**TITLE:** The association between ward staffing levels, mortality and hospital readmission in older hospitalised adults, according to presence of cognitive impairment: a retrospective cohort study

**KEYWORDS:**

Workforce, cognitive dysfunction, mortality, thirty-day readmission

**KEY POINTS:**

* Mortality in hospital is known to be influenced by levels of registered nurse staffing.
* Post-surgical studies suggest that people with cognitive impairments may be more sensitive to the effects of lower staffing.
* We found higher nurse staffing was associated with reduced mortality, with greater effect in cognitively impaired patients.
* Higher nurse staffing levels were also associated with a reduction in readmissions for patients with cognitive impairment.
* Increased nursing assistant hours benefitted cognitively impaired patients but increased mortality in the cognitively intact.

**WORD COUNT:**

2570

**ABSTRACT**

**Background**

Lower nurse staffing levels are associated with increased hospital mortality. Older patients with cognitive impairments have higher mortality rates than similar patients without cognitive impairments and may be additionally vulnerable to low staffing.

**Objectives**

To explore associations between registered nurse (RN) and nursing assistant (NA) staffing levels, mortality and readmission in older patients admitted to general medical/surgical wards.

**Research Design**

Retrospective cohort.

**Participants**

All unscheduled admissions to an English hospital of people aged ≥75 with cognitive screening over 14 months.

**Measures**

The exposure was defined as deviation in staffing hours from the ward daily mean, averaged across the patient stay. Outcomes were mortality in hospital/ within 30 days of discharge and 30-day re-admission. Analyses were stratified by cognitive impairment.

**Results**

12,544 admissions were included. Patients with cognitive impairment (33.2%) were exposed to similar levels of staffing as those without. An additional 0.5 RN hours per day was associated with 10% reduction in the odds of death overall (Odds Ratio 0.90 [95% CI 0.84-0.97]): 15% in patients with cognitive impairment (OR 0.85 [0.74-0.98]) and 7% in patients without (OR 0.93 [0.85-1.02]). An additional 0.5 NA hours per day was associated with a 15% increase in mortality in patients with no impairment. Readmissions decreased by 6% for an additional 0.5 RN hours in patients with cognitive impairment.

**Conclusions**

Although exposure to low staffing was similar, the impact on mortality and readmission for patients with cognitive impairment was greater. Increased mortality with higher NA staffing in patients without cognitive impairment needs exploration.

**INTRODUCTION**

Older hospitalised patients with cognitive impairments are at greater risk of death, longer hospital stays and increased early readmissions than otherwise similar patients without such impairments [[1](#_ENREF_1), [2](#_ENREF_2)]. Such patients need complex care to avoid deterioration in hospital, e.g. support with food and fluid intake, mobilisation, and prevention of hospital-acquired complications including delirium [[3](#_ENREF_3), [4](#_ENREF_4)]. Historically, hospitals have operated with lower nursing establishments on older people’s wards, and find it increasingly difficult to achieve planned staffing given staff shortages [[5](#_ENREF_5), [6](#_ENREF_6)]. Insufficient nursing resource may underlie care deficiencies in acute hospital care for people with dementia, but it is unknown how staffing levels influence outcomes such as mortality or early readmission [[7](#_ENREF_7)].

Research in general hospital populations has established an association between lower nurse staffing levels and increased risk of death and other adverse outcomes [[8-10](#_ENREF_8)]. The evidence is consistent with a causal relationship, with plausible mechanisms including lower adherence to observation schedules, medication errors and hospital-acquired complications [[11-13](#_ENREF_11)]. There is less evidence concerning staff such as nursing assistants (NA) who deliver substantial amounts of direct personal care on hospital wards, and assist registered nurses with clinical duties, e.g. pressure ulcer care [[14](#_ENREF_14)]. Associations between mortality and skill mix of the nursing team, (i.e. proportion of registered nurses of total nursing care workforce, including NA), have been demonstrated. Each 10% increase in staff with professional nursing qualifications was associated with 11% lower odds of mortality in patients aged ≥50 after general surgery in one study [[15](#_ENREF_15)]. Richer skill mix was associated with lower proportions of nurses reporting frequent occurrence of hospital-acquired complications such as pressure ulcers, urinary tract infections and injury after falls, i.e. care-sensitive indicators which lead to longer hospital stays and further deterioration, especially in patients with dementia [[15](#_ENREF_15), [16](#_ENREF_16)].

