality of care.

> *Nursing director, 28 "[…] so that you have enough time to spend on patient care. You can fulfil all your nursing tasks. That feels like; 'Oh, I've completely finished everything and everybody is satisfied'."*

The workload on the nursing wards of an academic hospital is high due to the complexity of patient care and non-patient related tasks. Nursing directors and head nurses mentioned that, due to shortage of time and resources, nurses are prioritizing their duties leaving some tasks unfinished, which can lead to undesirable or unsafe situations.

> *Head nurse, 25 "It is tragic that a nasogastric tube must remain in because the nurse does not have enough time to feed the patients. That is seriously wrong."*

Nurses and head nurses reported experiencing a shift away from their primary task of direct patient care. In particular, administrative burden and top-down implemented innovation projects kept nurses away from patients. One of the head nurses said that it was disappointing when she discovered that nurses spend much less time on patient care than she thought. However, the head nurses accepted that administrative tasks to control quality of care and innovation projects are part of the nursing profession. Nursing directors and quality advisors indicated that nurses are inwardly focused, struggling with organizational changes, and that some (head)nurses have a narrow vision on quality of care, overvaluing direct patient care and underestimating all other competencies which are important to deliver high quality and safe care.

> *Head nurse, 23 "I think 100% of the nurses want to provide good care, they want to be there for their patients. […] I got an e-mail yesterday from a colleague who is now working overseas for three months. The gist of her wonderful e-mail was: no disturbing monitors, no disturbing emergency admissions.She could just provide patient care. In my opinion this is what nurses want. It would be desirable to provide 100% direct patient care. Just like overseas…"*

Nurses' problem solving

Nurses and head nurses both mentioned that inefficient processes keep them away from direct patient care and cause a high workload. They not only feel they are, but in fact are made responsible for, solving many malfunctioning processes. Nursing directors and policy advisors also mentioned that, due to inefficient processes, the workload they experience is much higher than it ought to be.

> *Nursing director, 24 "There was a patient who came to our ward for chemo. […] But the chemo was not on our ward. The nurse searched, called, and checked again. She called the responsible physician, but he was abroad,*

and his deputy was asleep after his nightshift, and so he could not be reached. It turned out that the responsible physician had filled out another ward on the request form, instead of our ward. Just the wrong ward. […] The nurse had been busy for 45 minutes to correct the physician's mistake, and to make sure that the patient received the chemo. In the 45 minutes the nurse spent sorting this out, she could not do anything else."

All participants indicated that nurses contribute to inefficient processes by making ad-hoc decisions instead of constructive, long-term decisions. One of the head nurses said that making ad-hoc decisions is the nature of nursing care. Policy advisors confirmed that making ad-hoc decisions is something nurses naturally do; quickly assess and act to save someone's life. However, nurses acknowledge that making ad-hoc decisions influences the workload negatively; it causes severe fluctuations in the workload that nurses experience.

Nursing director, 28 ***"Sure, a part of nursing care consists of firefighting [making ad-hoc decisions]. That is the nature of nursing care. But many fires occur at places where they should not, where we could have done some fire prevention."***

Head nurses used ad-hoc strategies to solve staffing problems, i.e. reducing bed capacity when there is a lack of personnel or excessive nursing intensity on the ward. They also said that their behavior is reactive instead of proactive. Therefore, nurses' problem-solving behavior hampers sustainable solutions.

Head nurse, 16 ***"Our workload is determined by the physicians' operating program. We do not know how many resources we will need for the next week. We just respond afterwards."***

Different communication style

Nursing directors and policy advisors indicated that nurses' communication is different from other disciplines, which may cause misunderstandings about what nurses do and what the essence of their message is. The reason specified is that feelings and opinions are dominant in nurses' communication on nurse staffing, while other disciplines are more sensitive to facts or evidence.

Head nurse, 21 ***"Nurses are often not taken seriously because it is all about emotion."***

Different work ethic

Nursing directors, head nurses and policy advisors believed that nurses do not spend their time efficiently. While most nurses think of themselves as hardworking people who do not have enough time for professionalization due to a heavy workload, policy advisors said that when their workload is light, nurses do not spend this time on professional development or quality improvement projects, but instead take longer breaks.

Head nurse, 11 ***"I will tell you something… I do not think our nurses behave like an academic nurse. It is my opinion, but when they have time to innovate and do some work for projects, the return on investment for me is very low."***

Lacking authority

Conflicting interests

Another underlying cause of inefficient processes is conflicting interests between different disciplines. Nurses and head nurses said that they bear the brunt of decisions made by others. They do not have enough power to argue for more resources, which results in disregarded interests. When it comes to the admission of patients to the hospital wards, nurses mentioned that physicians may even change the rules somewhat to get a patient admitted, and in the end nurses always draw the short straw.

Nurse, focus group 3 ***"Dirty games are played to admit a patient to a ward."***

Nurses' value

Nurses are not involved in decision-making concerning strategic goals and policies, such as staffing policies, even if they indicate that they want to contribute. Decisions are simply made in a top-down fashion by chairpersons and directors, which makes nurses feel like they do not matter.

Head nurse, 21 ***"From each group a representative was selected to speak about reorganizing our division. They formed a think tank. However, no nurses were chosen! […] You cannot exclude such an important discipline and simply say that they do not have a comprehensive view. That is nonsense! […] So, I made it clear that this was not a desirable situation."***

There is still a rigid hierarchy in hospitals, placing the physicians in charge. Nurses said that, although nurses are indispensable, their work is still not valued.

Nurse director, 24 "What would you be without a nurse! […] How is it possible that a physician, standing so close, does not see the adding value of a nurse..."

Enhancing autonomy

Quantifying nursing care

Nurses and head nurses indicated the number of patients is not the main factor causing high workload, but rather the complexity of nursing care for these patients. Patient characteristics, outcomes, mental state (e.g. multi-morbidity, complications, anxiety) and administrative burden play an important role in nursing workload. Psychosocial activities and administrative tasks are particularly hard to quantify. Some nurses and head nurses mentioned they tried to develop their own PCS to quantify their nursing care intensity. However, as these systems are not validated or tested for reliability, the intensity scores are inconsistent and lead to unexpected nursing care intensity scores.

Head nurse, 21 "We have discussed it with several hospital wards... How can we demonstrate that we are busy, and how can we decide how many resources we need? Do we have too few, or too many resources?"

Therefore, nurses have difficulties showing other disciplines what their work entails. Some head nurses mentioned the lack of a valid system as the causative factor of misunderstandings in the communication with other disciplines.

Head nurse, 4 "They see five empty beds and wonder why we cannot admit more patients. That is because of the nursing care intensity and available nursing resources. However, we have no uniform measure for that. How can we sell that and how can we expect that they will agree with our refusal to admit more patients?"

Desire for more autonomy

Nurses and head nurses mentioned that they yearn for a valid nursing care intensity measure to give insight into their work, make their work visible, and create more respect for their profession. Nurses believed that a valid PCS to measure nursing care intensity would give them the opportunity to get involved in decision-making on nurse staffing, give them more autonomy and authority.

Head nurse, 4 "For nurses, I think, it is nice because nurses can... Now they can say very clearly: the ward is overcrowded or not. […] With such a system, you give the nurse, and I think this is very important, their own autonomy"

Although others state that lacking a valid PCS is just an excuse for the real problem, i.e. poor nursing leadership and communication.

Quality advisor, 29 "The problem is…. it is not the system. The problem is, nurses do not dare to engage in the dialogue!"

Quality advisor, 30 "You have to earn autonomy. It is not something you just get, you have to enforce it by showing who you are and what you can do. That is how you get autonomy."

Nurses want a valid PCS for interdisciplinary communication, to enable constructive and objective dialogue between nurses and physicians, frontline nurses and their head nurses, head nurses and their directors and policymakers. Head nurses and frontline nurses want to be fully engaged in the discussion about nurse staffing.

Head nurse, 25 "We have to start with a clear standard for nurse staffing and stay in dialogue about it. Top-down and bottom-up."

DISCUSSION

Main findings

Experiences with nurse staffing comprise three main themes: *nursing behavior, authority* and *autonomy*. Nurse staffing therefore appears to be the *tip of the iceberg,* masking many and much larger problems beneath. All of these themes boil down to one focus: the position of nurses. This appears to be highly important for the professionalization of nursing and ultimately for the quality of patient care. Time to provide direct patient care is mentioned by the nurses as the most important factor to provide high quality of care and therefore adequate nurse staffing is considered crucial because it enables them to provide this care.

According to the nurses in our study, current nurse staffing and inefficient processes adversely affect the quality of care. They believe that a valid nursing care intensity score, measured by a PCS, could be used as an interdisciplinary communication tool, i.e. providing insight in nurses' work, aligning organizational processes on the ward (e.g. admitting patients), and tailor personnel and resources. This would also enhance autonomy in decisions about nurse staffing and help to establish a professional culture that values nurses more highly.

Asking nurses about their perceptions on nurse staffing led to valuable information on the nurses' work situation. Apparently, nurses did not have specific visionary ideas on nurse staffing, but used the focus groups and interviews to express their dissatisfaction on issues related to workload. However, or results are confirmed by other studies that provided quantitative insight into the association between nurse staffing levels, a work system full of inefficient processes and negative patient outcomes[6,22,23]. Surprisingly, none of the interviewees supported their beliefs about the necessity of adequate nurse staffing with scientific evidence. This confirms our findings on different communication styles among disciplines. Apparently, nurses still have to catch up with other disciplines when it comes to evidence-based decision making [24,25]. Nurses think of themselves as hard working people who have to deal with a heavy workload. However, their self-concept differs from that in other disciplines. Their image has suffered from public stereotyping[26] and, although the nursing profession has changed[27], it is still perceived as a profession serving other disciplines. Nevertheless, nurses have shown little proactivity to change this image. Instead, they continue to act in an ad-hoc and reactive fashion to processes (often inefficient ones) over which they have little influence.

Nurses in this study appear to be inwardly focused, even though they would be happy to be more involved in decision-making on staffing and professionalization on the health care organization level. The phenomenon of nurses complaining and struggling with physicians and management is not limited to the hospital in the present study[28,29]. Part of this phenomenon can be traced back to pre-professional nursing history: motherhood, altruism, charity and piety[30]. These values are reflected by the nurses in our study when they express their opinions about the quality of care, the time allotted for direct patient care and attention to the patients' families. It seems likely that nursing history has made a position of powerlessness acceptable for nurses who are faced with the 'impossibility' of their role in the organizational hierarchy[31]. This supports the finding that, even if nurses are supported to act professional, they sometimes choose not to do so.

According to studies that relate nursing organizational models or work systems to patient outcomes[23,32], the Dutch organizational model is a 'basic functional model': it lacks a supporting climate for nursing professionalization and dealing with inefficient processes and low NPRs. These deficiencies do not facilitate the aims of high-performance and reliable organizations, especially in a university hospital.

Implications on the health care organization level

Besides being responsible for direct patient care, nurses are also challenged to take responsibility to improve their work system and communicate adequately by using facts or evidence. Head nurses and nursing directors can help frontline nurses face this challenge though empowerment and role modelling, by being nurse leaders. Strong leadership leads to staffing adequacy, involvement in policymaking and better collaboration with physicians[33], and improves outcomes for patients (e.g. nursing-sensitive outcomes), organization (e.g. efficiency and quality) and personnel (e.g. job satisfaction, less absenteeism)[34,35]. Aiken et al. attributed the better outcomes in high-performance organizations especially to professional nursing work systems, where nurses experienced more autonomy, more control over their practice and better relationships with other disciplines within the hospital[36]. Adopting principles of high performance has proven successful in many countries, regardless of differences in financial and delivery systems[37]. Therefore, as a future perspective, it is worthwhile addressing this issue more extensively in the Netherlands, in addition to implementing a valid nursing care intensity scoring system.

Implications on the policy level

Considering the American, Australian and British literature on nurse staffing and the effect on patient outcomes[6,32,38], it is clear that not only hospital boards and nursing directors should support frontline nurses regarding nurse staffing and positioning issues, but also politicians.

Little research is available on the current and optimal NPRs in the Netherlands. However, recent research has shown that lower NPRs, also in the Netherlands, will improve patient outcomes in surgical patients[6].

Limitations

Some limitations warrant consideration. First, this study took place at only one university hospital in the Netherlands. Although the findings can probably be generalized to other Dutch hospitals (the consulted nursing directors from other academic hospitals in the Netherlands agreed on the identified themes), they cannot be generalized to all other hospitals or hospitals in other countries. However, depending on their degree of professionalization, many hospitals will likely recognize the themes from this study. Furthermore, the message that nurses have to play an active professional role to provide high-quality patient care is valid for nurses worldwide.

Second, the role of the researchers may have influenced the data collection. However, the shared experiences were open-faced and authentic, probably because the participants assumed the researchers to understand and handle the information with integrity[39].

CONCLUSION

Our study on the perception of nurses regarding nurse staffing shows that the positioning of nurses is crucial. On the patient interaction level nurses are challenged by a lack of authority and autonomy in decision-making on nurse staffing. They are hindered by their current communication skills, which can be improved if they would support their arguments with evidence on the association between nursing care intensity and the adverse effects on outcomes for patients and personnel. Further research is needed to explore whether an objective nursing care intensity score can influence nurses' position and enable a constructive (interdisciplinary) dialogue on adequate nurse staffing.

On the health care organization level, nursing directors should discuss how they can move from a basic functional model to a professional functional model. Such a professional model creates a work environment that values and empowers nurses, and generates possibilities for evidence-based quality improvement. This will result in both personal growth for their staff and improvements in patient safety and quality.

On the policy level, it would be helpful to re-open the discussion on formulating legislation regarding optimum nurse staffing levels. To support this discussion, more research on the relationship between nurse staffing levels and patient outcomes (i.e. nurse-sensitive outcomes and complications) is needed. In the meantime, nursing leaders should begin taking responsibility for transforming their own profession.

COMPETING INTEREST

The authors declare that they have no competing interests.

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Part III

STAFFING ON CLINICAL WARDS

PRE-IMPLEMENTATION

STUDIES OF A WORKFORCE PLANNING TOOL

FOR NURSE STAFFING AND HUMAN RESOURCE MANAGEMENT IN UNIVERSITY HOSPITALS

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J Nurs Manag. Provisionally accepted

ABSTRACT

AIM: Investigating the reliability, validity and feasibility of the RAFAELA workforce planning system (including the Oulu patient classification system (OPCq)), before implementation in Dutch hospitals.

BACKGROUND: Budgetary restraints and demand for high-quality patient care have ignited the need for transparent hospital workforce planning.

METHODS: Nurses from 12 wards of two Dutch university hospitals were trained to test the reliability of the OPCq by investigating the agreement of nursing care intensity (NCI) measurements among nurses. Validity was tested by assessing whether optimal NCI/nurse as calculated by RAFAELA was realistic. System feasibility was investigated through a questionnaire among all nurses involved.

RESULTS: Almost 67.000 NCI-measurements were performed between December 2013 and June 2014. Absolute agreement using the OPCq varied between 38% and 91%. For only 1/12 wards the optimal NCI area calculated was judged as valid. Although the majority of respondents was positive about the applicability and user-friendliness, RAFAELA was not accepted as useful workforce planning system.

CONCLUSION AND IMPLICATIONS FOR NURSING MANAGEMENT: The nurses' performance using the RAFAELA system did not warrant its implementation. Hospital managers should first focus on enlarging the readiness of nurses regarding the implementation of a workforce planning system.

KEY WORDS: WORKFORCE PLANNING; PATIENT CLASSIFICATION SYSTEM; WORKLOAD; PERSONNEL STAFFING AND SCHEDULING; NURSING CARE INTENSITY; DEMAND FOR CARE; NURSING; RELIABILITY; VALIDITY; FEASIBILITY

BACKGROUND

Present-day developments in care complexity, budgetary restraints and demand for safe and high-quality patient care have ignited the need for systematic and transparent workforce planning in hospitals[1].

Many studies show an evident association between nurse staffing levels (in quantity and skill mix) and patient outcomes[2-4]. In hospitals with low nurse-to-patient ratios (NPRs), adverse events occur more frequently, and patients experience higher mortality and failure-to-rescue rates[2-4]. Furthermore, nurses in hospitals with low NPRs are more likely to experience burnout and job dissatisfaction[2,5]. Thus, it is important for nurse managers and policy makers to know what determines the optimal number and skill mix of nurses required to deliver high quality and cost effective patient care.

While NPRs are easily intelligible for politicians, public and policy makers to understand, nurse managers have to guarantee sufficient staffing to meet the patients' demand for care. Therefore, appreciating the impact of the demand for care on nursing care intensity (NCI) would help managers to plan the optimal number and skill mix of nurses. For this purpose, a uniform and valid measurement and communication tool is lacking[6]. Such a tool would enable nurse managers and nurses to balance NCI and nurse staffing levels, not only on the tactical management level (i.e., hospital directors and policymakers) for determining optimal nurse staffing levels, but also on the operational level in terms of admission planning (with planners and physicians), daily nurse allocation and nurse-to-patient assignment (with nursing colleagues)[7]. The need for a tool to quantify NCI is especially high in some European countries where legislation or a national policy on nurse staffing is lacking, unlike for instance in California (NPR)[8] and Australia (NHPPD)[9].

