

## Nurse staffing and education in Europe: if not now, when?



By financing the [RN4CAST](#) project,<sup>1</sup> the European Union (EU) showed its concern about patient safety: the project's aim was to measure the value of nursing care. Such measurement has long been recognised as challenging. Drawing on discharge data from nine of the 12 RN4CAST countries for more than 420 000 patients aged 50 years or older, Linda Aiken and colleagues<sup>2</sup> in *The Lancet* show that an [increased workload of one patient per nurse](#) was associated with an increase in the [odds of surgical inpatient mortality](#), within 30 days of admission, [by 7%](#) (odds ratio 1.068, 95% CI 1.031–1.106). Patients in hospitals in which 60% of the nurses had a bachelor's degree, who looked after an average of six patients, had a mortality rate almost 30% lower than patients in hospitals where only 30% of the nurses had a bachelor's degree and cared for an average of eight patients. The investigators included hospitals from two countries of the European Free Trade Association (Switzerland and Norway) and seven of the 28 countries in the EU. The EU is a vast area linked by bilateral agreements in which the prevailing objective of a European market has recently introduced a social dimension to address inequalities (eg, workers' rights and safe working conditions);<sup>3</sup> patients can circulate freely to get the best care, and nurses can travel for optimum occupational working conditions.<sup>4,5</sup>

To search for associations between mortality and nurse staffing and educational level, the investigators developed a European study with an ecological design. The analytical methods applied were consistent with the state of knowledge in the specialty, and researchers introduced the necessary control variables to account for differences in the environment in which patients and nurses were surveyed. The investigators recognise the limitations of the study and possible effects on their results. However, the findings are consistent with those already documented in the USA<sup>6</sup> and Europe,<sup>7,8</sup> and contribute to a body of knowledge that should provide information for health-care policies of several countries.

The study is the first pan-European public report to monitor how many patients were managed by nurses during their last work-shift. This method is more accurate than the nurse–population ratio, which often includes midwives too,<sup>9</sup> and is more informative than

other measures (eg, number of full-time equivalent nurses), which provide information about how many nurses are in employment, but not how many work in the clinic. The data suggest [important variability](#) within and between countries, possibly because no homogeneous standards exist, even in countries with a public health service where patients should receive a standard level of nursing care and nurses should work in similar conditions. The study includes information about how decisions with respect to university nursing education were indicative of the composition of daily nursing staff and their patients, which raises an important question about variability despite the tenure in Europe, since 1999, of the Bologna Process. This declaration includes more than 47 EU, European Free Trade Association, and other countries (ie, European higher education area), and aims to harmonise university education.<sup>10</sup>

Results of the study by Aiken and colleagues<sup>2</sup> show that the skills of the staff acquired at university create the conditions for safe staffing. The investigators report a [7% reduction in patient mortality](#) for every [10% increase](#) in the [number of nurses with bachelor's degrees](#). The continuing presence of graduate nurses in the staff (ie, at least one per shift), able to guarantee surveillance and clinical judgment, creates a protective environment for surgical patients.

The data refer to the years 2007–10, so the researchers did not document the situation

Published Online  
February 26, 2014  
[http://dx.doi.org/10.1016/S0140-6736\(14\)60188-4](http://dx.doi.org/10.1016/S0140-6736(14)60188-4)  
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immediately before the EU economic crisis or the effects of austerity measures introduced in several countries.<sup>11</sup> If the study was replicated, the results might be different; in many countries, austerity measures have caused a reduction in the number of nurses at patients' bedsides.<sup>12</sup> The nurses remaining at the bedside have large workloads, with negative results on patients, and as a result the public image of nurses is worsening in several countries.<sup>13</sup>

Recession has highlighted the cost of graduate education for nurses; therefore, health-care organisations could be attracted by vocationally trained nurses, in the belief that costs might be lower and the nurses more effective. Paradoxically, and notwithstanding the support for research (including from the EU's Seventh Framework Programme), in November, 2013,<sup>5</sup> the EU decided to approve two pathways for nursing education: a vocational school or training after 10 years of general education; and a higher education or university pathway after 12 years of education, which is a change from the previous directive that envisioned at least 12 years of general education before nursing education.

The study by Aiken and colleagues<sup>2</sup> provides evidence in favour of appropriate nurse-patient ratios and also provides support for graduate education for nurses. Whether these findings are used to inform health-care policy or how they are implemented in practice will be interesting to see. We fear that the evidence here will not be tried and found wanting, but will rather be deemed too expensive to act upon.

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We declare no competing interests.