The increase in mortality associated with low staffing levels may be exacerbated in patients with cognitive impairment. A study including older post-surgical patients found a 10% increase in the proportion of professional nursing staff was associated with 10% lower odds of death in patients with Alzheimer’s disease and related dementias, but only 4% lower odds in those without [[17](#_ENREF_17)]. Qualitative evidence suggests that missed care may be related to active decision-making by staff, and that patients with dementia may be monitored less frequently [[18](#_ENREF_18)]. Additionally, nursing staff have expressed a lack of knowledge and training in caring for older patients with cognitive impairments [[19](#_ENREF_19), [20](#_ENREF_20)].

This study aims to determine whether older patients with cognitive impairment are more vulnerable to the effects of staffing provision. Examining a cohort of unscheduled hospital admissions of older people, we explore associations between exposure to low nurse staffing and risk of death or readmission in all older people and according to presence of cognitive impairment.

**METHODS**

**Design**

Retrospective cohort study using routinely collected electronic healthcare records.

**Setting**

A district general 1,200 bed hospital in England, including tertiary services for cancer and renal care.

**Population**

Unscheduled admissions of people aged ≥75 with cognitive screening performed (>80% coverage), admitted and discharged between 29th January 2014 and 31st March 2015.

**Data Sources**

Administrative and clinical databases were used to extract patient demographics, admission and discharge details, ward transfers, date of death and diagnoses, vital signs, National Early Warning Scores (NEWS), and Malnutrition Universal Screening Tool (MUST) scores.

Patients were routinely screened for cognitive impairment as part of clinical care. An existing diagnosis of dementia was established from medical history. If no dementia, the following questions were answered from clinical assessments, patient/carer history, or medical notes: (1) “Is the patient exhibiting disturbed behaviour?” (2) “Has the patient been increasingly forgetful over the last 12 months so that it has had an impact on their daily life?” If ‘yes’ to one or both questions, an Abbreviated Mental Test (AMT) was performed. Cognitive impairment was defined as either a known diagnosis of dementia, or a positive answer to at least one screening question and AMT score ≤8.

Staffing data was extracted from an electronic rostering system for hospital staff and a database including agency data and hospital employee supra-contract shifts. Job titles and salary bands were used to identify RNs and NAs. Information on dates, times and wards of shifts worked was aggregated for 32 defined medical and surgical ward entities.

**Exposure**

Hours Per Patient Day (HPPD) was defined as the number of RN/NA/total hours worked over 24 hours per ward, divided by total patient hours (accounting for admission times and ward transfers). As staffing requirements vary by ward for each ward and for each day, we normalised the staffing level by calculating the deviation in hours per day from the ward mean. The ward means closely corresponded to the planned staffing levels shift as determined by the Safer Nursing Care Tool, thus used as reference levels [[12](#_ENREF_12), [21](#_ENREF_21)]. For each patient we calculated the mean HPPD for RNs and NAs across the study period, creating a variable which reflected the average staffing level that the patient was exposed to, relative to the ward’s planned staffing across their entire stay. Days with highly atypical staffing patterns (generally immediately preceding ward closures or after openings or because of a mismatch between patient and staff data during ward moves) were excluded.

The patient’s ward location at midnight was linked to HPPD data for each day of admission. Staffing exposures relative to the mean per patient admission were derived by calculating the differences between the daily RN/NA HPPD and total care hours per patient day (CHPPD) and the ward mean for the study period, then averaging the differences over the admission days.

**Outcomes**

Outcomes included: (1) death in hospital or within 30 days of discharge; (2) unplanned readmission to hospital within 30 days of discharge (for patients discharged alive).

**Statistical methods**

A forward stepwise multivariable logistic regression approach was used to explore associations between exposure and outcome, using Akaike and Bayesian information criteria to assess variable contribution to model fit. Analyses were performed for the whole dataset and stratified by presence/absence of cognitive impairment. Models included quadratic and cubic terms as per recent evidence [[12](#_ENREF_12)]. Observed relationships, i.e. magnitude of associations (Odds Ratios) and their precision (95% confidence intervals), are described, with p-values relating to significance testing for the null hypothesis [[22](#_ENREF_22)]. Confidence intervals for combined workforce terms at 0.5 hours HPPD above the mean were calculated using a linear combination of estimators. The linear combination of the staffing terms was plotted, illustrating the shape of the relationship and marginal effects relative to mean staffing when all other variables are held at the mean or reference category, displaying results within the central 80% range of the data. Patient-level risk was adjusted with covariates in Table 1.