NCI is defined as 'patient-related workload', as measured with a wide range of patient classification systems (PCSs)[10]. However, in the way these systems are commonly used, the resulting NCI is not considered an objective measure because of reliability and validity problems[11]. This has rarely been investigated because methods for validating these instruments, for instance time and motion studies, are time-consuming. At present a variety of unreliable and invalidated PCSs are used in hospitals, which causes difficulties in comparing nursing intensity scores among wards and hospitals.

A positive exception on these common but unreliable PCSs is a workforce planning tool based on NCI, called the "RAFAELA patient classification system" which was developed and introduced in Finland by Fagerström and Rainio in the late 1990s[11]. The validity and feasibility of the different parts of this system have been

assessed in many clinical studies[11-13]. Furthermore the RAFAELA system offers a fully ICT-supported and uniform system for all clinical nursing wards, which facilitates a clear communication about nursing care intensity on all management levels throughout the hospital, and even on regional and national levels[14].

Given these purported merits, we investigated the reliability, validity and feasibility of the RAFAELA-system in two university hospitals in the Netherlands, before a final decision could be made on a broad implementation of this system.

METHODS

For the proper conduct and description of this study the Standard of Quality Improvement Reporting Excellence (SQUIRE) checklist[15] was used.

Ethics

Our local medical ethics review board (Academic Medical Center, Amsterdam, The Netherlands) approved the study but waived the need for written informed consent, as the study had no effect on the patient's treatment or psychological wellbeing. Furthermore, the authors state they have no conflicts of interest in implementing and evaluating RAFAELA.

Setting

Two Dutch university hospitals, each with approximately 700-1000 beds, contributed to the study; the Academic Medical Center (AMC) and the Free University VU Medical Center (VUmc) in Amsterdam. These hospitals were represented by at least five wards of different specialties per hospital (Table 1). Each of these wards had 20-47 operational beds and employed 11-49 Full Time Equivalents (FTE) nurses at both Licensed Vocational Nurse (LVN) and Bachelor Science Nurse (BSN) levels and working 8-hour shifts. Staffing policies in both hospitals did not differentiate between LVN or BSN levels.

Intervention of interest

The RAFAELA system consists of three subsystems: 1) the Oulu Patient Classification qualisan (OPCq), 2) a database of available nursing resources, in which one resource unit is equal to eight nursing hours per day, and 3) the Professional Assessment of the Optimal Nursing Care Intensity Level (PAONCIL) tool.

The OPCq instrument determines the individual patients' caring needs (NCI) per 24 hours and is based on nursing experiences and the patient reports documented by the nurses of each contributing ward. The OPCq consists of six subsections, or nursing areas, regarding patient care that are to be scored; 1) planning and coordination of nursing care, 2) breathing, blood circulation and symptoms of disease, 3) nutrition and medication, 4) personal hygiene and secretion, 5) activity, sleep and rest, and 6) teaching, guidance in (follow-up) care and emotional support. Each subsection is scored on a four-point scale; 'slight' up to 'very demanding' or 'continuously'. Therefore, the total NCI-score can vary between six and 24 points per patient.

The PAONCIL tool is used to calculate the optimal daily NCI/N for each ward by dividing the total NCI by the available nursing resources. As input for the PAONCIL calculation, nurses have to assess the optimal NCI on a scale from -3 (below optimal), through 0 (optimal) up to +3 (above optimal).

To determine an estimate of the optimal NCI/N per ward, the daily NCI/Ns are compared with the average PAONCIL values by means of a regression analysis, which is integrated in the system. The resulting estimate is used to determine the optimal NCI range (i.e., optimum value +/- 15%). Comparing this area with the daily NCI/N provides information about the adequacy of the current nurse staffing level and facilitates solutions for (ad hoc) staff (re-) allocation[14].

The PAONCIL instrument also includes 12 additional non-patient factors to assess ward processes and aspects that may affect nurses' workload during a shift, i.e. organizational and planning issues, managerial roles, staff situations, meetings, trainings or other absences, students, collaboration among nursing team members, collaboration with physicians, collaboration with other disciplines, nurses own physical and mental state and other factors[16].

Several conditions must be met to enable calculation of the optimal NCI area; 1) Assessment of the OPCq should be reliable, i.e., the agreement between OPCq measurements by two nurses of the same patient should be at least 70%[17], 2) The available resources must be recorded completely, and 3) At least 70% of the nurses must assess their NCI by means of the PAONCIL tool during the measurement period. Finally, the regression analyses have to find an explanation degree of at least 25% for PAONCIL explaining the NCI/N[18].

Design

This study contained three parts, based on the three study questions:

1. a reliability study, investigating the agreement among nurses when scoring NCI using the OPCq of the RAFAELA system.
2. a validity study, in which head nurses were to assess whether these NCI scores, together with the nurses' appreciation of their workload, would result in a realistic NCI/N score as calculated and presented graphically by the RAFAELA system. This would supply them with valuable information regarding staff allocation and benchmarking.
3. a feasibility study (in terms of user-friendliness, applicability and acceptability) of the whole RAFAELA system, as judged by all nurses involved.

Each of these study parts would result in a 'go' or 'no-go' outcome regarding a hospital-wide implementation of the RAFAELA system. Criteria for a 'go' were a 70% agreement regarding the reliability[17], a 'realistic' verdict as to its validity, and 50% of the nurses should appreciate the RAFAELA system as 'feasible'. Feasibility was justified if the median Likert-score was ≥5 and less than 25% of the scores were below the 25% percentile[19].
Results of the different study parts had no consequences for current ward processes or policies, as this study was a pre-implementation study.

Study conduct

The OPCq and the PAONCIL instruments were translated into Dutch by the researchers based on forward and backward translation.
Data collection for the three study parts took place from December 2013 until June 2014. All nurses on the participating wards were to measure their patients' NCI once per 24-hours, seven days a week, between December 2013 and June 2014.
To facilitate the introduction of RAFAELA on the nursing wards, a users' support team was composed in each hospital. These teams consisted of one 'super-user' (a researcher), for conducting the study, and at least two 'key-users' (nurses) per participating hospital ward, for teaching and motivating the nursing team involved. All super- and key-users attended three dedicated RAFAELA trainings conducted by an associate of the Finnish supplier of RAFAELA, FCG International Ltd., Helsinki. During a three-month practicing period, nurses gained experience in measuring the nursing care intensity by the OPCq, while members of the support team practiced recording nursing resources.

PART 1: reliability study

After the training period, the NCI of at least 50 patients per ward were scored using the OPCq in the RAFAELA system by two nurses independently. These parallel measurements were taken once per 24-hours during a one-week period. The RAFAELA system provides an absolute measure of agreement between two parallel OPCq measurements in the same patient. Agreement was defined as a difference between the nurses' scores of less than two NCI points[17].

PART 2: validity study

Nurses were to score the PAONCIL every shift and the NCI once per 24 hours during a six-week period. Based on these data, the RAFAELA system generates output about the NCI/N for each ward.
Subsequently, these management reports regarding the optimum NCI/N would be presented to the head nurses of each contributing ward to assess face validity of the RAFAELA system.

PART 3: feasibility study

Nurses of all contributing wards were asked to evaluate the user-friendliness (functionality), applicability, and the acceptability of RAFAELA by means of a digital questionnaire (Surveymonkey.com). The questionnaire contained 17 questions, each with a 10-point Likert scale, and 4 open questions about the use of RAFAELA (Appendix). Nurses were given two weeks to complete the questionnaire and received two reminders if needed.

RESULTS

From December 2013 until June 2014, 38.819 and 26.261 OPCq measurements and 1.441 and 405 PAONCIL measurements were performed by 443 nurses, respectively for hospital A and B, totalling 66.926 measurements.

Table 1 Agreement based on the parallel measurements for total nursing care intensity points (NCI) per ward

	HOSPITAL A			HOSPITAL B		
SPECIALTY	ward	Period 1 *Consensus (%)*	Period 2 *Consensus (%)*	ward	Period 1 *Consensus (%)*	Period 2 *Consensus (%)*
Neurology	1	48	75	1	62	44**
Neurosurgery						
Neurosurgery/ orthopedics				2	56	67***
Gastro-Intestinal-surgery/hematology				3	50	76
Vascular surgery/ Urology	2	X*	73			
Cardio-thoracic surgery	3	67	59**			
Short-stay surgery				4	69	62***
Internal medicine				5	50	38**
Pulmonology/Gastro-Intestinal medicine	4	40	X**			
Kidney transplantation	5	45	78			
Cardiology	6	41	91			
Pediatrics >1-10 years	7	60	82			

not able to participate in the parallel period; **performed less than 50 parallel measurements; ***To continue the consensus proportion was set at 60%; X = no data

PART 1: reliability study

Agreement for the OPCq measurements ranged from 40% to 67% for hospital A and 50% to 69% for hospital B. Given these low agreement results, it was decided to allow a second measurement after another one-month training and motivation period of the nurses involved, and accepting an agreement of at least 60%.
This resulted in agreements between 59% and 91% for hospital A, and between 38% and 76% for hospital B (Table 1). The number of performed measurements increased by 20% (Figure 1). A total of 8 wards scored a sufficient agreement to continue on to part 2: In hospital A five out of seven, in hospital B three wards out of the five passed.

PART 2: validity study

Only the nurses on the neurology/neurosurgery ward in hospital A performed enough PAONCIL measurements (77%; Figure 2) to calculate an optimal NCI area for their ward (Figure 3). The variance explained by the regression model was 29.4%. The head nurse involved judged the output to be valid and valuable for staff planning and benchmarking.

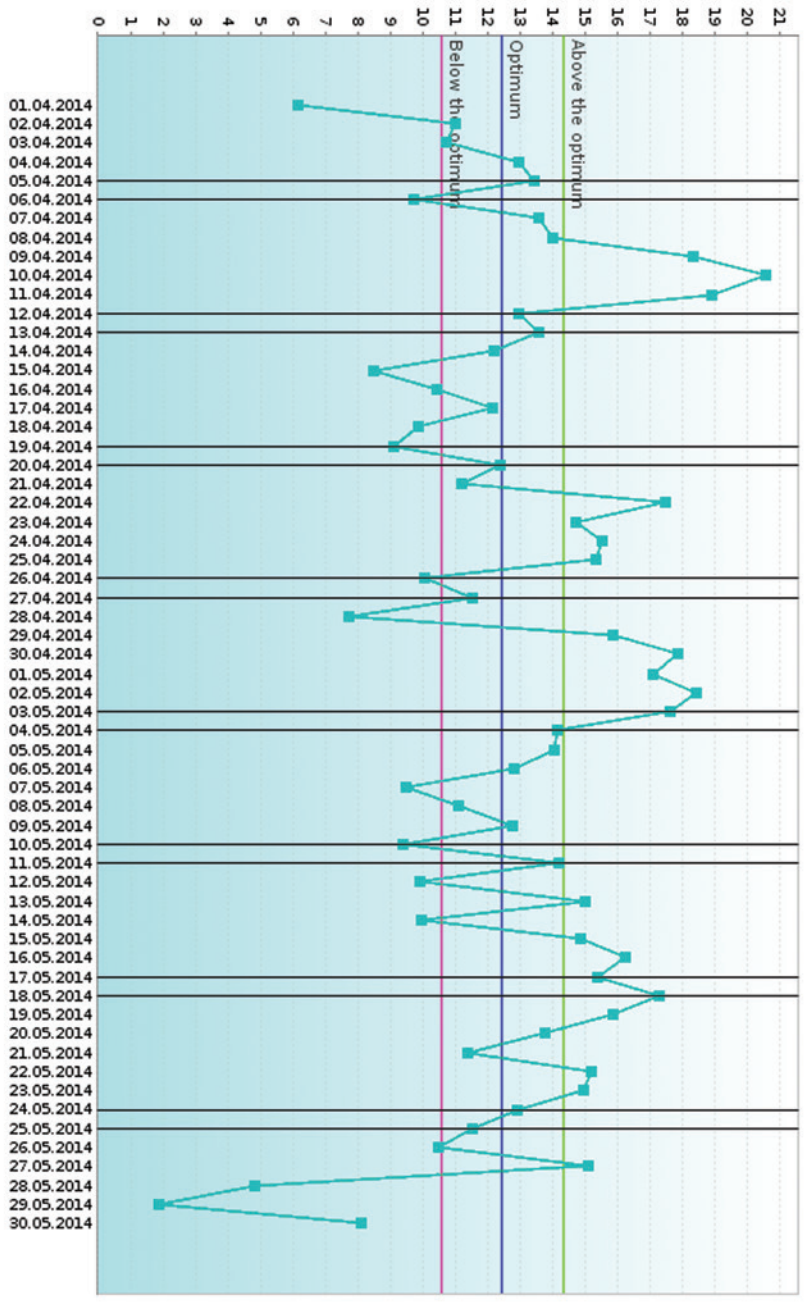
PART 3: feasibility study

Response rate of the questionnaire was 30%. Median scores for each question varied between 4 and 8, while 2-34% of the scores were below the 25th percentile (Table 2), for the questions (Q) 9 to 17, respectively (Appendix 1). The respondents perceived the OPCq as a suitable instrument to measure all aspects of the nursing care intensity (Table 2; Q9; 10% <25th percentile). However, the OPCq was not perceived as a correct reflection of the nursing care intensity (Table 2; Q10; 20% <25 percentile). The respondents were positive about the usability of RAFAELA (Table 2; Q13 & Q15; 7% and 15% <25th percentile), but did not see RAFAELA as an improvement (Table 2; Q16 & Q17; 30% and 34% <25th percentile). In the open questions about half of the respondents was positive and appreciated the benefits of RAFAELA on the operational level, i.e. (ad hoc) allocation of nursing resources and nurse-patient assignment.
Sensitivity analysis (i.e. by selecting subgroups of nurses based on their role on the ward) of these data showed that only team leaders and members of the support team were able to appreciate some of the benefits of RAFAELA for the tactical and strategic levels, i.e. evaluating nurse staffing levels and benchmarking. Difficulties the respondents experienced with RAFAELA were: the nursing areas in the OPCq were considered too abstract and a checklist with patient acuity items was preferred, there was no confidence in the 24-hour measurement as nurses felt the previous patient reports were not sufficient, and the benefit of an uniform measure was not clear for nurses on an operational level.

Figure 1 Mean percentages OPCq measurements performed by hospitals A and B per ward

Figure 2 Mean percentages PAONCIL measurements performed by hospitals A and B per ward

Figure 3 Optimal Nursing Care Intensity/ Nurse area ↻



Hospital A - Ward 4

Table 2 Main results from the digital survey

MAIN RESULTS			
Question	Median	% <25 percentile	% <75 percentile
9	5.5	10	59
10	4	20	30
11	4.5	21	32
12	7.5	2	82
13	6.5	7	59
14	6.5	7	59
15	8	15	39
16	5	30	30
17	5.5	34	28

for questions see appendix 1

DISCUSSION

This study examined the reliability, face validity and feasibility of the RAFAELA system in two Dutch hospitals to decide upon its implementation. In the first place, the OPCq instrument to measure NCI was found reliable for a subset of 8 out of 12 wards; second, the calculated optimal NCI area was found to be valid for only 1 out of 8 wards, and third, the questionnaire showed a small majority of the respondents was positive about the applicability and user-friendliness of RAFAELA. These results suggest that the Dutch version of RAFAELA provides valid information, but the present circumstances are not ready for implementation of the system.

The agreement between NCI-scores remained insufficient for some wards, even after a second training period. This is commensurate with the results from other investigators in Norway who also experienced the need for continuous verification, quality assurance and training in using the system to guarantee a reliable NCI[20]. Nurses found it difficult to reflect on the care they gave. They appeared to score care complexity rather than care intensity, e.g. they scored highly what they thought was beyond their routine and complex work to perform instead of assessing patients' caring needs as 'slight', 'very demanding' or 'continuously'. This resulted in an erroneous estimation of the NCI and low scores for the OPCq's ability to reflect the nursing care intensity.

Most of the wards did not perform enough PAONCIL measurements to calculate an optimal NCI area. We anticipated nurses to be enthusiastic about assessing their NCI and give additional information about their ward-related workload.