- 1 Sermeus W, Aiken LH, Van den Heede K, et al, for the RN4CAST consortium. Nurse forecasting in Europe (RN4CAST): rationale, design and methodology. *BMC Nurs* 2011; **18**: 6.
- 2 Aiken LH, Sloane DM, Bruyneel L, et al, for the RN4CAST consortium. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet* 2014; published online Feb 26. [http://dx.doi.org/10.1016/S0140-6736\(13\)62631-8](http://dx.doi.org/10.1016/S0140-6736(13)62631-8).
- 3 Commission of European Communities. Green Paper on the European Workforce for Health. Brussels. Dec 10, 2008. [http://ec.europa.eu/health/ph\\_systems/docs/workforce\\_gp\\_en.pdf](http://ec.europa.eu/health/ph_systems/docs/workforce_gp_en.pdf) (accessed Feb 5, 2014).
- 4 European Union. Directive 2011/24/EU of the European Parliament and of the Council of 9 March 2011 on the application of patients' rights in cross-border healthcare. March 9, 2011. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:088:0045:0065:en:PDF> (accessed Feb 17, 2014).
- 5 European Union. Directive 2013/55/EU of the European Parliament and of the Council of 20 November 2013 amending Directive 2005/36/EC on the recognition of professional qualifications and Regulation (EU) No 1024/2012 on administrative cooperation through the Internal Market Information System ("the IMI Regulation"). Dec 28, 2013. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:354:0132:0170:en:PDF> (accessed Feb 17, 2014).
- 6 Aiken L, Clarke SP, Cheung RB, Sloane DM, Silber JH. Educational levels of hospital nurses and surgical patient mortality. *JAMA* 2003; **290**: 1617-23.
- 7 Rafferty AM, Clarke SP, Coles J, et al. Outcomes of variation in hospital nurse staffing in English hospitals: cross-sectional analysis of survey data and discharge records. *Int J Nurs Stud* 2007; **44**: 175-82.
- 8 Diya L, Van den Heede K, Sermeus W, Lesaffre E. The relationship between in-hospital mortality, readmission into the intensive care nursing unit and/or operating theatre and nurse staffing levels. *J Adv Nurs* 2012; **68**: 1073-81.
- 9 Buchan J, Aiken L. Solving the nursing shortage: a common priority. *J Clin Nurs* 2008; **17**: 3262-68.
- 10 Vassiliou A. Focus on higher education in Europe. The impact of Bologna Process. Brussels, Belgium: Education, Audiovisual and Culture Executive Agency, 2010.
- 11 Wray J. The impact of the financial crisis on nurses and nursing. *J Adv Nurs* 2013; **69**: 497-99.
- 12 European Federation of Nurses Associations. Caring in crisis: the impact of the financial crisis on nurses and nursing. A comparative overview of 34 European countries. January, 2012. <http://www.efnweb.be/wp-content/uploads/2012/05/EFN-Report-on-the-Impact-of-the-Financial-Crisis-on-Nurses-and-Nursing-January-2012.pdf> (accessed Feb 5, 2014).
- 13 Dean E. *Lancet* Commission to tackle the poor perception of UK nursing. *Nurs Stand* 2014; **28**: 10.

## Nursing in the UK: where next?

Since we published *The Lancet* Commission on Nursing in 1932, how much has nursing changed? In our original Commission a strong voice representing the patient was absent. Today, while nursing's future remains unclear and the profession is often perceived to be in a state of chaos, the patient has emerged as the central voice. This month has seen the convergence of National Nurses' Week, International Nurses' Day, and the anniversary of Florence Nightingale's birthday, leading to even more media interest and discussion around the role of the nurse than usual. What is clear is that there is a need for an overarching vision which is in the patient's interest, and enough political support for the profession to take it through the next decades.

Several major professional reviews have been undertaken in recent years, including the Willis Commission on Nursing Education, Sir Bruce Keogh's Mortality Review, and the Prime Minister's Commission on the Future of Nursing and Midwifery in England. More are planned in the next 3 years. All of them outline problems in nursing, and yet there has been failure to implement and follow through the recommendations of these reports, often because of a lack of political will. The public continues to have a deep-seated perception of the profession as a service industry, and to align nurses with health-care assistants rather than with doctors, yet expectations and demands on individuals are high. Uniformed staff in hospitals cover a wide range of roles, and the lack of clarity around the qualifications needed by different levels of health-care assistants negatively affects the image of nurses. A minimum level of training needs to be introduced for all people actively giving patient care, and graduate nurses need to work alongside team members with transparency of qualifications equating to their respective responsibility.

Last week, the Royal College of Physicians published *National Care of the Dying Audit for Hospitals*, which shows that the quality and provision of care across hospitals in England varies substantially, and that training and standards are inconsistent. Although around half of all deaths take place in hospitals, approaches to end-of-life care are frequently unsatisfactory. The audit has led to ten key recommendations, including training in how to

communicate dying to patients and their families and friends, a need for specialist palliative care services to be available 7 days a week to support patients, and a need for collaboration within the multidisciplinary team to recognise when a patient is dying in order to provide appropriate care. Although none of these measures is the sole responsibility of nurses, the audit highlights the teamwork needed within the ward, and the crucial and central role of the nurse as carer.

Training reform and education still need further definition. Myriad choices and specialties exist for nurses, yet leadership roles are few and far between. The problem of a rapidly ageing workforce of nurses needs to be addressed, as do multicultural challenges in our changing demographic. Last week saw the release of a National Institute for Health and Care Excellence draft guideline that hints that a ratio of one nurse to eight patients is the minimum staffing level needed to avoid patient risk, although this falls short of findings published in today's *Lancet*. Linda Aiken and colleagues' RN4CAST study examines patient mortality rates in hospitals with varying levels of graduate nurses providing care. Results of the study show that in a hospital in which 60% of nurses are graduates caring for an average of six patients each, mortality is 30% less than in a hospital where nursing staff is comprised of only 30% graduates, on average caring for eight patients each. Poor conditions and decisions on investment have led to inadequate care, not the nurses themselves.