Admissions with no workforce data were excluded (n=24). For the remaining admissions, workforce data was unavailable for 10.2% of all days and averages/summary measures calculated from available days. Data completeness for covariates was above 99%, apart from MUST score, missing in 26.7% (n=3,346) of admissions. To maintain sample size and reduce selection bias, we included a dummy category to represent missing MUST values. Analyses were performed using Stata version 15.1 (College Station, Texas).

***>>> INSERT TABLE 1***

**Ethics**

Approved by the Isle of Wight, Portsmouth and South East Hampshire Research Ethics Committee, reference 08/02/1394.

**RESULTS**

The dataset included 161,822 days from 12,544 patient admissions (9,643 patients). Workforce data was available for 89.8% (n=145,271) days. Overall, the median RNHPPD was 3.95 [IQR 3.4-5.06], median NAHPPD 3.23 [IQR2.66-3.88] and median total CHPPD 7.55 [IQR6.64-8.65]. The median RNHPPD by ward type varied between 3.7 in surgical wards to 7.3 in the Medical Assessment Unit, and median NAHPPD from 2.7 in medical wards to 3.8 in medicine for older people wards. The ratio of RNs to NAs (skill mix) varied from 0.5 in older people’s wards to 0.7 in the Medical Assessment Unit.

Cognitive impairment (CI) was present in 33.2% (n=4,159) admissions, accounting for 41% of the total days of hospital stay. Patients with CI spent 53% of days on medicine for older people wards, compared to 24% for patients with no CI. (Table 2) Median total CHPPD per admission was 0.33 hours above the mean, comprised of 0.11 RN hours and 0.23 NA hours. Total CHPPD was below the mean on 35.5% of days; 42.0% of days had RN staffing below the mean and 33.6% days had NA staffing below the mean. Exposure to staffing below the mean was similar between cognitive groups. Patients with CI were older, more likely to be female, with higher NEWS, Charlson and MUST scores. The proportion of patients with two or more ward transfers were similar between groups.

***>>>INSERT TABLE 2***

Overall, 14% (n=1,757) of patients died in hospital or within 30 days of discharge: 19.9% (826/4,519) of patients with CI and 11.1% (931/8,385) in those without. The readmission rate was 10.2% (1,179/11,512): 12.6% (464/3680) in those with CI vs 9.1% (715/7832) with no CI.

Results from multivariable models are presented in table 3 with plots of associations in Figure 1. Higher levels of RN staffing were associated with reductions in mortality. For the whole cohort, reductions in mortality occurred only as staffing increased above the mean (fig 1.i), with an average additional 0.5 hours RNHPPD (relative to the ward mean) reducing the odds of death by 10% (Odds Ratio (OR) 0.90, 95% CI 0.84-0.97). The relationship with RN staffing was stronger in patients with CI, although none of the RN staffing terms reached statistical significance (fig 1.ii). An additional 0.5 hours RNHPPD above the mean was associated with a 15% reduction in the odds of death (OR 0.85 [0.74-0.98]) for patients with CI but a 7% decrease in those with no CI (OR 0.93 [0.85-1.02]) (fig 1.iii). The odds of death increased with higher NAHPPD for the whole cohort, but the association was weak and no staffing terms were statistically significant (fig 1.i). However, higher NAHPPD for patients with CI gave similar benefits to RNHPPD, with an 0.5 hour increase associated with a 12% decrease in mortality (OR 0.88 [0.75-1.02]) (fig 1.ii), as compared to a 15% increase in mortality in patients with no CI (OR 1.15 [1.02-1.29] (fig 1.iii).

***>>>INSERT TABLE 3***

***>>>INSERT FIGURE 1***

The odds of readmission decreased when patients were exposed to levels of RN staffing above the mean, with a statistically significant association in patients with CI (Table 3, Fig 1 iv-vi). An 0.5 hour increase in RNHPPD reduced the odds of readmission in patients with CI by 6% (OR 0.94 [0.82-1.06]), and by 3% in patients without CI (OR 0.97 [0.88-1.07]). Higher NA staffing was associated with increased odds of readmission overall and for patients with CI in particular, although *p*>0.05 for all NA staffing terms in all models (fig 1 iv-vi).