However, despite repeated extensive trainings and motivation sessions, the number of performed PAONCIL measurements remained low, which appeared to be a sign of the lack of acceptance of the RAFAELA system as found in the questionnaire. Nurses preferred a ward-specific checklist to measure NCI rather than a tool that triggers nurses to assess the real patient needs and to reflect on the given quality of nursing care[14]. Furthermore, insufficient nursing documentation seemed a reason for nurses to dismiss a reliable and valid workforce planning tool (if correctly used). Nurses experiencing high workload and those working on wards with relatively few BSN-trained nurses, appeared to have a narrow vision of high quality of patient care. They prefer direct patient-related nursing tasks[21]. Moreover, these nurses tended to have limited sense of professionalism i.e. they were very inwardly focused and felt administrative tasks to control quality of care and innovation projects keep them away from their patients[21,22]. Even if nurses believed a workforce planning tool can change their working conditions[21], testing RAFAELA in its full extent was seen as an addition to the administrative burden by nurses in the hospitals under study. However, because in the Netherlands the majority of the nursing working population is trained as LVN[3], nursing workload will probably remain high due to increasing demand for care and limited healthcare budgets[23]. Hence, it is not likely that nurses will increase their professionalism and broaden their scope on quality on patient care without help. As nurses play a crucial role in delivering high quality patient care, nurses should be facilitated and motivated to achieve a high professional standard, for instance by showing more leadership[24], selective employment of BSN-trained nurses[25], and providing opportunities and time to develop skills for interdisciplinary collaboration, innovation, clinical reasoning, evidence-based practice and leadership[26,27].

Nurses in this study apparently did not clearly see the benefits of the RAFAELA system; improving person centered care for patients, improving workforce planning, and improving patient and personnel care[14]. Previous studies have shown that this is likely caused by the length of the implementation process for RAFAELA, competitive implementations or organizational changes affecting nurses work[19], and support by organizational leaders[28]. The implementation duration and competitive implementations are therefore limitations of our study. Time to perform this pre-implementation study was indeed limited due to other simultaneous implementation processes, but this seems to be a continuous hazard. It is also likely that nurses with less sense of professionalism could not appreciate the benefits because of lacking skills, which would be a smaller problem in more professionally functioning environments[22]. Furthermore, our implementation strategy was predominantly focused on education and motivation of the professionals, in retrospect we should have focused more on the social context, e.g. team functioning[29].

CONCLUSION AND IMPLICATIONS FOR NURSING MANAGEMENT

The RAFAELA system has its merits as a tool to appreciate nursing care intensity and to plan workforce, as was experienced in Scandinavian countries, but creating readiness and the right conditions for its acceptance and implementation is not simple. For this purpose hospital managers should consider an extensive implementation process with emphasis on the individual (e.g. education and motivation strategies) and de social context (e.g. strategies to enhance team functioning, professional development and leadership)[29]. Furthermore, nursing managers should discuss how they can move from a basic functional model to a professional functional model for their nurses.

COMPETING INTEREST

The authors declare that they have no competing interests.

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APPENDIX QUESTIONNAIRE

		EVALUATION USER-FRIENDLINESS, APPLICABILITY AND ACCEPTABILITY OF RAFAELA	
			Answer options
Questions	1	In which hospital do you work?	A /B
	2	On which nursing ward do you work?	1 to7 (A)/ 1 to 5 (B)
	3	What is your role on the ward?	student/ junior nurse/ nurse/ senior nurse/ head nurse/ key-user
	4	What is your gender?	male/ female
	5	What is your age?	open
	6	What is your highest education?	LVN/ BSN/ Post Bachelor/ Master
	7	What is your work experience after graduation in years?	open
	8	On my ward a nursing care intensity measure was already used	yes/ no
Applicability	9	The 6 nursing care areas of the OPCq correspond with my clinical view of the patient	10-point Likert scale
	10	The OPCq score is a correct reflection of the nursing care intensity	10-point Likert scale
	11	The OPCq score is suitable to balance the nursing care intensity on the ward	10-point Likert scale
User-friendliness	12	The start screen for RAFAELA is easy accessible	10-point Likert scale
	13	The explanation in the RAFAELA-system provides enough information about the usage of the OPCq and PAONCIL	10-point Likert scale
	14	The language used in the explanation in the RAFAELA-system is clear	10-point Likert scale
	15	It takes little time to measure the nursing care intensity by RAFAELA	10-point Likert scale
Acceptability	16	RAFAELA is an improvement compared to the previous situation	10-point Likert scale
	17	I would like to continue working with RAFAELA	10-point Likert scale
	18	What are my perceived benefits of RAFAELA?	open
	19	What are my perceived disadvantages of RAFAELA?	open
	20	What profit is there to be gained with? RAFAELA (for myself, for the ward, for the hospital, for the nursing occupational group)?	open

LVN = Licensed Vocational Nurse; BSN = Bachelor of Science in Nurse; OPCq = Oulu Patient Classification qualisan; PAONCIL = Professional Assessment of the Optimal Nursing Care Intensity Level

□

DEVELOPING AND TESTING

A COMPUTERIZED DECISION SUPPORT SYSTEM TO IMPROVE EFFICIENCY AND NURSES' SATISFACTION OF DAILY NURSE-PATIENT ASSIGNMENT IN HOSPITALS: A multimethod study

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ABSTRACT

Nurse-to-patient assignment is a frequently recurring, time-consuming, and complex process owing to the many considerations involved. Creating well-balanced, high-quality assignments is crucial to ensuring patient safety, quality of care, and job satisfaction for nurses. A computerized decision support system can assist (charge) nurses in the nurse-to-patient assignment process. In this two-phase multimethod study, a computerized decision support system was developed and evaluated.

Three nursing wards in a 1000-bed Dutch university hospital participated. In the first phase of this study, considerations relevant to the assignment process—and their relative importance—were investigated in a literature review, focus group sessions with nurses, and a survey among nurses.

Using information from the first phase, the computerized decision support system was developed based on an integer linear program. In the second phase, a before-and-after study was conducted to test and evaluate the computerized decision support system both quantitatively (duration of the assignment process) and qualitatively (survey on workload). Thirty-six measurements were performed to test the computerized decision support system. After implementation, a 30% time reduction was achieved in the nurse-to-patient assignments, and nurses (N=138) experienced a lower workload. Therefore, the implementation of computerized decision support system would increase both the quality and safety of care as well as the nurses' job satisfaction and should be investigated rigorously in the coming years.

KEYWORDS: COMPUTERIZED DECISION SUPPORT SYSTEM; MULTIMETHOD RESEARCH; NURSE-TO-PATIENT ASSIGNMENT; NURSING WORKLOAD; QUALITY OF CARE

INTRODUCTION

Nurse-to-patient assignment is a process that recurs daily at the start of each shift on clinical nursing wards. Assignment involves distributing the nursing workforce over the patients requiring care during that shift. Creating well balanced, high-quality assignments is crucial because patient assignments and workload distribution influence both the quality and safety of patient care[1]. Moreover, perceptions of unfair patient assignments negatively affect nurses' job satisfaction and morale and can eventually lead to burnout[2]. The nurse-to-patient assignment process involves many considerations, such as patient acuity, the experience levels of staff, nurse expertise, location of the patient on the unit, continuity of care, and patient preference. Creating well-balanced, high-quality assignments that account for all of these considerations is difficult to do manually and can be very time-consuming. Charge nurses indicate that it is not uncommon to spend up to 30 minutes prior to the shift preparing the nurse-to-patient assignment[3].

Hospitals are increasingly expected to improve efficiency, and there is a widespread trend toward creating larger nursing wards and merging nursing teams, which results in more complex and time-consuming nurse-to-patient assignment problems. In this article, we present a computerized decision support system (CDSS) to assist charge nurses and nursing teams with their daily, recurring nurse-to-patient assignment process.

Models to support nurse-to-patient assignment decisions have previously been developed in the US[3–12]. Operations researchers in Texas[3–9] have applied integer programming[4,5], stochastic programming[6], heuristics[7], and Markov decision theory[7] to create nurse-to-patient assignments, and researchers have developed a simulation model[8,9] to evaluate such assignments. Although the literature indicates that nurses consider many different factors in deciding nurse-to-patient assignments[1,13], these models merely consider the objective of workload balancing. Other operations researchers[10,11] have developed assignment models for neonatal intensive care using integer programming[10] heuristics[10] and constraint programming[11]. Beyond the objective of workload balancing, these models include constraints concerning the location of the patients on the unit, and the maximum number of patients whom nurses with particular roles (i.e., "admit" nurses and "non admit" nurses) can be assigned to handle. Using a more practical approach, a unit manager at the University of Pittsburgh Medical Center[12] divided her unit into four "pods," with two nurses assigned to each pod throughout each shift. Within each pod, patients are equally divided between the nurses according to patients' acuity. Clearly, there is a gap between the nursing literature, which mentions many considerations relevant for nurse-to-patient assignments, and the

developed models, which include, at most, three considerations in a single model. Moreover, although operations researchers have extensively tested their models, none of them have evaluated the overall effect of their models in a clinical setting.

In this study, we first investigated considerations relevant to the nurse-to-patient assignment process and their relative importance. We then used our findings to develop a CDSS. Finally, we evaluated the effect of our CDSS in a pilot study on three nursing wards in the Academic Medical Center (AMC) Amsterdam, a 1000-bed Dutch university hospital.

METHODS AND RESULTS

Both qualitative and quantitative approaches were used to develop and test the CDSS. The study was composed of two phases. First, to develop the CDSS (phase 1), considerations relevant for the nurse-to-patient assignment process were identified through a literature search and focus group sessions. The relative importance of the various considerations was then investigated through a survey of nurses. Following the most important considerations, the CDSS was developed based on an integer linear program (ILP). Second, to test the CDSS (phase 2), a before-and-after study was conducted in which the following were evaluated: the duration of the assignment process, charge nurse satisfaction, and perceptions of individual nursing workloads. Below, each component of this multimethod study is described in more detail in line with the Standards for QUality Improvement Reporting Excellence (SQUIRE) reporting checklist[14] for quality improvement studies.

Setting and Participants

The neurology, neurosurgery, and gastrointestinal surgery nursing wards of the AMC contributed to this study. These wards have 26, 20, and 28 beds, respectively, and employ approximately 30 nurses each, at both the vocational and baccalaureate levels. Only the neurology and neurosurgery wards contributed to the development of the CDSS, although all three wards evaluated the system. In most literature reports, the charge nurse prepares the nurse-to-patient assignment before the shift, whereas in the AMC, the nurses make the assignment together at the start of the shift and the charge nurse then finalizes the decision. Student nurses are present on each ward. The neurology and gastrointestinal surgery wards both have a number of beds dedicated to educating students, where the student nurses independently provide care for the patients while being coached by qualified nurses. Because student nurses perform their own assignment process for the patients in those dedicated beds, only qualified nurses were included in the CDSS assignment process in phase 2. All measurements were conducted during day shifts, in which approximately five nurses have to be assigned to patients on each ward. The study took place from January to December 2012.

Phase 1: Development of the Computerized Decision Support System

Literature search

Methods. A literature search was performed to identify considerations that are relevant for the nurse-to-patient assignment process. The Cochrane database for systematic reviews, MEDLINE, and CINAHL were searched using the keywords nurse-patient assignment, patient-nurse assignment, and assigning patients to nurses.
Results. The search yielded 432 and 33 potentially relevant articles from MEDLINE and CINAHL, respectively. No relevant systematic reviews were found in the Cochrane database. After checking the abstracts, nine relevant articles remained[1,5,6,8,9,12,13,15,16]. By performing forward and backward searches on these articles, six other relevant articles were found[2-4,7,10,11]. All relevant articles had been published between 1973 and 2013. Bostrom and Suter provide a comprehensive list of the considerations relevant for the nurse-to-patient assignment process, which covers the considerations mentioned in other articles[13]. An overview of the considerations from their article can be found in the "Results" under the "Consideration Importance Survey" section.

Focus group sessions

Methods. We organized two focus group sessions to identify the considerations that the neurology and neurosurgery ward nurses deemed relevant for the nurse-to-patient assignment process. On each ward, one 45-minute session with a convenience sample of three registered nurses took place. First, the nurses were asked to write down all of their considerations on sticky notes and stick these notes to the wall for all to see. The researchers explicitly asked the nurses to also write down implicit or socially undesirable considerations. Second, the considerations reported in the literature[13] were shown, and the nurses were asked to write down additional considerations until they thought that their collective overview was complete. Finally, the nurses were asked to cluster the considerations and to name each cluster.
Results. The neurology focus group yielded 18 considerations spread over four clusters, while the neurosurgery focus group yielded 29 considerations spread over six clusters. Table 1 shows the focus group findings.
Considerations mentioned during the focus group sessions ranged from purely process considerations to emotional ones, for example, as stated by the charge nurse

"When there are many [patient] admissions"

and

"How busy someone is [sighs]… I mean, there are people who feel busy very quickly… one has to take this into account"

or

"Recently, a pregnant nurse cared for patients at the backside of the ward most of the times because of the lower patient acuity at that side. She cared for more patients than the other nurses, but she did not have to perform physically demanding tasks."

In addition, nurses were sometimes astonished by some of the considerations reported in the literature. For example, in reaction to the consideration "physician preference for particular nurse-patient assignment," a nurse responded with

"Not done!"

Two researchers matched the considerations from the focus groups with those reported in the literature[13]. Six considerations from the focus groups could not be matched with the literature. We formulated three new considerations to cover these: patient-nurse culture match, nurse mental health status, and student's year of education. The items in the cluster "course of the process" from the neurology focus group were not matched because these are process related bottlenecks rather than considerations.

Consideration importance survey

Methods. To investigate the relative importance of the various considerations, a list of considerations was distributed among all nurses, both registered and students, working on the neurology and neurosurgery wards. The list consisted of all considerations reported in the literature[13] together with the three additional considerations that had been formulated from the focus group findings. Nurses were asked to identify what they considered the 10 most relevant considerations, giving 10 points to the most important one, 9 points to the second-most important one, and so on. *Results.* The consideration importance survey was given to 68 nurses (54 registered and 14 students) to complete. The response rate was 50%; 75% of the respondents were registered nurses and 25% were students. Table 2 shows the results of the survey. The considerations ranked as most important were "Patient acuity information from previous shift," "Patient (or family) preference," and "Nurse experience with this patient." Nurse employment status, nurse educational level (e.g., year of student nurse internship), and nurse licensure (e.g., registered nurse or licensed vocational nurse) were deemed the least important, and "Physician preference for particular nurse-patient assignment" was never ranked.

Table 1 Focus group findings and their literature correlates ►

NEUROLOGY		
Clusters	Considerations	Match (L = literature[13], R = researchers)
Nurse condition	· Emotional commitment	Nurse mental health status (R)
	· Inadequate patient acuity	Patient acuity information from previous shift (L)
	· Overload	Nurse health status (disabilities, etc.) (L)
	· Physical	Nurse health status (disabilities, etc.) (L)
Course of the process	· Some colleagues claim more say	Not matched
	· Long discussions	Not matched
	· Flexibility	Not matched
	· Slack	Not matched
	· Differences	Not matched
	· Effort	Not matched
	· Honesty	Not matched
Variety in work	· Student load	Student nurse assignment (L)
	· Culture	Patient/nurse culture match (R)
	· Same patients (or not)	Nurse experience with this patient (L)
	· Variety	Nurse experience with this patient (L)
	· Continuity	Nurse experience with this patient (L)
Practical	· Time investment	Patient acuity information from previous shift (L)
	· Patients close to each other	Location of patient on the unit (L)
NEUROSURGERY		
Clusters	Considerations	Match (L = literature[13], R = researchers)
Students	· Student-coach combination	Student nurse assignment (L)
	· Student assignment	Student nurse assignment (L)
	· Student's year of education	Student's year of education (R)
	· Who wants to coach a student	Student nurse assignment (L)
	· What tasks can a student perform	Student nurse assignment (L)
	· How many students does somebody have	Student nurse assignment (L)
Personal circum-stances	· (Mental) overload employee	Nurse mental health status (R)
	· Private circumstance employee	Nurse mental health status (R)
	· Pregnancy	Nurse health status (disabilities, etc.) (L)
	· Medical problems employee	Nurse health status (disabilities, etc.) (L)
	· How busy someone is	Nurse mental health status (R)

Table 1 Continued

NEUROSURGERY		
Clusters	Considerations	Match (L = literature[13], R = researchers)
Logistics	· Admissions	Amount of time patient is expected to be away from unit (L)
	· Location of the patient	Location of patient on the unit (L)
	· Surgery/diagnostic tests	Amount of time patient is expected to be away from unit (L)
	· Discharge	Amount of time patient is expected to be away from unit (L)
	· Isolation	Location of patient on the unit (L)
	· Who does the Brain Care Unit	Nurse experience/expertise with this type of patient (L)
Experience	· Experience of the employee	Years of nursing experience (L)
	· Experience vs. complexity of care	Years of nursing experience (L)
	· Orientation needs of new employees	Orientation needs of new nurses (L)
	· Persons that work	Nurse level (SNI, etc.) (L)
Workload	· Availability of auxiliary nurse	Availability of nonnursing support staff (L)
	· Patient acuity	Patient acuity information from previous shift (L)
	· Flex worker or regular	Nurse employment status (regular vs. per diem) (L)
	· Workload	Patient acuity information from previous shift (L)
	· Necessary time for projects or other activities	Other duties of nurses (administrative, orientation) (L)
Continuity of care	· First Responsible Nurse	Nurse experience with this patient (L)
	· Did employee work the previous day	Nurse experience with this patient (L)
	· Communication skills (family/transfer problems)	Nurse level (SNI, etc.) (L)