Everyone has an opinion of what nursing should be—personal experience and anecdotes abound. But what direction should nursing take in the future? Technology is changing the actual nature of care as remote support becomes a reality and care is increasingly delivered outside of hospitals, within communities. As our ageing population grows, the balance is changing. The profession needs clear measures in education and practice to ensure a high-quality and sustainable future for nursing, while providing appropriate and safe levels of patient care at all times. We are delighted to announce that a *Lancet* Commission on Nursing is underway for publication in 2016, with the intent of making a positive contribution to this rapidly shifting landscape. ■ *The Lancet*



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For *The Lancet* Commission on Nursing from 1932 see [http://ac.els-cdn.com/S0140673600576144/1-s2.0-S0140673600576144-main.pdf?\\_tid=21b76c8a-dcd7-11e3-888d-00000aab0f01&acdnat=1400230409\\_90d83df4fc62e532d98db07b089747c1](http://ac.els-cdn.com/S0140673600576144/1-s2.0-S0140673600576144-main.pdf?_tid=21b76c8a-dcd7-11e3-888d-00000aab0f01&acdnat=1400230409_90d83df4fc62e532d98db07b089747c1)

For more on the Royal College of Physicians' *National Care of the Dying Audit of Hospitals* see <http://www.rcplondon.ac.uk/resources/national-care-dying-audit-hospitals>

For the draft NICE guideline see <http://www.nice.org.uk/media/FA9/B9/StaffingForNursingInAdultInpatientWardsDraftForConsultationMay.pdf>



# Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study

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## Summary

**Background** Austerity measures and health-system redesign to minimise hospital expenditures risk adversely affecting patient outcomes. The RN4CAST study was designed to inform decision making about nursing, one of the largest components of hospital operating expenses. We aimed to assess whether differences in patient to nurse ratios and nurses' educational qualifications in nine of the 12 RN4CAST countries with similar patient discharge data were associated with variation in hospital mortality after common surgical procedures.

**Methods** For this observational study, we obtained discharge data for 422 730 patients aged 50 years or older who underwent common surgeries in 300 hospitals in nine European countries. Administrative data were coded with a standard protocol (variants of the ninth or tenth versions of the International Classification of Diseases) to estimate 30 day in-hospital mortality by use of risk adjustment measures including age, sex, admission type, 43 dummy variables suggesting surgery type, and 17 dummy variables suggesting comorbidities present at admission. Surveys of 26 516 nurses practising in study hospitals were used to measure nurse staffing and nurse education. We used generalised estimating equations to assess the effects of nursing factors on the likelihood of surgical patients dying within 30 days of admission, before and after adjusting for other hospital and patient characteristics.

**Findings** An increase in a nurses' workload by one patient increased the likelihood of an inpatient dying within 30 days of admission by 7% (odds ratio 1.068, 95% CI 1.031–1.106), and every 10% increase in bachelor's degree nurses was associated with a decrease in this likelihood by 7% (0.929, 0.886–0.973). These associations imply that patients in hospitals in which 60% of nurses had bachelor's degrees and nurses cared for an average of six patients would have almost 30% lower mortality than patients in hospitals in which only 30% of nurses had bachelor's degrees and nurses cared for an average of eight patients.

**Interpretation** Nurse staffing cuts to save money might adversely affect patient outcomes. An increased emphasis on bachelor's education for nurses could reduce preventable hospital deaths.

**Funding** European Union's Seventh Framework Programme, National Institute of Nursing Research, National Institutes of Health, the Norwegian Nurses Organisation and the Norwegian Knowledge Centre for the Health Services, Swedish Association of Health Professionals, the regional agreement on medical training and clinical research between Stockholm County Council and Karolinska Institutet, Committee for Health and Caring Sciences and Strategic Research Program in Care Sciences at Karolinska Institutet, Spanish Ministry of Science and Innovation.

## Introduction

Constraint of health expenditure growth is an important policy objective in Europe despite concerns about adverse outcomes for quality and safety of health care.<sup>1,2</sup> Hospitals are a target for spending reductions. Health-system reforms have shifted resources to provide more care in community settings while shortening hospital length of stay and reducing inpatient beds, resulting in increased care intensity for inpatients. The possible combination of fewer trained staff in hospitals and intensive patient interventions raises concerns about whether quality of care might worsen. Findings of the European Surgical Outcomes Study<sup>3</sup> across 28 countries recently showed higher than expected hospital surgical mortality and substantial between country variation in hospital outcomes.

Nursing is a so-called soft target because savings can be made quickly by reduction of nurse staffing whereas savings through improved efficiency are difficult to achieve. The consequences of trying to do more with less are shown in England's Francis Report,<sup>4</sup> which discusses how nurses were criticised for failing to prevent poor care after nurse staffing was reduced to meet financial targets. Similarly, results of the Keogh review<sup>5</sup> of 14 hospital trusts in England showed that inadequate nurse staffing was an important factor in persistently high mortality rates. Austerity measures in Ireland and Spain have been described as adversely affecting hospital staffing too.<sup>6,7</sup>

Research that could potentially guide policies and practices on safe hospital nurse staffing in Europe has been scarce. Jarman and colleagues<sup>8</sup> reported an

Lancet 2014; 383: 1824–30

Published Online

February 26, 2014

[http://dx.doi.org/10.1016/S0140-6736\(13\)62631-8](http://dx.doi.org/10.1016/S0140-6736(13)62631-8)

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association between large proportions of auxiliary nurses (which implies a low overall mix of nursing skill) and high mortality in hospitals in England. Rafferty and colleagues<sup>9</sup> noted that low hospital mortality in England after common surgeries was associated with nurses each caring for few patients. Research in Belgium<sup>10</sup> found hospital mortality after cardiac surgery was significantly lower in hospitals with lower patient to nurse staffing ratios and in hospitals with a higher proportion of nurses with bachelor's education than in hospitals with higher staffing ratios and fewer nurses with bachelor's education. Likewise, data from a Swiss study<sup>11</sup> suggested significantly increased surgical mortality associated with inadequate nurse staffing and poor nurse work environments.