Table 2 Results from the consideration importance survey

RANK	CONSIDERATIONS	REF	1	2	3	4
1	Patient acuity information from previous shift	1	16	34	8.35	8.35
2	Patient (or family) preference	8	7	26	7.23	5.53
3	Nurse experience with this patient	4	3	27	6.22	4.94
4	Student nurse assignment	NR	1	28	5.93	4.88
5	Patient/nurse language match	9	4	27	5.85	4.65
6*	Student's year of education	NR	0	25	4.80	3.53
7	Years of nursing experience	14	1	24	4.92	3.47
8	Nurse health status (e.g., disabilities)	NR	1	25	4.68	3.44
9	Location of patient on the unit	10	0	18	5.56	2.94
10*	Nurse mental health status	NR	0	19	5.21	2.91
11	Nurse experience/expertise with this type of patient	2	0	15	5.27	2.32
12	Amount of time patient is expected to be away from unit	15	0	11	4.55	1.47
13	Availability of non-nursing support staff	NR	0	11	3.73	1.21
14	Nurse preference	5	0	10	3.80	1.12
15	Clinical judgment of patient nursing needs	3	0	9	4.11	1.09
16	Orientation needs of new nurses	6	0	9	4.00	1.06
17	Other duties of nurses (administrative, orientation)	11	0	8	3.00	0.71
18*	Patient/nurse culture match	NR	1	7	3.43	0.71
19	Nurse employment status (regular vs. per diem)	NR	0	4	2.25	0.26
20	Nurse level (e.g., SNI)	13	0	2	4.50	0.26
21	Nurse licensure (e.g., RN, LVN)	12	0	1	5.00	0.15
22	Physician preference for particular nurse-patient assignment	NR	0	0	0.00	0.00

Consideration formulated by the researchers based on focus group findings.
RN = Registered Nurse; LVN = Licensed Vocational Nurse; SNI = Student Nurse Intern; NR = not ranked
REF = ranking in literature[13]; 1 = number of times ranked as most important; 2 = number of times ranked; 3 = average ranking over surveys in which the considerations was ranked; 4 = average ranking over all surveys

Model development

Methods. In consultation with the nursing manager of the neurology and neurosurgery wards, the considerations that were ranked highest in the consideration importance survey were selected for inclusion in the CDSS. For the development of the CDSS, the nurse-to-patient assignment problem was formulated as an ILP. An ILP is suitable for modeling multiple considerations and specifying their relative importance, while the intuitiveness of the model promotes the acceptability of the CDSS. The average ranking scores from the consideration importance survey (rightmost column in Table 2) were used to specify the weights of the various considerations in the ILP.

Results. The ILP consists of decision variables, constraints, and an objective function. For a detailed mathematical formulation of the model, see 'Mathematical formulation of the ILP' at the end of the article. The decision variables were defined as x_np and take the value of 1 if nurse n is assigned to patient p and 0 otherwise. The following considerations were included in the ILP and translated to constraints, as described below (where the numbering of the constraints corresponds to the numbering in 'Mathematical formulation of the ILP'):

'Patient acuity information from previous shift' & 'Clinical judgment of patient nursing needs': The total amount of care (defined as the sum of the patient acuity scores) is distributed evenly among nurses.
High-acuity patients (i.e., patients with the highest acuity score) are distributed evenly among nurses.
These constraints both promote an even distribution of the workload among nurses.

'Patient (or family) preference' & 'Nurse experience with this patient': Certain patients may have a 'first responsible nurse'. This is either the nurse who admitted the patient or a nurse for whom the patient or family has a special preference. We aimed for the assignment of first responsible nurses to patients.
We aimed to replicate the nurse-to-patient assignment from the previous day.
These constraints both promote continuity of care.

'Student-nurse assignment' & 'Student's year of education': At most, Q=3 patients may be assigned to a student nurse.
A nurse who coaches student nurses is responsible for both the patients to whom he or she is assigned and the patients looked after by those students. A coaching nurse may be ultimately responsible for at most R=6 patients.
'Location of patient on the unit':
The walking distance (defined as the sum of the distances between all patients' beds) is spread evenly among nurses.

A solution to the ILP consists of an assignment of the values 0 and 1 to the decision variables ^{x}np, such that exactly one nurse is assigned to each patient, the assignment complies with the hard Constraints (5) and (6), and the assignment complies with the other (soft) constraints as much as possible. The objective function of the ILP specifies the desired compliance of the solution to the soft constraints. It is defined as

$$\min \beta y+\delta w-\theta e-\mu b+\varphi a,$$

where
y represents the maximum total acuity score assigned to a nurse (Constraint 1),
w represents the maximum number of high-acuity patients assigned to a nurse (Constraint 2),
e represents the number of patients assigned to their first responsible nurse (Constraint 3),
b represents the number of patients with the same nurse as the day before assigned to them (Constraint 4), and
a represents the maximum walking distance assigned to a nurse (Constraint 7).
The parameters β,δ,θ,μ, and φ are the weight factors that specify the relative importance of the various components of the objective function. Based on a normalization procedure and the results from the consideration importance survey, the following weight factor values were used: β=5.500; δ=44.000; θ=14.190; μ=9.130; and φ=0.425.
The ILP was implemented in ILOG OPL 6.3 (IBM, Armonk, NY, USA) and solved using CPLEX 12.1. A detailed mathematical formulation of the model can be found in the appendix 'Mathematical formulation of the ILP' at the end of the article.

Phase 2: Evaluation of the Computerized Decision Support System

Before-and-After study

Methods. To measure the effect of the CDSS that we had developed, a before-and-after study was applied in which the duration of the assignment process, charge nurse satisfaction, and perceptions of individual nursing workloads were measured. The quality criteria formulated by Ramsay et al.[17] were used as a guide to set up the study. We interviewed the staff in the nursing departments to ensure that no other interventions were planned during the research period.
The researchers observed 12 nurse-to-patient assignment processes at the start of the day shifts on each of the three wards (neurology, neurosurgery, and gastrointestinal surgery) namely six assignments before and six assignments after the intervention. In the post intervention phase, the CDSS was used to generate a nurse-to-patient assignment that was discussed and, if necessary, amended by the

nurses until they were satisfied with the assignment. During the observations, one of the researchers inconspicuously measured the duration of the assignment process, which was the primary endpoint of this study. The researchers also observed the process and took field notes. Directly after each assignment, the charge nurse was asked to rate his/her satisfaction with the assignment process on a visual analog scale. At the end of the shift, all registered nurses were asked to complete a workload satisfaction survey. This survey also contained questions that had been designed to collect information about tasks or patients transferred to colleagues during the shift. There were no differences in the data collection during the pre-intervention phase compared with the post-intervention phase.

Analysis. Data were imported into the SPSS v 20 (IBM, Armonk, NY).Categorical data (i.e., satisfaction on workload) were presented as proportions, and continuous variables (i.e., duration of the assignment process and charge nurse satisfaction) were summarized as means with standard deviations. The analysis of the duration of the nurse-to-patient assignment process and charge nurse satisfaction was performed by multivariable analysis of covariance (MANCOVA) using Pillai's trace. During the analysis, we corrected for bed occupancy to ensure that the measured effect was a result of the CDSS. In addition, a separate analysis of variance (ANOVA) was performed to compare the bed occupancy both pre- and post-intervention and between the nursing units. Descriptive statistics were used for the results from the workload satisfaction survey. The numbers of patients transferred to other nurses during the shifts were analyzed using a Fisher exact test for proportions. We interpreted P ≤.05 as statistically significant; alternatively, we calculated a 95% confidence interval.

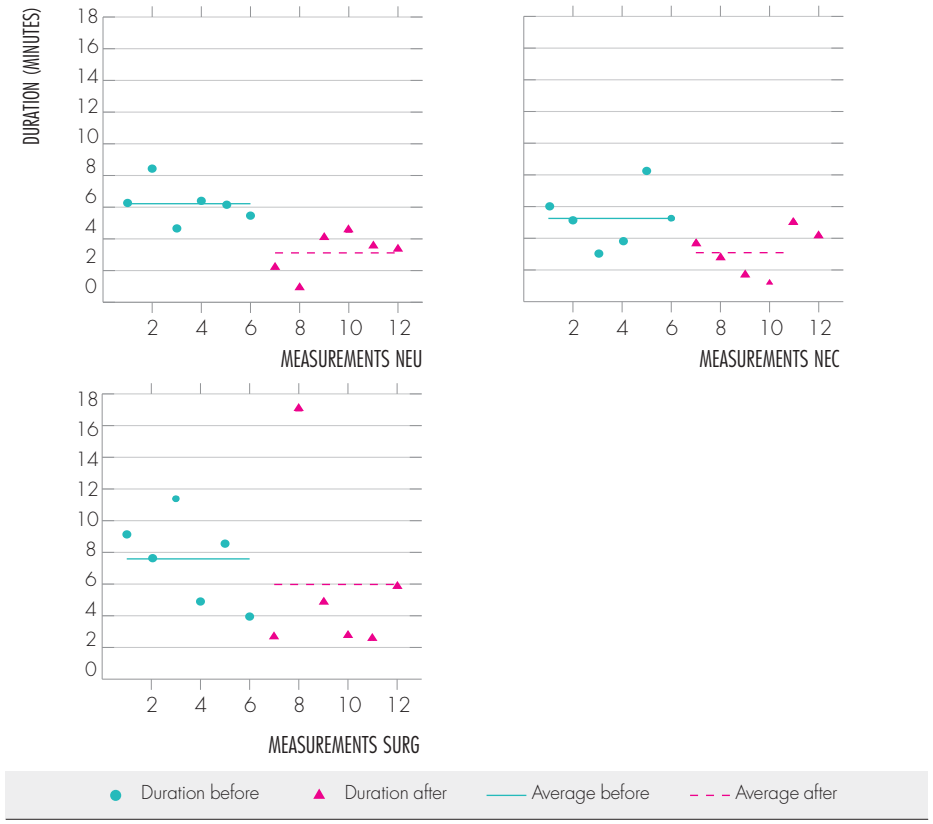
Results. In total, 36 measurements were performed (18 pre and 18 post intervention). There was no significant effect of phases (V=0.160, $F_{2,28}$=2.70; p=0.085), units (V=0.150; $F_{4,58}$=1.17; p=0.335), or bed occupancy (V=0.003; $F_{2,28}$=0.04; p=0.957) on the duration of the assignment process and charge nurse satisfaction. However, separate univariable ANCOVAs on the outcome variables revealed significant effects of phase on the duration of the assignment process ($F_{5,30}$=5.54; p=0.026). The total mean (SD) duration of the nurse-to-patient assignment process was reduced from 6 (2) to 4 (3.5) minutes (see Figure 1).

No difference was found for the mean [SD] charge nurse satisfaction pre (5.9 [2.4]) or post (5.7 [2.1]) intervention ($F_{5,30}$=0.06; p=0.803). No differences in the duration ($F_{5,30}$=2.40; p=0.109) or charge nurse satisfaction ($F_{5,30}$=0.10; p=0.904) were found between the nursing wards. No significant effect was found for bed occupancy on the duration of the assignment process ($F_{5,30}$=0.90; p=0.766) or on charge nurse satisfaction ($F_{5,30}$<0.001; p=0.983). Performing a separate ANOVA showed that the bed occupancy differed significantly from pre to post intervention ($F_{5,30}$=4.40; p<0.001) and between the units ($F_{5,30}$=12.63; p=0.044).

A total of 138 respondents completed the workload satisfaction survey. Table 3 shows the results.

The answers to questions 1 to 7 and 9 indicate that the nurses experienced a lower workload after the intervention. However, the nurses' satisfaction with the group of patients assigned to each nurse also decreased (question 8). No differences were found between pre and post intervention in the numbers of patients transferred to colleagues during the shift when applying a Fisher exact test (question 10).

Figure 1 Duration of the nurse-to-patient assignment process pre and post intervention



NEU = Neurology; NEC = Neurosurgery; SURG = Gastro-Intestinal surgery

Table 3 Results from the workload satisfaction survey *Page 176-177* ►

NEU = Neurology; NEC = Neurosurgery; SURG = Gastro-Intestinal surgery

QUESTIONS	ANSWER POSSIBILITIES	TOTAL NUMBER (%)		NEU NUMBER (%)		NEC NUMBER (%)		SURG NUMBER (%)	
Phase		pre	post	pre	post	pre	post	pre	post
1. How high was the work rate that was expected of you?	· Quite high	8 (11.8)	3 (4.3)	0 (0.0)	1 (4.8)	1 (4.2)	2 (10.5)	7 (30.4)	0 (0.0)
	· Relatively high	28 (41.2)	16 (22.9)	8 (38.1)	4 (19.0)	9 (37.5)	4 (21.1)	11 (47.8)	8 (26.7)
	· Neutral	27 (39.7)	35 (50.0)	12 (57.1)	13 (61.9)	11 (45.8)	9 (47.4)	4 (17.4)	13 (43.3)
	· Relatively low	5 (7.4)	15 (21.4)	1 (4.8)	3 (14.3)	3 (12.5)	3 (15.8)	1 (4.3)	9 (30.0)
	· Quite low	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.3)	0 (0.0)	0 (0.0)
2. What do you think of this rate?	· Too high	25 (36.8)	8 (11.4)	8 (38.1)	2 (9.5)	1 (4.2)	3 (15.8)	16 (69.6)	3 (10.0)
	· High	8 (11.8)	0 (0.0)	0 (0.0)	0 (0.0)	8 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)
	· Neutral	27 (39.7)	45 (64.3)	10 (47.6)	16 (76.2)	11 (45.8)	10 (52.6)	6 (26.1)	19 (63.3)
	· Low	3 (4.4)	3 (4.3)	3 (14.3)	3 (14.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	· Too low	5 (7.3)	14 (20.0)	0 (0.0)	0 (0.0)	4 (16.7)	6 (31.6)	1 (4.3)	8 (26.7)
3. Were there times when you had to work extra hard?	· Quite often	2 (2.9)	3 (4.3)	1 (4.8)	0 (0.0)	1 (4.2)	3 (15.8)	0 (0.0)	0 (0.0)
	· Often	22 (32.4)	13 (18.6)	5 (23.8)	2 (9.5)	6 (25.0)	2 (10.5)	11 (47.8)	9 (30.0)
	· Sometimes	25 (36.8)	19 (27.1)	5 (23.8)	5 (23.8)	10 (41.7)	4 (21.1)	10 (43.5)	10 (33.3)
	· Now and then	5 (7.4)	18 (25.7)	2 (9.5)	9 (42.9)	2 (8.3)	3 (15.8)	1 (4.3)	6 (20.0)
	· Rarely	13 (19.1)	17 (24.3)	7 (33.3)	5 (23.8)	5 (20.8)	7 (36.8)	1 (4.3)	5 (16.7)
	· Missing	1 (1.5)	0 (0.0)	1 (4.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
4. Were there times when you could take it easy during your work?	· Quite often	1 (1.5)	5 (7.1)	0 (0.0)	1 (4.8)	1 (4.2)	2 (10.5)	0 (0.0)	2 (6.7)
	· Often	10 (14.7)	18 (25.7)	2 (9.5)	3 (14.3)	6 (25.0)	6 (31.6)	2 (8.7)	9 (30.0)
	· Sometimes	25 (36.8)	20 (28.6)	12 (57.1)	7 (33.3)	5 (20.8)	4 (21.1)	8 (34.8)	9 (30.0)
	· Now and then	12 (17.6)	15 (24.1)	1 (4.8)	4 (19.0)	4 (16.7)	2 (10.5)	7 (30.4)	9 (30.0)
	· Rarely	13 (19.1)	8 (11.4)	4 (19.0)	4 (19.0)	5 (20.8)	3 (15.8)	4 (17.4)	1 (3.3)
	· Missing	7 (10.3)	4 (5.7)	2 (9.5)	2 (9.5)	3 (12.5)	2 (10.5)	2 (8.7)	0 (0.0)
5. What do you think about your total amount of work?	· Huge	1 (1.5)	2 (2.9)	1 (4.8)	0 (0.0)	0 (0.0)	2 (10.5)	0 (0.0)	0 (0.0)
	· Large	27 (39.7)	8 (11.4)	6 (28.6)	2 (9.5)	7 (29.2)	3 (15.8)	14 (60.9)	3 (10.0)
	· Nearly good	36 (52.9)	40 (57.1)	12 (57.1)	13 (61.9)	16 (66.7)	8 (42.1)	8 (34.8)	19 (63.3)
	· Small	3 (4.4)	16 (22.9)	2 (9.5)	5 (23.8)	1 (4.2)	6 (31.6)	0 (0.0)	5 (16.7)
	· Very small	0 (0.0)	3 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (10.0)
	· Missing	1 (1.5)	1 (1.4)	0 (0.0)	1 (4.8)	0 (0.0)	0 (0.0)	1 (4.3)	0 (0.0)
6. Could you get away from your work easily when it was necessary today?	· Always	1 (1.5)	4 (5.7)	0 (0.0)	0 (0.0)	1 (4.2)	2 (10.5)	0 (0.0)	2 (6.7)
	· Mostly	30 (44.1)	42 (60.0)	11 (52.4)	17 (81.0)	9 (37.5)	10 (52.6)	10 (43.5)	15 (50.0)
	· Often not	31 (45.6)	20 (28.6)	10 (47.6)	3 (14.3)	8 (33.3)	5 (26.3)	13 (56.5)	12 (40.0)
	· Never	6 (8.8)	4 (5.7)	0 (0.0)	1 (4.8)	6 (25.0)	2 (10.5)	0 (0.0)	1 (3.3)
7. Could you get away from your work today to get, for example, a cup of coffee?	· Always	2 (2.9)	9 (12.9)	1 (4.8)	0 (0.0)	0 (0.0)	4 (21.1)	1 (4.3)	5 (16.7)
	· Mostly	33 (48.5)	38 (54.3)	11 (52.4)	16 (76.2)	13 (54.2)	8 (42.1)	9 (39.1)	14 (46.7)
	· Often not	26 (38.2)	14 (20.0)	5 (23.8)	1 (4.8)	10 (41.7)	4 (21.1)	11 (47.8)	9 (30.0)
	· Never	5 (7.4)	4 (5.7)	3 (14.3)	1 (4.8)	0 (0.0)	2 (10.5)	2 (8.7)	1 (3.3)
	· Missing	2 (2.9)	5 (7.1)	1 (4.8)	3 (14.3)	1 (4.2)	1 (5.3)	0 (0.0)	1 (3.3)
8. How satisfied were you about the group of patients to whom you were assigned today?	· Very satisfied	3 (4.4)	7 (10.0)	1 (4.8)	0 (0.0)	1 (4.2)	4 (21.1)	1 (4.3)	3 (10.0)
	· Satisfied	50 (73.5)	34 (48.6)	16 (76.2)	13 (61.9)	19 (79.2)	5 (26.3)	15 (65.2)	16 (53.3)
	· Neutral	9 (13.2)	14 (20.0)	3 (14.3)	5 (23.8)	1 (4.2)	4 (21.1)	5 (21.7)	5 (16.7)
	· Dissatisfied	4 (5.9)	8 (11.4)	0 (0.0)	1 (4.8)	2 (8.3)	2 (10.5)	2 (8.7)	5 (16.7)
	· Very dissatisfied	1 (1.5)	2 (2.9)	0 (0.0)	0 (0.0)	1 (4.2)	2 (10.5)	0 (0.0)	0 (0.0)
	· Missing	1 (1.5)	5 (7.1)	1 (4.8)	2 (9.5)	0 (0.0)	2 (10.5)	0 (0.0)	1 (3.3)
9. How many tasks did you transfer to a colleague today because you did not have enough time to perform them yourself?	· Very little	21 (30.9)	38 (54.3)	8 (38.1)	14 (66.7)	7 (29.2)	13 (68.4)	6 (26.1)	11 (36.7)
	· Little	21 (30.9)	16 (22.9)	6 (28.6)	3 (14.3)	9 (37.5)	4 (21.1)	6 (26.1)	9 (30.0)
	· Some	22 (32.4)	12 (17.1)	7 (33.3)	2 (9.5)	7 (29.2)	2 (10.5)	8 (34.8)	8 (26.7)
	· Many	4 (5.9)	2 (2.9)	0 (0.0)	1 (4.8)	1 (4.2)	0 (0.0)	3 (13)	1 (3.3)
	· Very much	0 (0.0)	1 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.3)
	· Missing	0 (0.0)	1 (1.4)	0 (0.0)	1 (4.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
10. Did you transfer an assigned patient to a colleague during the shift?	Yes	10	8	3	3	2	2	5	3
	No	51	54	15	16	21	13	15	25