This nascent but growing scientific literature about nursing outcomes in Europe is complemented by research from North America showing that improved hospital nurse staffing is associated with low mortality.<sup>12</sup> Additionally, growing evidence exists that bachelor's education for nurses is associated with low hospital mortality.<sup>13–17</sup>

Research into nursing has had little policy traction in Europe compared with the USA where almost half the 50 states have implemented or are considering hospital nurse staffing legislation.<sup>18,19</sup> On the basis of findings showing improved outcomes for patients, the Institute of Medicine recommended that 80% of nurses in the USA have a bachelor's degree by 2020,<sup>20</sup> and hospitals have responded with preferential hiring of bachelor's nurses. European decision makers might be unclear about the applicability of research done in individual countries in Europe or North America to Europe more generally. Specifically, scientific evidence is needed to inform the continuing European Union policy debate about harmonisation of professional qualifications for nurses.<sup>21</sup>

RN4CAST, funded by the European Commission, was designed to provide scientific evidence for decision makers in Europe about how to get the best value for nursing workforce investments, and to guide workforce planning to produce a nurse workforce for the future that would meet population health needs.<sup>22</sup> Investigators of the study of 488 hospitals in 12 European countries noted substantial variation between countries with regards to patient to nurse workloads and the percentage of nurses qualified at the bachelor's level.<sup>23</sup> These variations in nursing resources are important predictors of patients' satisfaction with their care and in nurses' assessments of quality and safety of care.<sup>24</sup>

We aimed to assess whether differences in patient-to-nurse workloads and nurses' educational qualifications in nine of the 12 RN4CAST countries with similar patient discharge data are associated with variation in hospital mortality after common surgical procedures. The nine countries are representative of variation in Europe with respect to organisation, financing, and resources given to health services. The study's findings provide previously unavailable evidence to guide important decisions about

improvement of hospital care in Europe in the context of scarce resources and health-system reforms.

## Methods

### Study setting

Data for this observational study were from administrative sources on hospital patients and characteristics of hospitals, and surveys of 26 516 bedside care professional nurses done in 2009–10 in 300 hospitals in nine European countries (Belgium, England, Finland, Ireland, the Netherlands, Norway, Spain, Sweden, and Switzerland). Similar patient discharge data consistent with the patient mortality protocol were not available for three RN4CAST countries (Germany, Poland, and Greece). The study included most adult acute care hospitals in Sweden, Norway, and Ireland, and geographically representative samples of hospitals in the other countries.<sup>22</sup>

The European study protocol received ethical approval by the lead university, Catholic University of Leuven, Belgium. Each grantee organisation in the nine participating countries received ethical approval at the institutional level to do nurse surveys and analyse administrative data for patient outcomes. We also obtained country level approvals to acquire and analyse patient outcomes data.

### Outcomes

We obtained patient mortality data for postoperative patients discharged from study hospitals in the year most proximate to the nurse survey for which data were available, which ranged between countries from 2007 to 2009. Our analyses included patients aged 50 years or older with a hospital stay of at least 2 days who underwent common general, orthopaedic, or vascular surgery, and for whom complete data were available for comorbidities present on admission, surgery type, discharge status, and other variables used for risk adjustment. We used the procedures published by Silber and colleagues<sup>25</sup> to define common surgeries and comorbidities (appendix). We selected common surgeries for study because almost all acute hospitals undertake them, risk adjustment procedures for surgical patients have been well validated, and risk-related comorbidities can be more accurately distinguished for surgical patients than for medical patients because they are present at admission by contrast with complications arising in the hospital. We coded data in all countries with a standard protocol by use of variants of the ninth or tenth version of the International Classification of Diseases.<sup>26</sup> Researchers are not able to validate coding in administrative hospital discharge files. Countries can have validation protocols for administrative data but this information is not available. Findings of studies in Europe show that routinely collected administrative data predict risk of hospital death with discrimination similar to that obtained from clinical databases.<sup>27</sup> We restricted

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hospitals to those with 100 or more targeted patients. The primary outcome measure was whether patients died in the hospital within 30 days of admission. Risk adjustment variables included patient age, sex, admission type (emergency or elective), 43 dummy variables suggesting surgery type, and 17 dummy variables suggesting comorbidities present at admission, which are included in the Charlson index.<sup>28</sup>

Nurse staffing and education measures were derived from responses to surveys of nurses in each hospital with the RN4CAST nurse survey instrument.<sup>22</sup> The term nurse refers to fully qualified professional nurses. In all countries except Sweden, hospitals were sampled in different regions, after which a variable number of adult medical and surgical wards were randomly sampled in each hospital, depending on hospital size (between two and six wards in each hospital in every country except England, where all wards were sampled, up to a maximum of ten). All nurses providing direct patient care in these wards were surveyed. In Sweden, all hospitals and all medical and surgical wards were included by sampling all medical surgical nurses nationally.

In the RN4CAST study, nurse staffing for each hospital was calculated from survey data by dividing the number of patients by the number of nurses that each nurse reported were present on their ward on their last shift, and then averaging ratios across all nurse respondents in each hospital. Low ratios suggested more favourable staffing. Collection of data for hospital nurse staffing directly from nurses avoided differences in administrative reporting methods across countries and ensured that only nurses in inpatient care roles are counted. We measured nurse education by calculating the percentage of all nurses in each hospital that reported that the

highest academic qualification they had earned was a bachelor's degree or higher.

### Statistical analyses

We estimated associations between nurse staffing and nurses' education and 30 day inpatient mortality for patients before and after adjusting for additional hospital characteristics and risk-adjusting for differences in patient characteristics. Hospital characteristics included country, bed size, teaching status, and technology; we defined high technology hospitals as those that undertook open heart surgery or organ transplantation. We included the hospital nurse work environment, measured by the Practice Environment Scale of the Nursing Work Index, as a control variable like in previous studies of nursing and mortality.<sup>15</sup> Patient characteristics included age, sex, admission type, type of surgery (with 43 dummy variables for the specific surgery types), and presence of 17 comorbidities (appendix). Because individual patient outcomes were modelled with a combination of hospital and patient characteristics, we estimated the effects of different characteristics with population average models using a generalised estimating approach and random intercept models using hierarchical linear modelling. Both approaches took into account patients being nested within hospitals, and in both types of models we included dummy variables to allow for unmeasured differences across countries. Because the results were almost identical, and the estimated effects of nursing characteristics were the same in terms of their size and importance, we show only the generalised estimating results. We tested for the effects on mortality of an interaction between nurse staffing and education, which was not significant and is not included in the results. All statistical analyses were done with SAS (version 9.2).

### Role of the funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

### Results

We obtained mortality data for 422730 patients; the number of hospitals and surgical discharges varied across countries (table 1). The percentage of surgical patients who died in the hospital within 30 days of admission was 1·3% across the nine countries combined, and was lowest in Sweden and highest in the Netherlands (table 1).

Response rates for surveys of nurses ranged from less than 40% (2990 of 7741) in England, to nearly 84% (2804 of 3340) in Spain, and averaged 62% (29251 of 47160) across the nine countries. Differences in both nurse staffing and nurse education were large both between

	Number of hospitals	Mean discharges per hospital (range)	Deaths/discharges (%)
Belgium	59	1493 (413–4794)	1017/88 078 (1·2%)
England	30	2603 (868–6583)	1084/78 045 (1·4%)
Finland	25	1516 (175–3683)	303/27 867 (1·1%)
Ireland	27	738 (103–1997)	292/19 822 (1·5%)
Netherlands	22	1419 (181–2994)	466/31 216 (1·5%)
Norway	28	1468 (432–4430)	518/35 195 (1·5%)
Spain	16	1382 (186–3034)	283/21 520 (1·3%)
Sweden	62	1304 (295–4654)	828/80 800 (1·0%)
Switzerland	31	1308 (158–3812)	590/40 187 (1·5%)
Total	300	1308 (103–6583)	5381/422 730 (1·3%)

Only hospitals with more than 100 surgical patient discharges were included in the analyses. Data shown are for discharged patients for whom information about 30 day mortality, age, sex, type of surgery, and comorbidities were complete. Data were missing for those characteristics for less than 4% of all patients.

**Table 1: Hospitals sampled in nine European countries with patient discharge data, numbers of surgical patients discharged, and numbers of patient deaths (RN4CAST data)**

countries and between hospitals within each country (table 2). In Spain and Norway, all nurses had bachelor's degrees. The mean age of the patient sample was 68 years (SD=10); table 3 shows other patient characteristics. Of

	Nurse staffing (patients to nurse)		Nurse education (% of nurses with bachelor's degrees)	
	Mean (SD)	Range	Mean (SD)	Range
Belgium	10.8 (2.0)	7.5–15.9	55% (15)	26–86%
England	8.8 (1.5)	5.5–11.5	28% (9)	10–49%
Finland	7.6 (1.4)	5.3–10.6	50% (10)	36–71%
Ireland	6.9 (1.0)	5.4–8.9	58% (12)	35–81%
Netherlands	7.0 (0.8)	5.1–8.1	31% (12)	16–68%
Norway	5.2 (0.8)	3.4–6.7	100% (0)	100–100%
Spain	12.7 (2.0)	9.5–17.9	100% (0)	100–100%
Sweden	7.6 (1.1)	5.4–9.8	54% (12)	27–76%
Switzerland	7.8 (1.3)	4.6–9.8	10% (10)	0–39%
Total	8.3 (2.4)	3.4–17.9	52% (27)	0–100%

Means, SDs, and ranges are estimated from hospital data—eg, the 59 hospitals in Belgium have a mean patient-to-nurse ratio of 10.8, and the patient-to-nurse ratio ranges across those 59 hospitals from 7.5 to 15.9. Similarly, the 31 hospitals in Switzerland have, on average, 10% bachelor's nurses, and the percent of bachelor's nurses ranges across those 31 hospitals from 0% to 39%.