DISCUSSION

This is the first study on nurse-to-patient assignment supporting tools to be conducted outside the US. A CDSS to assist nurse-to-patient assignments at the start of each working shift was successfully developed and evaluated at three different nursing wards of a university hospital. The CDSS was found to decrease the time required for the assignment process and to reduce the perceived nursing workload.

Considerations relevant for the assignment process identified in the first phase of this study are somewhat aligned with those found in previous studies[1,3,4,6–8,11,16] but there are significant differences in the type of considerations and in their perceived relative importance.
First, some considerations reported in the literature are not relevant to the nurses in our Dutch hospital. An example is physician influence on the nurse-to-patient assignment, a consideration that astonished the Dutch nurses. Second, we formulated three extra considerations (e.g., ''nurse mental health status'') that significantly influenced the nurse-to-patient assignment process in our study. We found that nurses are significantly influenced by each other's emotional commitment, private circumstances, and mental load, all of which were incorporated into this study. Third, the relative importances of the considerations we found are considerably different from those in the study by Bostrom and Suter[13]. Although ''patient acuity'' is the most important consideration in both the study of Bostrom and Suter and ours, the subsequent order differs. Clinical and nurse related concerns dominated the top five of Bostrom and Suter; in this study, the top five consisted of primarily patient-related considerations, which suggests that there are significant differences in the considerations for nurse-to-patient assignment between the US and Europe. However, further research, spanning a larger number of hospitals, would be required to conclude whether these differences are country specific, hospital specific, or both.
An ILP model was developed as the basis for the CDSS. Such a model is generically applicable to hospitals with considerations different from those at the AMC because the applicability and priority of each consideration can easily be adjusted by changing the weight factor values in the objective function. When using a CDSS, work processes are most efficient when the CDSS can be automatically filled with data that are readily available so that nurses do not waste time on specifying the input for the CDSS. Therefore, the investigators chose to incorporate only considerations for which the required data are already available in hospital information systems. These are also the considerations ranked as most important. However, social considerations, which also appeared to play a significant role in the nurse-to-patient assignment process, were not incorporated into the ILP model for the same reason. The investigators are convinced that a CDSS can never completely replace human insight. The nurse-to-patient assignment generated by the ILP model is a proposal that has to be assessed and, if necessary, adjusted by one or more nurses to obtain the final nurse-to-patient assignment. The social considerations should be incorporated into this process.
In the second phase of this study, the before-and-after measurements on the effect of the CDSS showed that the CDSS decreases the amount of time spent on the nurse-to-patient assignment process. Because the assignment involves all nurses who work on a shift, such a decrease results in considerable annual time savings for the hospital as a whole because a hospital has multiple wards and several shifts each day. In hospitals in which charge nurses prepare the nurse-to-patient assignment prior to a shift, which is perceived to be one of the most challenging aspects of their role[1], the CDSS can assist with this task. The post-intervention measurements contained one extreme outlier (measurement 8 on the gastrointestinal surgery ward; see Figure 1). From the field notes, the investigators deduced that this outlier was due to a malfunctioning computer. If this had not happened, the effect of the decrease in time would have been even larger.

One limitation of this study is the small number of measurements on each of the wards. Furthermore, the time spent on the nurse-to-patient assignment process differs considerably day-to-day, resulting only in broad confidence intervals and substantial standard deviations. Greater insight into the effects of applying the CDSS would be obtained by taking additional measurements, for example, by applying a time series design. Another methodological issue is the lack of a control group in this study. Both of these study designs are recommended for testing in quality improvement[18] and would enable a more rigorous evaluation of the CDSS.
The time that the nurses would save from a more efficient nurse-to-patient assignment process can be spent on direct patient care, thus improving the quality of care. The CDSS induces further time savings by minimizing the walking distance per nurse. It also promotes a balancing of the workload among nurses, which can have a positive effect on quality of care[15]. Perceptions of unfair patient assignments negatively affect nurses' job satisfaction and morale and can eventually lead to burnout[1]. Thus, in addition to improving the quality of care, the CDSS can also improve job satisfaction, thereby making a hospital a better employer, which is especially important in the face of nurse shortages.

We conclude from the workload satisfaction survey that nurses experienced lower workloads using the CDSS. This may be a consequence of an improved workload balance brought about by the CDSS, but it could also be caused by the lower bed occupancy in the post-intervention phase. Nurses were less satisfied about the patients assigned to them after the intervention. This might be because nurses feel

that they lose part of their authority when they do not "choose" their own patients. In hospitals where the charge nurse is already deciding the nurse-to-patient assignment, this will not be an issue, but when implementing the CDSS in a hospital where nurses decide the assignment jointly, this issue needs to be addressed. Furthermore, we suggest making some changes to the ILP model before implementing the CDSS. First, a constraint should be included that assigns nurses to expected admissions and distributes these admissions evenly among nurses. Second, the mental health, physical health, and other duties of nurses could be incorporated into the CDSS by adding the percentage availability per nurse. The availability percentage would have a default value of 100% but could be decreased for a particular nurse whenever necessary. Other prerequisites for implementing the CDSS are that all patients and their acuity are correctly registered in the hospital information system at all times and that the CDSS is linked to the hospital information system such that it can automatically obtain the data it needs.

CONCLUSION

A CDSS was developed that generates a suggested nurse-to-patient assignment before the start of a shift. The suggested assignment serves as input for a charge nurse or a group of nurses when making the definitive assignment. The CDSS ultimately led to improved quality of care by facilitating time savings for nurses and balancing their workload distribution. It also increased the job satisfaction of nurses because it promoted fairer nurse-to-patient assignments. While the CDSS is already beneficial in the current situation, its potential will grow along with the construction of larger nursing wards. Therefore, it is worthwhile to improve the CDSS and investigate it in a more rigorous study design.

COMPETING INTEREST

The authors declare that they have no competing interests.

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APPENDIX
MATHEMATICAL FORMULATION OF THE ILP

For an introduction to linear programming, the reader is referred to Ozcan[19]. Table below shows the notation used in the ILP. The numbering of the constraints corresponds to the numbering in the main text; thus, an explanation of the constraints can be found in the main text. Constraint (8) represents the requirement that exactly one nurse should be assigned to each patient.

MIN	$\beta y + \delta w - \theta e - \mu b + \varphi a$		
Subject to	$\sum_{p} A_p x_{np} \leq y,$	$\forall n,$	(1)
	$\sum_{p \mid A_p = M} x_{np} \leq w,$	$\forall n,$	(2)
	$\sum_{n,p} F_{np} x_{np} \geq e,$		(3)
	$\sum_{n,p} H_{np} x_{np} \geq b,$		(4)
	$\sum_{p} x_{np} \leq Q,$	$\forall n \in N_s,$	(5)
	$\sum_{p} x_{np} + \sum_{\hat{n} \in N_s, p} C_{n\hat{n}} x_{\hat{n}p} \leq R,$	$\forall n \in N_c,$	(6)
	$x_{np} + x_{n\hat{p}} \leq 1 + r_{np\hat{p}},$	$\forall n, p, \hat{p} \neq p,$	(7a)
	$\sum_{p, \hat{p} \neq p} D_{p\hat{p}} r_{np\hat{p}} \leq a,$	$\forall n,$	(7b)
	$\sum_{n} x_{np} = 1,$	$\forall p.$	(8)

INDICES		SETS	
$n, \hat{n}$	nurses	N_s	student nurses
$p, \hat{p}$	patients	N_c	coaching nurses

BINARY PARAMETERS		BINARY VARIABLES	
F_{np}	1 if nurse n is the first responsible nurse for patient p	x_{np}	1 if nurse n is assigned to patient p
H_{np}	1 if nurse n was assigned to patient p the day before	$r_{np\hat{p}}$	1 if nurse n is assigned to both patients p and $\hat{p}$
$C_{n\hat{n}}$	1 if nurse $n \in N_c$ coaches student nurse $\hat{n} \in N_s$		

GENERAL INTEGER PARAMETERS		GENERAL INTEGER VARIABLES	
A_p	acuity score of patient p	y	maximum total acuity score assigned to a nurse
M	maximum acuity score	w	maximum number of high acuity patients assigned to a nurse
Q	maximum number of patients to whom a student nurse may be assigned	e	number of patients to whom their first responsible nurse is assigned
R	maximum number of patients for whom a coaching nurse may be responsible	b	number of patients to whom the same nurse is assigned as the day before
$D_{p\hat{p}}$	walking distance between the beds of patients p and $\hat{p}$	a	maximum walking distance assigned to a nurse

□

9

SUMMARY AND FUTURE CHALLENGES

SAMENVATTING EN
TOEKOMSTIGE UITDAGINGEN

SUMMARY AND FUTURE CHALLENGES

Hospital directors, managers and health care professionals are expected to manage their hospitals and departments as efficiently as possible and deliver excellent patient care. To do so, they must be provided with valid parameters. These parameters should provide information about the patients, workforce planning and outcomes, i.e. the patient, personnel- and organizational outcomes.

The studies in this thesis were conducted to provide these parameters for hospital managers and healthcare professionals, in order to organize patient care more efficiently and taking into account quality and safety. The outline and aims of this thesis are described in chapter 1.

Part I Demand for care

Chapter 2 presents the results of a systematic literature review of patient characteristics, models or combinations of patient characteristics associated with the use of medical or nursing staff, and diagnostic and therapeutic interventions in a clinical hospital setting. A total of 17 studies with a reasonable to good methodological quality were included. In most studies significant associations were found between the deployment of personnel or the use of interventions and characteristics such as age, gender, medical diagnosis, nursing diagnosis, severity of illness, patient acuity or nursing care intensity, co-morbidity and complications during hospitalization. The models found predicted or explained mainly the use of nursing resources but were not suitable to predict or explain the use of medical, nursing and therapeutic and diagnostic resources, i.e. the total demand for care. Predicting or explaining the overall demand for care helps hospital managers and healthcare professionals (re)organize patient care. This set of patient characteristics will help substantiate the hospitals' top-referral or top-clinical character, can be used for budget and capacity or capability planning, and evaluate the hospital care services. The fact that we did not find a suitable model for predicting or explaining the demand for care led to the development of our own model.

Chapter 3 describes the development of an explanatory model for the demand for care of surgical patients. We included 174 representative patients from six different wards at the surgical department of the Academic Medical Center in Amsterdam (AMC) for time and motion research. Surgeons and surgical nurses used Personal Digital Assistants (PDAs) to record the direct and indirect time spent during hospitalization on the enrolled patients. Time spent was converted into costs, and costs for diagnostic and therapeutic interventions were added to arrive at the total costs of the demand for care. The best model of patient characteristics to predict the total costs contained the number of medications during hospitalization, num-

ber of co-morbidities, number of complications, age and surgical specialty. This model explained 56% of the cost variation as to the demand for care. Total costs increased with 18% per additional complication (95% confidence interval [CI] 1 to 38%), while an additional medication caused a 3% increase in costs (95% CI 1 to 5%). Per increasing year in age the costs increased with 0.5%, but this was not statistically significant (95% CI 0 to 1%). In contrast, an additional co-morbid condition lowered the costs with 9% (95% CI -16 to -3%). Patients with severe co-morbidities may be less likely to undergo surgery and the need for care is therefore less costly. The advantage of this new model is that the input for this instrument can be derived from data readily available in hospital databases and does not require additional registration. A logical next step was the validation of this model in a broader clinical patient population.

This validation is described in **chapter 4.** We used the same method as described in chapter 3 to record the patients' demand for care and to test the patient characteristics of fifty patients from three major specialties in the AMC; Surgery, Pediatrics, and Obstetrics and Gynecology. Polypharmacy, complication severity level, and whether a surgical intervention was performed best explained the demand for care. This model explained 55% of the cost variation in the demand for care, a value similar to the previous surgical model. Undergoing surgery led to a cost increase of 215% (95% CI 65% to 348%). A complication, such as a wound infection for which no antibiotics were needed, led to a cost increase of 78% (95% CI 19% to 532%), and an increase of 87% (95% CI 61% to 2494%) if patients had a more serious complication, for example a wound infection requiring antibiotics. Polypharmacy was responsible for a 72% (95% CI 0.6% to 150%) increase in costs. Notably, all of these characteristics are measured during hospitalization. This implies that the demand for hospital care can be assessed during and after the patient's hospitalization rather than predicted before submission. Therefore, we concluded that the model is useful as a managerial tool to retrospectively assess the (trends in the) demand for care. However, predicting the demand for care before admission of the patient remains difficult.

Part II Patient Care Intensity

Care intensity is a concept that is used for decades by nurses to express patient-related workload (which is the result of the demand for care). In hospitals, this care intensity is measured by means of a variety of (mostly unreliable or invalid) instruments to organize personnel planning, admission planning or nurse-to-patient assignments. Physicians, however, have difficulty in understanding care intensity in this context, which is intensified by the variety of instruments used. This causes misunderstandings, particularly on surgical wards due to emergency admissions and ad hoc decisions that are to be made to admit patients to the wards.

Chapter 5 presents a conjoint analysis. Surgeons and nurses from surgical wards were presented 20 scenarios of hospitalized patients (i.e., patient-cases described by 13 varying factors affecting the condition of the patient, physical symptoms and admission and discharge situation) to detect the relative contribution of various patient and care characteristics to the perceived patients' care intensity and possible perception differences between physicians and nurses. These factors were chosen based on the studies in the previous chapters, and a Delphi study among surgeons and nurses from our hospital. A total of 82 surgeons and 146 nurses from the Netherlands scored the scenarios. According to both surgeons and nurses, the following factors were found to influence care intensity: age, polypharmacy, medical diagnosis, complication level, Intensive Care Unit stay (ICU stay) and ASA-classification (American Society of Anesthesiologists classification). In addition, nurses also considered body mass index (BMI), nutrition status, admission type, patients' physical dependency, anxiety or delirium during hospitalization, and discharge type as important factors influencing caring intensity. This implies that more factors play a role for nurses than for surgeons. Surprisingly, the contribution to care intensity according to surgeons and nurses was in opposite directions for some factors. Nurses seemed to perceive care complexity rather than care intensity, e.g., they only scored highly what they thought was beyond their routine and complex work to perform. These results indicate that it is important to understand each other's care intensity criteria, and use an objective and uniform care intensity concept. Such a concept provides opportunities for tailoring organizational processes like admission and workforce planning, but also interdisciplinary cooperation.

Care intensity hardly plays a role in nurse staffing models currently used in the Netherlands, so there is no valid care intensity measure available at the moment. In **chapter 6**, the perspectives of nursing managers, policymakers, and nurses on nurse staffing in the AMC are described using a qualitative study design. They were asked about their experiences with the current staffing model by means of interviews and focus groups. Nurses felt the current model underestimated the nursing staff required, but objective data to substantiate this were missing. However, nurses' dissatisfaction with current staffing model appeared to be just the 'tip of the iceberg', and also covered issues about nurses behavior, autonomy and authority. Nurses showed ad hoc and reactive behavior and tended to have a limited sense of professionalism. Furthermore, they experienced little autonomy or authority in nurse staffing, so that their position in the hospital was subordinate to managers, policy makers and the medical discipline. Regarding their staffing, nurses felt a valid nursing care intensity measure could make nursing care visible and debatable, and would enable them to act more autonomously and to get more authority over nurse staffing. Our conclusion is that dissatisfaction with the current staffing model is partly due to the perceived subordinate position of nurses in the hospital.

Part III Staffing on clinical wards

Chapter 7, reports on the feasibility in the Dutch context of an evidence-based Finnish workforce system for nurse staffing; RAFAELA. This system is used in Scandinavian countries and calculates valid numbers of required personnel, based on nursing care intensity (NCI) and workload assessments by nurses, and is used for the planning of personnel. We tested the user-friendliness, applicability, and acceptability of RAFAELA for Dutch (head) nurses in two university hospitals in a three-tiered study: 1) a reliability study of the agreement among nurses when scoring the NCI, 2) a validity study, in which head nurses were to assess whether the calculated optimum of NCI was realistic, and 3) a feasibility study (in terms of user-friendliness, applicability and acceptability) of the whole RAFAELA system, as judged by all nurses involved by means of a questionnaire. RAFAELA was found to be a reliable tool also in the Netherlands. However, motivating and training of nurses to achieve reliable NCI measurements unexpectedly required extensive effort. Unfortunately, RAFAELA's validity could not be evaluated due to a low number of workload assessments. This appeared to be a sign of the lack of acceptance of RAFAELA as found in the questionnaire. The majority of the respondents did not perceive RAFAELA as an improvement. Nurses mentioned that completing RAFAELA felt like an addition to the administrative burden that would keep them away from their patients. We concluded RAFAELA has its merits as a tool to appreciate nursing care intensity and to plan workforce, but the nurses' performance using the RAFAELA system in the two collaborating hospitals did not warrant its implementation. Hospital managers should first focus on education and motivation of nurses regarding the implementation of a workforce planning system.

The practical implications of a reliable and valid measure of the intensity of care are described in chapter 8. Based on the finding that the patient assignment process before each nursing shift is a lengthy and non-transparent process, we conducted a two-phased study with quantitative and qualitative research methods to optimize this process. In phase one, all considerations relevant for the nurse-to-patient assignment process were identified through literature research, focus groups, and a survey among nurses. Nursing care intensity appeared to be the most important consideration. This information was used to develop a computerized decision support system (CDSS) to automate patient assignment. In the second phase, the CDSS was tested through 36 quantitative (duration of the assignment) and 138 qualitative (survey on workload) measurements in a before-after study. A 30% time reduction was achieved and nurses experienced less workload. We concluded that the implementation of the CDSS can lead to a higher quality of care through considerable time savings and even distribution of the patient-related workload among nurses.

FUTURE CHALLENGES FOR HOSPITAL ADMINISTRATORS, MANAGERS AND PROFESSIONALS

In the current era, aligning the patients' demand for care with actual care supply in hospitals is a complex issue. To define and reach a stable equilibrium calls for research and evidence-based improvements in clinical care institutes. However, due to the multifactorial nature of this issue[1], research focusing on this topic is complex, not only in design but also in implementation. This explains why the chapters in this thesis merely provide partial answers to the initial clinical questions (Chapter 1) and are a first step towards improvements in clinical practice. On the other hand, this thesis does provide insight into the complex relationship between demand and supply. It also provides opportunities for improvements and future challenges for administrators, managers and professionals in clinical healthcare.

In retrospect, several reasons can be identified from our studies why organizational research, in particular by nurses and with nurses, is difficult:

1. Most hospitals lack the infrastructure for initiating organizational research that enables evidence-based management (EBMgt). Therefore a limited number of hospitals was able to participate in our studies.
2. Management data are recorded inadequately and in many different ways in hospitals. This causes a lack of (reliable) data to answer organizational research questions.
3. Knowledge, skills and attitude to participate in (multidisciplinary) research is still underdeveloped among clinical nurses. This limits their participation in research and the reliability of the data they collect.
4. Nurses appear to be inwardly focused, while their innovation skills need further development.

These findings are based on the process evaluations of several studies in this thesis, including the one that was awarded the first Brilliant Failure Award by ZonMw†. These process evaluations yielded valuable insights and challenges as to the use of EBMgt, collaboration between physicians and nurses, and the professional level of nurses. These three challenges are described below.

Evidence-based management

The first challenge concerns the establishment of an infrastructure that allows for more organizational research. This is desirable because scientific evidence in this area is limited and administrators and managers are not yet used to apply

† http://www.briljantemislukkingen.nl/2013/09/tijd-voor-topzorg-nominatie-award-health-2013/

evidence-based principles. This is, however, something we would expect from organizations where evidence-based practice is the standard for decision-making in patient care[2]. However, decisions in healthcare organizations are often made based on the normative beliefs of administrators and the experience of the top management is highly esteemed[3].

To promote this EBMgt, development of a national partnership of University Medical Centers (UMCs) and the association of tertiary medical teaching hospitals (Samenwerkende Topklinische Ziekenhuizen; STZ) might be helpful. This partnership could foster a culture of applying scientific organizational research in healthcare organizations, and may initiate activities for building and expanding the infrastructure that promotes EBMgt in practice. Collaboration of UMCs and STZ-hospitals within consortia for studies with medical content already exists. Such collaboration actually improved the methodological quality and generalizability of their studies[4]. However, in the context of organization management, the focus of these healthcare organizations seems limited to their own organizational performance.

In addition, overarching organizations, like the Netherlands Federation of University Medical Centers (NFU) and STZ, should commit themselves to support administrators and managers in applying EBMgt through a uniform policy on the usage of clear definitions and uniform registration systems in order to enhance comparability and exchange of management data among hospitals. Such a commitment may also improve the usability and applicability of, for example, the Hospital Standardized Mortality Ratio (HSMR), which is still poorly comparable among hospitals due to a lack of standardization for case mix or differences in coding[5].

Fostering a culture and building an infrastructure for organizational research fits well in the current trends in healthcare. During the past decade, physicians, allied health care personnel and nurses have received structural education in evidence-based practice as part of their curricula to improve the quality and safety of their healthcare systems. Leaders should challenge, facilitate and motivate them to continually apply this knowledge, both in clinical as well in organizational decisions and research. This may involve allowing time to apply and conduct research as a second core competence besides patient care, support in the form of appointing academic staff, mentors and role models on the wards, as well as clarity about what is expected from modern healthcare professionals[6].

Inter-professional collaboration

The second challenge is to achieve effective collaboration between physicians and nurses and among the various departments within a hospital. Collaboration and teamwork is a pivotal condition for delivering high-quality, safe patient care[7,8]. To date, however, clinicians tend to disregard the capabilities of other professionals, fail to recognize the value of an interprofessional approach and a shared vision, and lack communication skills to set goals and priorities to improve health care[9].

The changing demographic structure of the population and increasing treatment options result in a patient population with a complex, challenging demand for care. This demand can best be met by interdisciplinary teams consisting of professionals from various disciplines[10,11]. Physicians and nurses should therefore look beyond the borders of their own profession and department. Effective interdisciplinary teams are characterized by an open communication, mutual trust and respect, shared decision-making, and clear roles and accountabilities[12].

Chapters 5 and 6 showed that communication between physicians and nurses, and understanding and appreciation for each other's work needs to be improved. Tools like the Team Strategies and Tools to Enhance Performance and Patient Safety (TEAMSTEPPS), can improve inter-professional communication and team functioning, subsequently leading to better understanding and appreciation[13]. Such methods focus on shared goal-setting to achieve high-quality patient care, aligning differences in knowledge, attitude and skills between disciplines. Furthermore, (the importance of) interdisciplinary collaboration should be part of the educational program and continuous professional development of physicians and nurses, for example by introducing joint education sessions in their curricula[14].

Professionalization

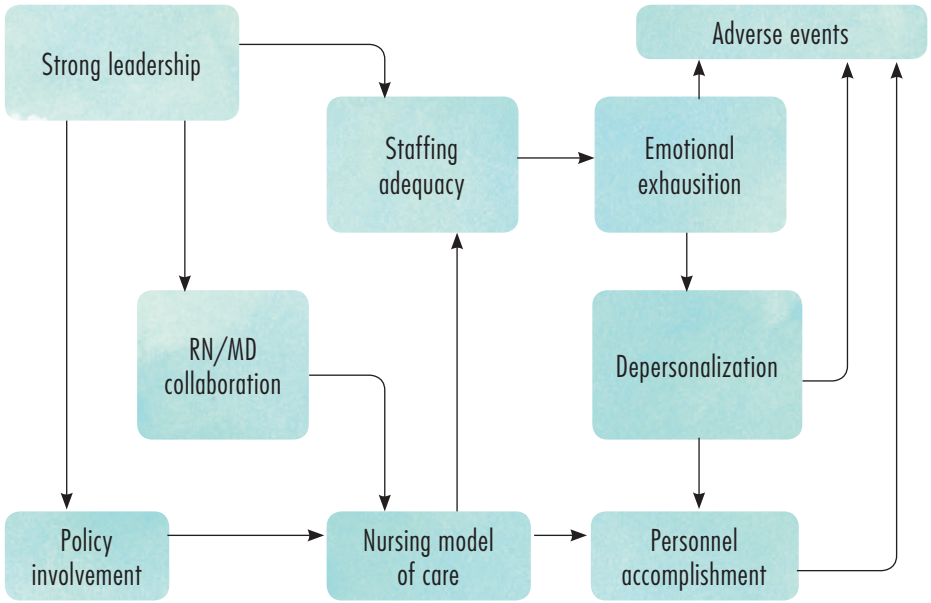
Interprofessional collaboration implies a culture of shared autonomy and authority, i.e. equal and complementary relationships, between nurses and physicians[15]. However, as nurses perceived low autonomy and authority levels, such collaboration would be based on inequality.

The majority of professional nursing population in the Netherlands is trained at the licensed vocational level, and seems to have a narrow vision of their contribution to high-quality care (Chapter 5). These signs of a low degree of professionality are detrimental to the quality of patient care as well as personnel- and organizational outcomes[16,17]. The nurses' willingness to change this was evident in Chapter 5 as nurses stated their desire for more autonomy and authority, and more involvement in decision-making for their own profession. Apparently, nurses are not able to enhance their autonomy and authority by themselves and most healthcare organizations lack formal nurse government structures involving frontline nurses in decision-making. How to foster these initiatives to empower nurses is therefore the third challenge.

Nurses working in institutions with strong leadership as to a professional working environment (high number of bachelor-level nurses (BSN) and prospects for professional development) perceive more autonomy and control over their work and experience better collaboration with physicians[16,18]. Strong leadership results in adequate staffing, better collaboration with physicians and involvement in govern-

ance and policy-making in the hospital (Figure 1). This professional work environment has a positive effect on patient-related outcomes, e.g., falls, infections, medication errors and patient satisfaction, but also on personnel-related outcomes, like emotional exhaustion and burnout[16]. Furthermore, adequate staffing and higher numbers of BSN-trained nurses could eventually lead to better organization-related outcomes, e.g., cost savings due to prevention of adverse events and a shorter length of hospital stay[19].

Figure 1 Nursing work environment



Adapted from Laschinger HK and Leiter MP. J Nurs Adm. 2006;5:259-267.

Future nurse leaders should develop into strong, effective leaders[20] and facilitate and empower their colleagues to develop professionally. They should do this by means of clear organizational nursing goals, proper recruitment and selection of peers, career development of nurses, commensurate organization goals, involvement of nurses in decision-making at the tactic and operational levels (i.e., presence of a formal nurse governance structure), and steering on outcomes of nursing care[21]. These strategies are common in so-called 'high-performance organizations'; i.e., organizations that systematically apply EBMgt, and show better patient, personnel- and organizational outcomes.

The Dutch association of nurses (Verpleegkundigen en Verzorgenden Nederland; V&VN) already started a national initiative ("Excellent Care") to improve nurses' work environments by putting emphasis on these strategies. Studies that empirically document the effects of this program are not yet published, but adopting principles of high performance has proven successful in many countries, regardless of differences in financial and delivery systems[22].

Future perfect

In summary, providing excellent and affordable care to complex patients requires a) evidence on how to achieve an effective and efficient hospital organization and management, b) inter-professional collaboration between physicians and nurses in a hospital, and c) a professionally challenging work environment for nurses. The commitment to achieve these goals should be provided by different parties at different levels and require system modifications; for example redesigning a hospital organizational model along the lines of high-performance organizations or participation in the "Excellent Care" program of the Dutch nurses association. Such an organizational model and program facilitates a stimulating nurse governance structure. This furthermore supports a shift from the current basic functional nursing environment to a professionally challenging nursing environment in which nurses are facilitated and motivated to contribute to scientific research, effective interdisciplinary teamwork, and professionalization.

As nurse governance structures receive much attention nowadays in media, scientific journals, nursing associations and in hospitals themselves, this change is gradually setting in. This change needs to be consolidated by integration in governance structures in hospitals and research to investigate the effect on outcomes.

Although quite a feat, this is well worth the challenge if excellent patient care is a common goal!

> ***"No health system can plan its future without thinking about nurses and doctors together"***
>
> - Richard Horton, editor-in-chief, The Lancet

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SAMENVATTING EN TOEKOMSTIGE UITDAGINGEN

Ziekenhuisbestuurders, managers en zorgprofessionals worden geacht hun ziekenhuizen en afdelingen efficiënt te besturen en excellente patiëntenzorg mogelijk te maken. Hiervoor dienen zij te kunnen beschikken over valide parameters om de te behandelen patiënten, het in te zetten personeel en de uiteindelijke uitkomsten van de zorg in kaart te brengen; de zogenoemde patiënten-, personele- en organisatie-uitkomsten.
De studies in dit proefschrift zijn uitgevoerd om ziekenhuisbestuurders, managers en zorgprofessionals te voorzien van geschikte parameters om de zorg efficiënter te organiseren. In **hoofdstuk 1** staan de achtergronden en doelen van dit proefschrift beschreven.