**Table 2: Nurse staffing and education in nine European countries**

	Number (%)
Men	189 815 (45%)
Emergency admissions	141 584 (34%)
Inpatient deaths within 30 days of admission	5381 (1.3%)
Surgical categories	
General surgery	162 974 (39%)
Orthopaedic surgery	220 301 (52%)
Vascular surgery	39 455 (9%)
Comorbidities	
Cancer	15 297 (4%)
Cerebrovascular disease	7400 (2%)
Congestive heart failure	10 274 (2%)
Chronic pulmonary disease	28 373 (7%)
Dementia	5744 (1%)
Diabetes with complications	6478 (2%)
Diabetes without complications	35 450 (8%)
AIDS/HIV	50 (0%)
Metastatic carcinoma	17 911 (4%)
Myocardial infarction	12 002 (3%)
Mild liver disease	5953 (1%)
Moderate or severe liver disease	1354 (0%)
Paraplegia and hemiplegia	2043 (1%)
Peptic ulcer disease	2323 (1%)
Peripheral vascular disease	12 452 (3%)
Renal disease	10 085 (2%)
Connective tissue disease or rheumatic disease	6962 (2%)

**Table 3: Characteristics of surgical patients (n=422 730) in the study hospitals**

	Partly adjusted models		Fully adjusted model	
	OR (95% CI)	p value	OR (95% CI)	p value
Staffing	1.005 (0.965–1.046)	0.816	1.068 (1.031–1.106)	0.0002
Education	1.000 (0.959–1.044)	0.990	0.929 (0.886–0.973)	0.002

The partly adjusted models estimate the effects of nurse staffing and nurse education separately while controlling for unmeasured differences across countries. The fully adjusted model estimates the effects of nurse staffing and nurse education simultaneously, controlling for unmeasured differences across countries and for the hospital characteristics (bed size, teaching status, technology, and work environment), and patient characteristics (age, sex, admission type, type of surgery, and comorbidities present on admission). OR=odds ratio.

**Table 4: Partly and fully adjusted odds ratios showing the effects of nurse staffing and nurse education on 30 day inpatient mortality**

439 800 patients studied more than 50% had orthopaedic surgeries, whereas roughly four in ten underwent general surgeries, and slightly less than one in 10 underwent vascular surgeries. The most common comorbidities were diabetes without complications, chronic pulmonary disease, metastatic carcinoma, and cancer.

Table 4 shows results of modelling the effects of the two nursing factors (staffing and education) on mortality after adjustment for differences across countries in mortality (in the partly adjusted model) and for differences in the full set of potentially confounding factors (in the fully adjusted model). After we considered severity of illness of the patients and characteristics of the hospitals (teaching status and technology) in the adjusted model, both nurse staffing and nurse education were significantly associated with mortality (table 4). The odds ratios (ORs) suggest that each increase of one patient per nurse is associated with a 7% increase in the likelihood of a surgical patient dying within 30 days of admission, whereas each 10% increase in the percent of bachelor's degree nurses in a hospital is associated with a 7% decrease in this likelihood. These associations suggest that patients in hospitals in which 60% of the nurses had bachelor's degrees and nurses cared for an average of six patients would have almost 30% lower mortality than patients in hospitals in which only 30% of the nurses had bachelor's degrees and nurses cared for an average of eight patients. We worked out this 30% reduction (reduction in mortality by a factor of 0.70) by applying (and multiplying) the reciprocal of the OR associated with nurse staffing across two intervals (from eight to six patients per nurse) and the OR associated with nurse education across three intervals (from 60% to 30%)—ie,  $1/1.068 \times 1/1.068 \times 0.929 \times 0.929 \times 0.929 = 0.703$ .

## Discussion

Our findings shows that an increase in nurses' workload increases the likelihood of inpatient hospital deaths, and an increase in nurses with a bachelor's degree is associated with a decrease in inpatient hospital deaths (panel). Findings of the RN4CAST study showed more

**Panel: Research in context****Systematic review**

We searched PubMed for original research articles published in English between Jan 1, 1985, and Aug 10, 2013, with the search terms (separately and in combination): “nursing”, “staffing”, “administrative data”, “outcomes”, “mortality”, “European Union”, and “cross-national” and “international.” We also did a manual search based on bibliographies of papers we found. Studies linking nursing and clinical patient outcomes were restricted in Europe to one country studies<sup>8–11</sup> and to research in North America.<sup>12–17</sup> In Europe, cross-national studies assessing how hospital nursing affects patient outcomes are restricted to assessment of outcomes based on patient or nurse report rather than objective clinical outcomes.<sup>24</sup>

**Interpretation**

We report the first study to use detailed information about nursing workforce such as staffing and education level to investigate how these factors affect patient mortality across countries in Europe. We relied on unique data from direct-care nurses collected with a common method across many hospitals in different countries. We used a standardised approach across countries to measure and adjust the risk of mortality on the basis of administrative records. Findings of our analysis of 300 hospitals in nine countries show that an increase in nurses' workloads by one patient increases the likelihood of inpatient hospital mortality by 7%, and a 10% increase in bachelor's degree nurses is associated with a decrease in odds on mortality by 7%. These findings emphasise the risk to patients that could emerge in response to nurse staffing cuts and suggest that an increased emphasis on bachelor's education for nurses could reduce preventable hospital deaths.

variation in hospital mortality after common surgical procedures in European hospitals than is generally understood. Variation in hospital mortality is associated with differences in nurse staffing levels and educational qualifications. Hospitals in which nurses cared for fewer patients each and a higher proportion had bachelor's degrees had significantly lower mortality than hospitals in which nurses cared for more patients and fewer had bachelor's degrees. These findings are similar to those of studies of surgical patients in US and Canadian hospitals in which similar measures and protocols were used.<sup>14,15</sup>