Deel I Zorgvraag

Hoofdstuk 2 geeft een systematisch literatuuroverzicht van patiëntkarakteristieken, modellen of combinaties van patiëntkarakteristieken die verklarend kunnen zijn voor de inzet van medisch of verpleegkundig personeel, en diagnostische en therapeutische interventies in een klinische setting. In totaal werden 17 studies van redelijke tot goede methodologische kwaliteit gevonden. Deze gaven aan dat leeftijd, geslacht, medische diagnose, verpleegkundige diagnose, mate van ziek-zijn, zorgzwaarte, co- morbiditeit en complicaties die de patiënt krijgt tijdens opname, geassocieerd zijn met de inzet van personeel en het gebruik van interventies. De gevonden modellen voorspelden of verklaarden voornamelijk het gebruik van verpleegkundige maar niet de medische, therapeutische en diagnostische resources. Dit bood dus onvoldoende informatie over de zorgvraag van de patiënt. Dit was aanleiding om zelf hiervoor een model te ontwikkelen.
In **hoofdstuk 3** is de ontwikkeling van een verklarend model beschreven voor de zorgvraag van chirurgische patiënten. Op zes chirurgische afdelingen van het Academisch Medisch Centrum in Amsterdam (AMC) includeerden we 174 representatieve patiënten voor een tijdbestedingsonderzoek. Chirurgen, verpleegkundigen en paramedici hielden met behulp van Personal Digital Assistants (PDA's) bij hoeveel directe en indirecte tijd zij besteedden aan de geïncludeerde patiënten gedurende hun ziekenhuisopname. Om de zorgvraag van patiënten uit te drukken hebben we de bestede tijd omgerekend naar kosten, inclusief die voor diagnostische en therapeutische interventies. Een model met de variabelen medicatiegebruik tijdens opname, complicaties, co-morbiditeit, behandelend specialisme en leeftijd verklaarde 56% van de variatie in zorgvraag van de patiënten. De totale kosten stegen met 18% (95% betrouwbaarheidsinterval (BI): 1 tot 38%) per elke extra complicatie en met 3% (95% BI: 1 tot 5%) per extra medicament. Elk extra levensjaar liet een stijgende trend zien in de totale kosten van 0.5% (95% BI: 0 tot 1%). Extra co-morbiditeit zorgde juist voor een kostenverlaging van 9% (95% BI: -16 tot -3%). Patiënten met veel co-morbiditeit worden waarschijnlijk minder snel geopereerd en de zorgvraag is daardoor minder kostbaar. Het voordeel van dit model is dat benodigde data al in het ziekenhuis worden geregistreerd. Dit leidt dus niet tot extra registratielast.
Een logische vervolgstap was een onderzoek naar de bruikbaarheid van dit model in een bredere klinische populatie. Dit is beschreven in **hoofdstuk 4**. Bij vijftig patiënten van drie grote specialismen in het AMC (chirurgie, pediatrie en obstetrie & gynaecologie) hebben we, volgens dezelfde methode als in **hoofdstuk** 3, de zorgvraag gemeten en de patiëntkarakteristieken geregistreerd. Nu bleken het gebruik van meer of minder dan 5 medicamenten tijdens opname, complicaties (uitgesplitst naar ernst) en het ondergaan van een operatie karakteristieken te zijn die de zorgzwaarte het beste konden verklaren. Het model verklaarde 55% van de variatie, vergelijkbaar met het eerdere gevonden chirurgische model. Het ondergaan van een operatie leidde tot een kostenstijging van 215% (95% BI: 65% tot 348%). Een complicatie, bijvoorbeeld een wondinfectie waarvoor geen antibiotica nodig waren, leidde tot een stijging in de kosten van 78% (95% BI: 19% tot 532%) en een stijging van 87% (95% BI 61% tot 2494%) als patiënten een ernstigere complicatie hadden, bijvoorbeeld een wondinfectie waarvoor wel antibiotica nodig waren. Wanneer een patiënt tijdens opname meer dan vijf medicamenten gebruikte, stegen de kosten met 72% (95% BI: 0.6% tot 150%). Deze karakteristieken worden pas duidelijk tijdens opname. Karakteristieken die voorafgaand aan de opname al bekend zijn verklaren of voorspellen de zorgvraag dus minder goed. We concludeerden dan ook dat het gevonden model het beste gebruikt kan worden om de (trends in de) zorgvraag van patiënten te monitoren, maar dat het voorspellen van de zorgvraag vóór opname van de patiënt blijft echter moeilijk.

Deel II Zorgzwaarte

Zorgzwaarte is een begrip dat verpleegkundigen al decennia gebruiken om patient-gerelateerde werklast (de impact van de zorgvraag) uit te drukken. Ziekenhuizen meten deze zorgzwaarte met een diversiteit aan (overigens weinig betrouwbare) instrumenten voor personeelsplanning, opnameplanning of patiënttoewijzingen op afdelingsniveau. Voor artsen is zorgzwaarte in deze context echter een weinig gekend begrip en ook moeilijk te begrijpen omdat er veel verschillende instrumenten worden gebruikt. Juist op chirurgische afdelingen leidt dit soms tot onbegrip, omdat er naast electieve opnames veel spoedopnames plaatsvinden en ad-hoc moet worden bepaald of patiënten kunnen worden opgenomen.
Hoofdstuk 5 betreft een zogenaamde vignettenstudie. Door chirurgen en verpleegkundigen 20 vignetten (patiënten-casussen opgebouwd uit 13 variërende

factoren die de conditie van de patiënt, fysieke symptomen en opname- en ontslagsituatie beschrijven) te laten beoordelen, hebben we gekeken welke factoren de zorgzwaarte van patiënten bepalen en of deze door chirurgen en verpleegkundigen wellicht verschillend gewogen werden. De gebruikte factoren waren gebaseerd op de studies in de voorgaande hoofdstukken en een Delphi-studie onder chirurgen en verpleegkundigen van ons ziekenhuis om hierover consensus te bereiken. In totaal hebben 82 chirurgen en 146 verpleegkundigen uit Nederland deze vignetten beoordeeld. Chirurgen vonden dat leeftijd, polifarmacie, medische diagnose, ernst van een complicatie, opname op de Intensive Care (IC) en ASA-classificatie (een wereldwijd classificatie model voor gezondheidsstatus, ontwikkeld door de American Society of Anesthesiologists) de zorgzwaarte van patiënten beïnvloeden. Verpleegkundigen waren het hiermee eens en vonden dat óók body mass index (BMI), voedingsstatus, opnametype, fysieke patiëntafhankelijkheid, angst of delier tijdens opname en ontslagtype de zorgzwaarte van patiënten beïnvloeden. Dit impliceert dat het kunnen opnemen van een patiënt op een verpleegafdeling voor een verpleegkundige van meer factoren afhankelijk is dan voor een chirurg. Opvallend was dat de weging van de individuele factoren voor chirurgen en verpleegkundigen in een aantal gevallen tegengesteld was. Verpleegkundigen scoorden moeilijke casussen hoog omdat ze deze complex vonden, maar niet omdat ze de zorgzwaarte hoog achtten. Deze resultaten geven aan dat het belangrijk is om hetzelfde te verstaan onder het concept zorgzwaarte, een eenduidige taal te spreken, en zo inzicht te hebben in de verschillen in zorgzwaarte tussen chirurgen en verpleegkundigen. Dit biedt kansen voor het afstemmen van organisatorische processen zoals opname- en personeelsplanning, maar ook het interdisciplinair samenwerken.

Omdat in Nederland geen betrouwbare of valide maat voor zorgzwaarte voorhanden is, speelt zorgzwaarte nauwelijks een rol in de huidig gehanteerde modellen voor verpleegkundige personeelsinzet. In **hoofdstuk 6** zijn de ervaringen van verpleegkundig bestuurders, beleidsmakers en (hoofd)verpleegkundigen geïnventariseerd in een kwalitatieve studie met een fenomenologische benadering. In interviews en focusgroep-bijeenkomsten hebben we hun gevraagd naar hun ervaringen met het huidige model voor het inzetten van verpleegkundig personeel. Verpleegkundigen hadden het gevoel dat het huidige model niet voorzag in voldoende verpleegkundig personeel en dat objectieve gegevens om dit te onderbouwen ontbraken. Echter, de ontevredenheid met het huidige model bleek het topje van de ijsberg te zijn van andere frustraties. Onder de oppervlakte bevonden zich problemen rondom de autonomie, autoriteit en het gedrag van verpleegkundigen; concepten die de positie van verpleegkundigen in een ziekenhuis bepalen. Verpleegkundigen gedroegen zich reactief, namen ad-hoc beslissingen en hadden een beperkte visie op kwaliteit van zorg. Tevens voelden ze zich niet autonoom als het om hun eigen personele inzet ging en ervoeren ze geen autoriteit op eigen vakgebied waardoor hun positie in het ziekenhuis ondergeschikt was aan managers, beleidsmakers en de medische discipline. Met betrekking tot de personele inzet gaven zij aan dat een valide zorgzwaarte-instrument verpleegkundige zorg zichtbaar en bespreekbaar zou kunnen maken en een hulpmiddel zou kunnen zijn om verpleegkundigen meer autonoom te maken op het gebied van personele inzet en hun meer autoriteit te geven. Onze conclusie is dan ook dat de ondergeschikte positie die klinische verpleegkundigen ervaren mede verantwoordelijk is voor ontevredenheid met het huidige personele inzetmodel.

Deel III Zorgaanbod

In **hoofdstuk 7** wordt beschreven hoe het Finse personeelsplanningssysteem RAFAELA in de Nederlandse context werd getest op bruikbaarheid, hanteerbaarheid en acceptatie door Nederlandse (hoofd)verpleegkundigen in twee academische ziekenhuizen. De functionaliteitseisen waren; 1) het zorgzwaarte-instrument moet aantoonbaar betrouwbaar zijn, 2) het dient te leiden tot herkenbare resultaten ten aanzien van de relatie tussen verpleegkundige inzet en zorgzwaarte, en 3) (hoofd) verpleegkundigen moeten aantoonbaar tevreden zijn met de soort (management) informatie waar RAFAELA in kan voorzien. Ten aanzien van eis 1 bleek dat RAFAELA ook in Nederland een betrouwbaar instrument is. Door lage invulpercentages bleek het onmogelijk de tweede eis te beoordelen. Vervolgens bleek uit een enquête (30% respons) voor het evalueren van eis 3 dat het lage invulpercentage kenmerkend waren voor de lage motivatie bij verpleegkundigen om RAFAELA te gaan gebruiken. Dertig procent van de verpleegkundigen gaf aan in de toekomst te willen werken met RAFAELA. In tegensteling tot hoofd- en seniorverpleegkundigen vonden verpleegkundigen RAFAELA te abstract en niet afdelingsspecifiek genoeg om als uniforme maat voor de zorgzwaarte te dienen. Verpleegkundigen gaven aan dat het invullen van RAFAELA voor hen een toevoeging was aan de reeds bestaande administratieve last die hen weghoudt van wat voor hen de essentie is van verplegen; het leveren van directe patiëntenzorg. We concludeerden dat RAFAELA voordelen biedt voor het bepalen van zorgzwaarte en de personeelsinzet, maar dat het gebrek aan acceptatie van verpleegkundigen in beide ziekenhuizen implementatie op dit moment niet opportuun maakt. Wanneer implementatie wordt overwogen door ziekenhuismanagers zal de focus eerst moeten liggen op een intensieve strategie voor motivatie en educatie van verpleegkundigen.

Dat een betrouwbare en valide maat voor de zorgzwaarte ook praktische implicaties biedt, wordt beschreven in **hoofdstuk 8**. Vanuit de bevinding dat de patiënttoewijzing voorafgaand aan elke verpleegkundige dienst een langdurig en niet transparant proces is, hebben we een studie met een gecombineerde onderzoeksmethode (kwantitatief en kwalitatief) opgezet om dit proces te optimali-

seren. In fase één werden alle relevante overwegingen die van invloed zijn op de patiënttoewijzing geïdentificeerd met literatuuronderzoek, focusgroepen en een inventarisatie onder verpleegkundigen. Zorgzwaarte bleek hierbij de belangrijkste overweging. Vervolgens werd deze informatie gebruikt voor de ontwikkeling van een op linear programming gebaseerd computerondersteund beslissingsondersteunend systeem (CDSS) om de patiënttoewijzing te automatiseren. In de tweede fase werd het CDSS getest met 36 kwantitatieve (duur van de toewijzing) en 138 kwalitatieve (evaluatie op werklast) voor- en nametingen. Het resultaat was dat de duur van de patiënttoewijzingen met 30% afnam en dat verpleegkundigen minder werklast ervoeren. We concludeerden dat de invoer van het CDSS kan leiden tot kwaliteitsverbetering door een flinke tijdsbesparing en een evenredige verdeling van de patiënt-gerelateerde werklast onder verpleegkundigen.

TOEKOMSTIGE UITDAGINGEN VOOR BESTUURDERS, MANAGERS EN PROFESSIONALS IN ZIEKENHUIZEN

Afstemmen van zorgvraag en aanbod in ziekenhuizen blijkt complex. Het is een actueel onderwerp dat vele mogelijkheden bevat voor onderzoek en verbeteringen in de zorg. De multifactoriële aard van de relatie tussen zorgvraag en zorgaanbod[1] maakt echter dat onderzoek doen hiernaar niet alleen complex is in opzet, maar zeker ook in uitvoering. Dit heeft ertoe geleid dat de hoofdstukken in dit proefschrift slechts te dele antwoord geven op de initiële klinische vraagstellingen (hoofdstuk 1) en slechts een eerste aanzet vormen tot verbeteringen in de praktijk. Anderzijds heeft dit promotieonderzoek wel inzicht gegeven in de manieren hoe de relatie tussen zorgvraag en aanbod het beste kan worden onderzocht en biedt het inzichten voor verbeteringen en toekomstige uitdagingen voor bestuurders, managers en professionals in de zorg.

Reflecterend op het verloop van de studies, zijn verschillende oorzaken aan te wijzen waarom zorgorganisatorisch onderzoek, in het bijzonder met en door verpleegkundigen, lastig is:

1. In ziekenhuizen ontbreekt de infrastructuur voor het organiseren van zorgorganisatie-onderzoek dat *evidence-based management* (EBMgt) mogelijk maakt. Hierdoor kunnen slechts een beperkt aantal ziekenhuizen participeren in dergelijke studies.
2. Managementdata worden in ziekenhuizen niet eenduidig en onvoldoende geregistreerd. Hierdoor ontbreken (betrouwbare) data voor het beantwoorden van onderzoeksvragen.
3. Bij klinische verpleegkundigen blijken kennis, vaardigheden en attitude voor het meewerken aan (multidisciplinair) onderzoek nog onderontwikkeld. Dit verlaagt de participatiegraad en de betrouwbaarheid van de van hen verkregen data.
4. Verpleegkundigen blijken voornamelijk op hun eigen professie en afdeling gericht te zijn. Hun competenties om te innoveren zijn nog onderontwikkeld.

Deze bevindingen zijn gebaseerd op procesevaluaties van verschillende studies, waarvan één is bekroond met de eerste Brilliant Failure Award van ZonMw† Deze procesevaluaties leverden verrassende inzichten en uitdagingen op voor het gebruik van *EBMgt, samenwerking* van artsen en verpleegkundigen en de *professionaliteit* van verpleegkundigen. Deze drie uitdagingen worden hieronder beschreven.

Evidence-based management

De eerste uitdaging betreft het opzetten van een infrastructuur voor het doen van meer zorgorganisatieonderzoek om in de toekomst *evidence-based* te kunnen managen. Dit is nodig omdat wetenschappelijke inzichten op dit gebied beperkt zijn en het daarnaast nog niet vanzelfsprekend is om beleidsbeslissingen te nemen op basis van *evidence*. Dit past echter niet in organisaties waar, als het gaat om zorginhoudelijke beslissingen, *evidence-based* denken en handelen niet meer weg te denken is[2]. Daarentegen worden beslissingen in zorgorganisaties nog vaak genomen op basis van de normatieve overtuigingen van bestuurders en wordt veel waarde gehecht aan de ervaring van het topmanagement[3].

Een nationaal samenwerkingsverband van Universitair Medische Centra (UMC's) en Samenwerkende Topklinische Ziekenhuizen (STZ) dat de ontwikkeling en toepassing van wetenschappelijk zorgorganisatieonderzoek voor zorgmanagers ondersteunt en initieert, kan de infrastructuur bieden die EBMgt in de praktijk bevordert. Wanneer de UMC's en STZ-ziekenhuizen samen onderzoek doen verbetert dit de kwaliteit en generaliseerbaarheid van het onderzoek door onder andere grotere steekproeven[4]. Het lijkt echter dat de focus van ziekenhuisorganisaties in het kader van organisatieonderzoek voornamelijk intern gericht is.

Daarnaast zouden organisaties als de Nederlandse Federatie van Universitair Medische Centra (NFU) en de STZ zich in moeten zetten voor de promotie van EBMgt en het leren toepassen van EBMgt door zorgbestuurders en managers. Dit maakt tevens het gebruik van eenduidige definities en registratiesystemen noodzakelijk om de vergelijkbaarheid van managementdata tussen ziekenhuizen te vergroten. Deze inzet zal ook ten goede komen aan het gebruik en de bruikbaarheid van de *Hospital Standardized Mortality Ratio* (HSMR). Vooralsnog is deze parameter niet vergelijkbaar tussen ziekenhuizen door een gebrek aan standaardisatie voor casemix en verschillende manieren van coderen[5].