Our finding that each 10% increase in the proportion of nurses with a bachelor's degree in hospitals is associated with a 7% decrease in mortality is highly relevant to the recent decision by the European Parliament (Oct 9, 2013) to endorse two educational tracks for nurses—one vocational and one higher education.<sup>21</sup> In view of the RN4CAST findings, the goal of standardised qualifications of professionals as expressed in the Bologna process<sup>29</sup> is a long way off from being achieved. Our findings support the recent EU decision to recognise professional nursing education within institutions of higher education starting after 12 years of general education. However, our results

challenge the decision to continue to endorse vocational nursing education after only 10 years of general education because this training might hamper access to higher education for nurses in some countries—eg, Germany where no nurses in the 49 hospitals studied in RN4CAST had a bachelor's degree.<sup>23</sup>

The RN4CAST finding that improved hospital nurse staffing is associated with decreased risk of mortality might be inconvenient in the present difficult financial context and amid health-system reforms to shift resources to community-based settings. Nevertheless, this study is the largest and most rigorous investigation of nursing and hospital outcomes in Europe up to now, and has robust results. Our findings reinforce those of smaller studies in Europe,<sup>8–11</sup> and a large body of international published work.<sup>12,14</sup> Our data suggest a safe level of hospital nurse staffing might help to reduce surgical mortality, as called for by the European Surgical Outcomes Study.<sup>3</sup>

Beyond improvements in care, investments in nursing could make good business sense. In the USA, each US\$1 spent on improvements to nurse staffing was estimated to return a minimum of \$0.75 economic benefit to the investing hospital, not counting intangible benefits.<sup>30</sup> Furthermore, a move from less qualified licensed vocational nurse hours to qualified professional nurse hours is estimated to save lives and money.<sup>31</sup> Improved nurse staffing in US hospitals is associated with significantly reduced readmission rates, which is compelling in view of financial penalties in 2013 to 2225 hospitals for excessive readmissions.<sup>32</sup> Although hospital finance and payment policies differ between the USA and Europe, the underlying goal of better value for investments is the same.<sup>33</sup>

Our study has several limitations. We assessed one outcome, mortality, and only in patients undergoing common general surgeries. Our measure of education relied on each country's definition of bachelor's education for nurses, which differs by country. Our global measure of nurse staffing shows nurse workloads across all shifts, and might be skewed in some hospitals if nurses working at night (when patient-to-nurse ratios are higher than in the day) responded to our survey at different rates than nurses on day shifts. The models we used to measure associations allowed us to control for unmeasured differences in mortality across countries and for measured differences across patients and hospitals, but unmeasured confounding factors at the individual, hospital, and community level could have affected our results. We cannot link the care of individual patients to individual nurses. Additionally, mortality outcomes for patients were taken from the year that most closely matched the nurse survey year, but because of lags in patient data availability, the two data sources were not always perfectly aligned. Finally, our data are cross-sectional and provide restricted information about causality.



Additional research in Europe is needed to establish whether our multicountry findings can be replicated for high mortality surgeries and for medical patients; and whether in Europe, like in the USA, nursing is related to a range of adverse outcomes that contribute to high costs. Longitudinal studies of panels of hospitals would be especially valuable to help to establish causal associations between changes in nursing resources and outcomes for patients. Comparative effectiveness research is needed to identify what workforce investments return the greatest value, and under what circumstances. Research beyond simple mortality outcomes would be welcome to help to establish standards of care by which performance of health-care organisations could be more fully assessed. In a context of widespread health-system redesign and reforms, increased funding for studies of health workforce investments could result in high-value health care.

In summary, educational qualifications of nurses and patient-to-nurse staffing ratios seem to have a role in the outcomes of hospital patients in Europe. Previous findings from RN4CAST show that patients are more likely to express satisfaction with hospital care when nurses care for fewer patients each.<sup>24</sup> To add to these findings, our data suggest that evidence-based investments in nursing are associated with reduction in hospital deaths.

#### Contributors

LHA, WS, LB, MM, PG, RB, and MTM-C did the literature search. LHA, WS, DMS, KVdH, AMR, PG, MM, RB, AS, and CT designed the study. WS, LHA, KVdH, RB, PG, MD, JK, MK, MTM-C, AMR, RS, AS, CT, and TVA collected data. LHA, DMS, LB, MM, WS, and TVA analysed data. All of the authors contributed to data interpretation, writing, and revision of the report.

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#### Conflicts of interest

We declare that we have no conflicts of interest.

#### Acknowledgments

European Union's Seventh Framework Programme (FP7/2007–2013, grant agreement no. 223468; WS and LHA), National Institute of Nursing Research, National Institutes of Health (R01NR04513; LHA), the Norwegian Nurses Organisation and the Norwegian Knowledge Centre for the Health Services (IMH), Swedish Association of Health Professionals, the regional agreement on medical training and clinical

research between Stockholm County Council and Karolinska Institutet, Committee for Health and Caring Sciences and Strategic Research Program in Care Sciences at Karolinska Institutet (CT), Spanish Ministry of Science and Innovation (FIS PI080599; TM-C). We thank Tim Cheney for analytic assistance and the Norwegian Patient Register, which sourced patient data for the study in Norway.

#### References

- Karanikolos M, Mladovsky P, Cylus J, et al. Financial crisis, austerity, and health in Europe. *Lancet* 2013; **381**: 1323–31.
- Rechel B, Wright B, Edwards N, Dowdeswell B, McKee M, eds. Investing in hospitals of the future. European Observatory on Health Systems and Policies: World Health Organization, 2009.
- Pearse RM, Moreno RP, Bauer P, et al, and the European Surgical Outcomes Study (EuSOS) group for the Trials groups of the European Society of Intensive Care Medicine and the European Society of Anaesthesiology. Mortality after surgery in Europe: a 7 day cohort study. *Lancet* 2012; **380**: 1059–65.
- Francis R. Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry. London: The Stationery Office, 2013.
- Keogh B. Review into the quality of care and treatment provided by 14 hospital trusts in England: overview report. 2013. <http://www.nhs.uk/NHSEngland/bruce-keogh-review/Documents/outcomes/keogh-review-final-report.pdf> (accessed Jan 13, 2014).
- Thomas S, Keegan C, Barry S, Layte R. The Irish health system and the economic crisis. *Lancet* 2012; **380**: 1056–57.
- Legido-Quigley H, Otero L, la Parra D, Alvarez-Dardet C, Martin-Moreno JM, McKee M. Will austerity cuts dismantle the Spanish healthcare system? *BMJ* 2013; **346**: f2363.
- Jarman B, Gault S, Alves B, et al. Explaining differences in English hospital death rates using routinely collected data. *BMJ* 1999; **318**: 1515–20.
- Rafferty AM, Clarke SP, Coles J, et al. Outcomes of variation in hospital nurse staffing in English hospitals: cross-sectional analysis of survey data and discharge records. *Int J Nurs Stud* 2007; **44**: 175–82.
- Van den Heede K, Lesaffre E, Diya L, et al. The relationship between inpatient cardiac surgery mortality and nurse numbers and educational level: analysis of administrative data. *Int J Nurs Stud* 2009; **46**: 796–803.
- Schubert M, Clarke SP, Aiken LH, de Geest S. Associations between rationing of nursing care and inpatient mortality in Swiss hospitals. *Int J Qual Health Care* 2012; **24**: 230–38.
- Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Med Care* 2007; **45**: 1195–204.
- Aiken LH, Clarke SP, Cheung RB, Sloane DM, Silber JH. Educational levels of hospital nurses and surgical patient mortality. *JAMA* 2003; **290**: 1617–23.
- Estabrooks CA, Midodzi WK, Cummings GG, Ricker KL, Giovannetti P. The impact of hospital nursing characteristics on 30-day mortality. *Nurs Res* 2005; **54**: 74–84.
- Aiken LH, Cimiotti JP, Sloane DM, Smith HL, Flynn L, Neff DF. Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Med Care* 2011; **49**: 1047–53.
- Blegen MA, Goode CJ, Park SH, Vaughn T, Spetz J. Baccalaureate education in nursing and patient outcomes. *J Nurs Adm* 2013; **43**: 89–94.
- Kutney-Lee A, Sloane DM, Aiken LH. An increase in the number of nurses with baccalaureate degrees is linked to lower rates of postsurgery mortality. *Health Aff (Millwood)* 2013; **32**: 579–86.
- American Nurses Association. Safe nurse staffing laws in state legislatures. 2013. <http://safestaffingsaveslives.org/whatisanadoing/StateLegislation.aspx> (accessed Jan 13, 2014).
- Aiken LH, Sloane DM, Cimiotti JP, et al. Implications of the California nurse staffing mandate for other states. *Health Serv Res* 2010; **45**: 904–21.
- Institute of Medicine (IOM). The future of nursing: leading change, advancing health. Washington: The National Academies, 2011.
- European Parliament. Recognition of professional qualifications and administrative cooperation through the Internal Market Information System. Article 31 amended. <http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P7-TA-2013-408#BKMD-17> (accessed Jan 24, 2014).

- 22 Sermeus W, Aiken LH, Van den Heede K, et al, and the RN4CAST consortium. Nurse forecasting in Europe (RN4CAST): Rationale, design and methodology. *BMC Nurs* 2011; **10**: 6.
- 23 Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Sermeus W, and the RN4CAST Consortium. Nurses' reports of working conditions and hospital quality of care in 12 countries in Europe. *Int J Nurs Stud* 2013; **50**: 143–53.
- 24 Aiken LH, Sermeus W, Vanden Heede K, et al. Patient safety, satisfaction, and quality of hospital care: cross-sectional surveys of nurses and patients in 12 countries in Europe and the United States. *BMJ* 2012; **344**: e1717.
- 25 Silber JH, Kennedy SK, Even-Shoshan O, et al. Anesthesiologist direction and patient outcomes. *Anesthesiology* 2000; **93**: 152–63.
- 26 Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care* 2005; **43**: 1130–39.
- 27 Aylin P, Bottle A, Majeed A. Use of administrative data or clinical databases as predictors of risk of death in hospital: comparison of models. *BMJ* 2007; **334**: 1044.
- 28 Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; **40**: 373–83.
- 29 Zabalegui A, Macia L, Márquez J, et al. Changes in nursing education in the European Union. *J Nurs Scholarsh* 2006; **38**: 114–18.
- 30 Dall TM, Chen YJ, Seifert RF, Maddox PJ, Hogan PF. The economic value of professional nursing. *Med Care* 2009; **47**: 97–104.
- 31 Needleman J, Buerhaus PI, Stewart M, Zelevinsky K, Mattke S. Nurse staffing in hospitals: is there a business case for quality? *Health Aff (Millwood)* 2006; **25**: 204–11.
- 32 McHugh MD, Berez J, Small DS. Hospitals with higher nurse staffing had lower odds of readmissions penalties than hospitals with lower staffing. *Health Aff (Millwood)* 2013; **32**: 1740–47.
- 33 Quentin W, Scheller-Kreinsen D, Blümel M, Geissler A, Busse R. Hospital payment based on diagnosis-related groups differs in Europe and holds lessons for the United States. *Health Aff (Millwood)* 2013; **32**: 713–23.