† http://www.briljantemislukkingen.nl/2013/09/tijd-voor-topzorg-nominatie-award-health-2013/

Het bevorderen van een cultuur en de opbouw van een infrastructuur voor het doen van organisatieonderzoek sluit aan bij de huidige trend in de gezondheidszorg. Het afgelopen decennium hebben artsen en HBO-verpleegkundigen structureel onderwijs genoten in EBP. Om deze kennis te kunnen (blijven) toepassen, zowel in klinisch(e) als in organisatorisch(e) beslissingen en onderzoek, moeten zij gefaciliteerd, uitgedaagd en gemotiveerd worden door bestuurders en managers. Dit betreft niet alleen het creëren van tijd om naast patiëntenzorg onderzoek te doen, maar ook ondersteuning in de vorm van bijvoorbeeld wetenschappelijke medewerkers, mentoren en rolmodellen die verbonden zijn aan het operationele niveau in een ziekenhuis en helder zijn over de verwachtingen die gesteld worden aan de moderne professionele zorgverleners[6].

Samenwerken

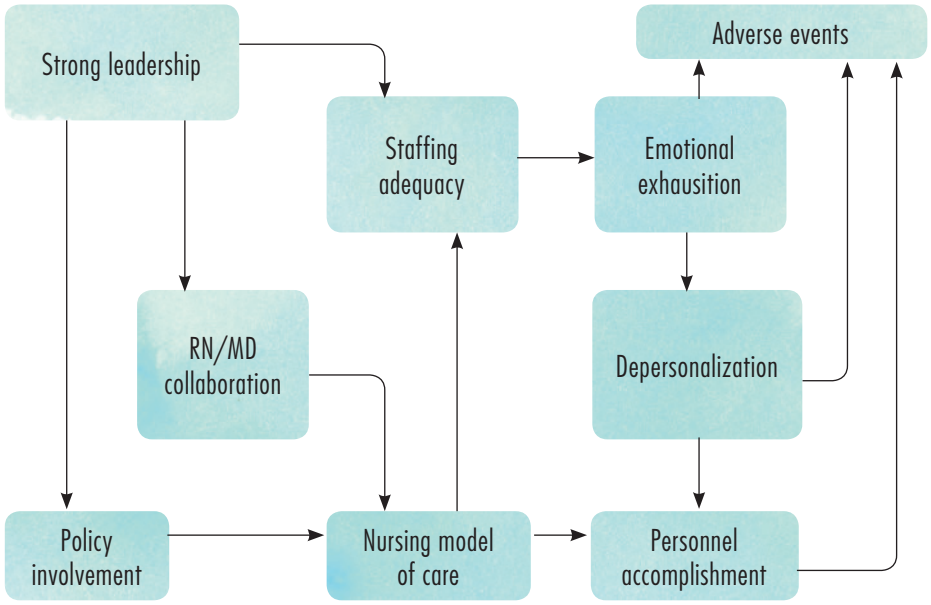
De tweede uitdaging is samenwerking tussen ziekenhuizen in een samenwerkingsverband zoals hierboven voorgesteld, maar ook tussen artsen en verpleegkundigen en tussen afdelingen binnen een ziekenhuis. Samenwerken en teamwork wordt niet voor niets als voorwaarde genoemd voor het leveren van kwalitatief hoogstaande, veilige patiëntenzorg[7,8]. Echter, vandaag de dag is er nog onvoldoende respect voor de kwaliteiten van andere professionals, wordt het nut van een interprofessionele aanpak en een gedeelde visie nog onvoldoende op waarde geschat en ontbreekt het professionals aan communicatieve vaardigheden voor het stellen van doelen en prioriteiten om de gezondheidszorg te verbeteren[9].
De veranderende demografische opbouw van de bevolking en toenemende behandelmogelijkheden leiden tot een patiëntenpopulatie met een complexe, uitdagende zorgvraag. Deze zorgvraag kan het beste worden onderzocht en beantwoord door een interdisciplinair team[10,11]. Artsen en verpleegkundigen worden daarbij geacht over de grenzen van hun eigen professie en afdeling heen te kijken. Interdisciplinaire teams zijn het meest effectief bij open communicatie, wederzijds respect, gezamenlijke besluitvorming en een duidelijke rolverdeling[12].
In hoofdstuk 5 en 6 bleek dat de communicatie tussen beide disciplines en het inzicht in, en de waarderingen voor elkaars werk nog verbetering behoeft. Een manier om in de toekomst beter te communiceren en elkaar te waarderen is het implementeren van methoden voor het bevorderen van interprofessionele samenwerking, bijvoorbeeld Team Strategies and Tools to Enhance Performance and Patient Safety (TEAMSTEPPS). Hierbij staat het gezamenlijk doelen stellen ter bevordering van patiëntuitkomsten centraal en worden de verschillen in kennis, attitude en vaardigheden op elkaar afgestemd[13]. Daarnaast zal ook in het onderwijs en de professionele ontwikkeling van artsen en verpleegkundigen meer aandacht moeten zijn voor het (belang van) interdisciplinair samenwerken, bijvoorbeeld door het organiseren van gezamenlijk onderwijs[14].

Professionaliseren

Interprofessioneel samenwerken impliceert een cultuur van gedeelde autonomie en autoriteit, dat wil zeggen gelijke en complementaire relaties, tussen verpleegkundigen en artsen[15]. Verpleegkundigen ervaren echter weinig autonomie en autoriteit waardoor deze samenwerking wordt gebaseerd op ongelijkwaardigheid.
De meerderheid van de professionele verpleegkundige beroepsbevolking in Nederland is opgeleid op MBO-niveau, en lijkt een beperkte visie te hebben op hun bijdrage aan kwalitatief hoogwaardige zorg (hoofdstuk 5). Dit zijn signalen van een lage professionaliteitsgraad en komen zowel de kwaliteit van de patiëntenzorg alsook de personele- en organisatie-uitkomsten niet ten goede[16,17]. Dat verpleegkundigen dit anders willen werd duidelijk in hoofdstuk 5. Verpleegkundigen gaven aan meer autonomie en autoriteit te willen en meer betrokken te willen zijn bij het ontwikkelen en bepalen van beleid rondom de eigen beroepsgroep. Blijkbaar zijn verpleegkundigen niet in staat zelf de autonomie en autoriteit te versterken en in de meeste ziekenhuizen ontbreekt een formele structuur om verpleegkundigen te betrekken bij besluitvorming. Het bevorderen en versterken van de positie van verpleegkundigen is daarom de derde uitdaging.
Verpleegkundigen in een professionele werkomgeving (merendeel HBO-verpleegkundigen en mogelijkheden voor professionele ontwikkeling) hebben meer autonomie en controle over hun werk en ervaren betere samenwerking met artsen. Sterk leiderschap is de drijvende kracht achter een professionele werkomgeving[16,18] en leidt tot adequate personele inzet, betere samenwerking met artsen en betrokkenheid bij bestuurs- en beleidszaken in het ziekenhuis (Figuur 1). Deze professionele werkomgeving heeft effect op patiëntgerelateerde uitkomsten, zoals vallen, infecties, medicatiefouten en klachten van patiënten, maar ook op personele uitkomsten, zoals emotionele uitputting en burn-out[19].
Toekomstige verpleegkundige leiders moeten zich dan ook ontwikkelen als sterke, effectieve leiders[20] en verpleegkundigen faciliteren en in staat stellen zich professioneel te ontwikkelen. Dit kunnen ze doen door middel van heldere verpleegkundige organisatiedoelen, juiste werving en selectie van collega's, ontwikkeling van verpleegkundigen die past bij de organisatiedoelen en het betrekken van verpleegkundigen op de werkvloer bij de besluitvorming op tactisch en operationeel niveau (dus een formele verpleegkundige organisatiestructuur opzetten) en sturen met behulp van uitkomstparameters van verpleegkundige zorg[21]. Dit zijn strategieën die zogenoemde '*high-performance organizations*' gebruiken; m.a.w. organisaties die systematisch gebruik maken van EBMgt toepassingen. Dit leidt tot betere patiënt-, personele- en organisatie-uitkomsten.
De Nederlandse beroepsvereniging voor verpleegkundigen en verzorgenden (V&VN) is reeds gestart met een nationaal initiatief ("Excellente Zorg") voor het verbeteren van de werkomgeving van verpleegkundigen. Hierin wordt de nadruk

gelegd op deze strategieën. Studies die effecten van dit programma beschrijven zijn nog niet gepubliceerd, echter het adopteren van *high performance*-principes is succesvol gebleken in meerdere landen, ongeacht verschillen in zorgverlening of budget[22].

Figure 1 Nursing work environment



Adapted from Laschinger HK and Leiter MP. J Nurs Adm. 2006;5:259-267.

Toekomstideaal

Voor excellente, maar betaalbare zorg aan complexe patiënten vereist a) *evidence* op het gebied van doelmatig en efficiënt organiseren en besturen van een ziekenhuis, b) interprofessionele samenwerking tussen artsen en verpleegkundigen in een ziekenhuis en c) een professionele en uitdagende werkomgeving voor verpleegkundigen. De inspanningen om dit te kunnen bereiken moet door verschillende partijen op verschillende niveaus worden geleverd en vereisen systeemaanpassingen; bijvoorbeeld het herinrichten van een ziekenhuisorganisatiemodel naar het voorbeeld van *high-performance organizations* of door het deelnemen aan een programma als "Excellente Zorg". Een dergelijk organisatiemodel of programma faciliteert een stimulerende verpleegkundige organisatiestructuur. Alleen zo kan er een verschuiving plaatsvinden van een basale functionele naar een professionele verpleegkundige werkomgeving waarin verpleegkundigen gefaciliteerd en gemotiveerd worden om bij te dragen aan wetenschappelijk onderzoek, effectief interdisciplinair werken en professionalisatie.

Met de toegenomen aandacht voor een verpleegkundige organisatiestructuur, zowel in de media, wetenschappelijke tijdschriften, beroepsvereniging en in de ziekenhuizen zelf, begint deze verandering langzaam te komen. Deze verandering zal geconsolideerd moeten worden door integratie in de bestuursstructuren in ziekenhuizen en onderzoek naar het effect op uitkomsten.

Deze aanpassingen zijn niet eenvoudig, maar de moeite waard als excellente patiëntenzorg het gezamenlijke doel is!

> *"No health system can plan its future without thinking about nurses and doctors together"*
>
> - Richard Horton, editor-in-chief, The Lancet

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APPENDICES

PHD PORTFOLIO

Name PhD student	Catharina J van Oostveen
PhD period	January 2012 - December 2014
PhD supervisors	Prof. dr. PJM Bakker
	Prof. dr. DJ Gouma
PhD co-supervisors	Dr. H Vermeulen
	Dr. DT Ubbink

PHD TRAINING	year	workload (ECTS)
General academic skills		
Writing in English for Publication, James Boswell Institute	2010	2,3
Expert Management of Medical Literature	2012	0.2
Oral Presentation	2012	0,8
The AMC World of Science	2012	0,7
ADDITIONAL COURSES (research skills)		
EBRO course – guideline development	2011	0.3
Systematic Reviews	2012	0.3
Practical Biostatistics	2012	1,1
Clinical Epidemiology	2012	0,6
BROK: Basic Course in Legislation and Organization for Clinical Researchers, including ICH-Good Clinical Practice (GCP), WMO and the organisation of research	2012	0,9
Advanced Topics in Clinical Epidemiology	2012	1,1
Qualitative Health Research	2013	1,9
Clinical Data Management	2013	0,8
Computing in R	2014	0.4
SUMMER SCHOOL		
Complex nursing interventions, European Academy for Nursing Science (EANS)	2013-2015	6.0

SEMINARS, WORKSHOPS AND MASTERCLASSES	year	workload (ECTS)
Oral presentations		
Explaining the amount of care needed by hospitalised surgical patients: a prospective time and motion study		
International's (STTI) 22nd International Nursing Research Congress, Cancun, Mexico	2011	0.5
Modeling and managing the patients' need for clinical care		
Work visit, Institute of Nursing Science, Faculty of Medicine, University of Basel, Basel, Switzerland	2014	1.0
POSTER PRESENTATIONS		
Developing and testing a computerized decision support system for nurse-to-patient assignment: A multi methods study		
Royal College of Nursing (RCN) Research Conference 2014, Glasgow, Scotland	2014	0.5
What determines the patients' demand for hospital care services?		
Health Services Research, Evidence-based practice conference, London, United Kingdom	2014	0.5
Nurse staffing issues; just the tip of the iceberg		
Health Services Research, Evidence-based practice conference, London, United Kingdom	2014	0.5
Which factors determine the patients' care intensity for surgeons and surgical nurses? A conjoint analysis		
Health Services Research, Evidence-based practice conference, London, United Kingdom	2014	0.5

CONFERENCES	year	workload (ECTS)
International conferences		
Honor Society of Nursing, Sigma Theta Tau International's (STTI) 22nd International Nursing Research Congress, Cancun, Mexico	2011	1.0
European Academy for Nursing Science (EANS) summer conference, Complex Interventions research in Nursing: Patient involvement and Use of Mixed methods, Nijmegen, The Netherlands	2013	0.5
Royal College of Nursing (RCN) Research Conference, Glasgow, Scotland	2014	1.0
Health Services Research, Evidence-based practice conference, London, United Kingdom	2014	1.0
European Academy for Nursing Science (EANS) summer conference, Essentials of Nursing Care Methods and Studies to Improve the Evidence Base, Rennes, France	2014	0.5
National conferences		
IQ Healthcare, Nijmegen	2012	0.3
Healthcare Management Forum, Lunteren	2013	0.3
European Academy for Nursing Science (EANS) summer conference, Essentials of Nursing Care Methods and Studies to Improve the Evidence Base, Nijmegen	2013	0.5
Other		
Journal Club (1 per month; 12 in total)	2012-2013	1.0
Research meeting (1 per 2 months; 12 in total)	2012-2013	0.4

TEACHING		
Lecturing		
Continuing- education course Evidence Based Practice for nurses (beginners course and advance course) – Academic Medical Center, Amsterdam, The Netherlands	2012-2014	3.0

Supervising master students	year	workload (ECTS)
CR Elzenga	2013	1.0
E Mathijssen	2013	1.0
SP van den Burg	2013	1.0
J Beuken	2014	1.0

OTHER ACADEMIC ACTIVITIES		
Moderating		
Honor Society of Nursing, Sigma Theta Tau International's (STTI) 22nd International Nursing Research Congress, Cancun, Mexico	2011	0.1
Scolarship		
Mentee ship by drs. Myriam Crijns, Verpleegkundigen en Verzorgenden Nederland (V&VN)	2012-2013	0.5
Memberships		
Member Rho Chi Chapter, at Large Sigma Theta Tau International (STTI), Honor Society of Nursing	2009-present	
Member board woman network Academisch Medisch Centrum, CURA	2010-2013	
Member of the European Academy for Nursing Science (EANS)	2013-present	

PARAMETERS OF ESTEEM	
Prizes and awards	
Tijd voor Topzorg study awarded by jury for the Brilliant Failure award. Issued by ZonMw and the Institute for Brilliant Failures	2013
Promising nurse 2014. Issued by Rho Cho at Large , Sigma Theta Tau International (STTI), Honor Society of Nursing	2014

PUBLICATIONS

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van Oostveen CJ, Vermeulen H, Gouma DJ, Bakker PJ, Ubbink DT. **Explaining the amount of care needed by hospitalised surgical patients.** BMC Health Services Research. 2013;13:42.	2013
van Oostveen CJ, Braaksma A, Vermeulen H. D**eveloping and testing a computerized decision support system for nurse-to-patient assignment: A multimethod study.** Computers Informatics Nursing. 2014;32:276–285.	2014
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van Oostveen CJ,_Braaksma A, Vermeulen H. **Developing and testing a computerized decision support system for nurse-to-patient assignment: A multi methods study**. Program and abstract book, Royal College of Nursing (RCN) Research Conference. 2014;page 98.	2014
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Cath □

NOTES

About the AUTHOR

Catharina Jacoba van Oostveen was born in Breukelen, The Netherlands on October 10th 1982. After finishing secondary school in 2000, she graduated Nursing school in 2004 at the University of applied sciences in Amsterdam, the Amsterdam School of Health Professions. Then her clinical career started at a nursing ward for Gastro-Intestinal surgery at the Academic Medical Center in Amsterdam. She became a medium care nurse for the Surgical medium care in 2006 and was appointed ´senior nurse´ in 2008, focussing on quality improvement and innovation.

During her clinical career in 2008, she started her Masters in Nursing Science at the University of Utrecht, which she completed in 2010. Her Master thesis was the start of her PhD programme "Modeling and managing the patients' need for clinical care". Here, she focused on patients' demand for healthcare services on strategic, (i.e. hospital costs) tactical and operational level (i.e. budget planning and staffing resources). Throughout this period she became a supporter of nursing professionalization and interprofessional collaboration as it became clear that these issues are very important in managing the demand and quality of patient care.

In the future, she will remain active in research on outcomes of nursing care, nursing professionalization and interprofessional collaboration. Also, she wishes to integrate both clinical and academic work in her career and hopes to be a role model for the clinical academic nurse, ultimately to improve quality, safety and efficiency of clinical practice.

Catharina is, next to nurse and scientist, married to Ewoud Willem van Os and mother of two sons Quinten (2005) and Olivier (2011).

“No health system can plan its future without thinking about nurses & doctors together”

Richard Horton, editor in chief, The Lancet