**DISCUSSION**

We aimed to determine how variation in staffing levels experienced by older patients with cognitive impairment influences adverse outcomes. We found that registered nurse and nursing assistant staffing levels are associated with the outcomes of older people with acute admissions to hospital. Higher RN staffing was associated with better patient outcomes, with improved outcomes occurring when patients experienced staffing levels above current means, especially for patients with cognitive impairment. These findings are consistent with previous evidence which found a stronger effect of RN staffing on mortality for surgical patients with dementia than for those without [[17](#_ENREF_17)]. Higher NA staffing for patients with cognitive impairment was associated with similar reductions in mortality to higher RN staffing. However, higher NA staffing in patients without cognitive impairment was associated with an increased risk of mortality.

Higher RN staffing was associated with a reduced risk of readmission for patients with cognitive impairment (CI). Nurses are instrumental in the discharge process, which is particularly complex for patients with CI, and their ability to fulfil this role adequately is restricted when staffing is low [[13](#_ENREF_13), [23](#_ENREF_23)]. Furthermore, higher nurse staffing may reduce delays in organising referrals as well as physical care, medications and pain control, thereby reducing in-hospital deconditioning to which people with CI are particularly prone, thus influencing readmission rates [[24](#_ENREF_24), [25](#_ENREF_25)].

Reductions in mortality and readmissions continued to accrue at RN staffing levels well above the mean. Older people with CI were not exposed to low staffing more than those without but did appear more vulnerable to its effects. Guidance to establish and monitor staffing levels reflects acuity and dependency, but is based at ward and specialty level, and may not accurately reflect daily changes in case-mix and complex care needs of older patients, particularly those with CI [[21](#_ENREF_21), [26](#_ENREF_26)]. It is likely further staffing adjustments would be useful for wards with older patients with complex conditions, based on a greater understanding of how staffing influences outcomes for different patient groups [[27](#_ENREF_27)].

Given the dip in uptake of nursing education in the UK, loss of trained nurses and increasing numbers of unfilled nursing posts, the protective effect of higher registered nurse staffing is significant [[28](#_ENREF_28)]. In this and other studies, reductions in mortality are only associated with higher RN staffing, which does not support arguments for substitution between RN and NA [[12](#_ENREF_12)] Although the nursing workforce shortage has stimulated the creation of cadres of staff such as nursing associates, the best ‘package’ of staffing numbers and education to optimise outcomes for older patients with CI remains unknown.

The association between higher NA staffing and higher mortality in patients with no CI reflects recent findings [[12](#_ENREF_12)]. Patients with CI often require specialling (1:1 care) to reduce risk of harm, which may have contributed to the downward trend in mortality in this study. Thus, NA staffing exposure may differ between patients with/without CI in a ward where specialling occurs, and differences may be exaggerated with staff shortages, since specialling is a priority. A recent review concluded the impact of specialling on patient outcomes is unclear, suggesting further research to understand its impact is required [[29](#_ENREF_29)].

Observed curvilinear effects may reflect differences in care focus with staffing levels, i.e. maintaining fundamentals of care and preventing acute clinical deterioration at lower staffing and providing more preventive care to reduce mortality at higher staffing levels. These relationships need to be explored more fully, by capturing data on mediators of the association between staffing levels and poor outcomes e.g. frequency of missed care, as well as intermediate outcomes (e.g. delirium, falls, malnutrition and functional decline), and move towards interventions to directly address these [[30](#_ENREF_30)].

**Strengths and Limitations**

This study uses a large dataset, and controls for risk factors for mortality and readmission. Although individual patient exposures to staffing are measured, using ward averages may not reflect individual-level care provision and may mask chronic ward-level understaffing. Staffing or patient-flow decisions arising during shifts could have influenced results, e.g. staff movement between wards or selective admission of patients to wards without staffing shortages, may not have been recorded. Data for other staff with important roles in the patients’ care and rehabilitation, e.g. doctors, dementia care workers, occupational therapists, speech and language therapists, dieticians and physiotherapists, was unavailable. Patient-level factors which could explain further variation, e.g. functional indicators of mobility, ability to self-care, delirium and palliative care, are not routinely collected in the electronic record but should be considered in prospective studies.

**CONCLUSIONS**

For older people with cognitive impairment admitted to hospital, there are associations between higher nurse staffing and reduced mortality and readmission. People with cognitive impairment appear to benefit more from higher staffing than people without and thus may be more vulnerable to the effects of lower staffing. Increased mortality with higher nursing assistant staffing in patients without cognitive impairment needs further exploration.

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**Author contributions**

All authors contributed to the concept of the paper. PM contributed to the acquisition of data. CF performed the analysis and drafted the paper. All authors revised the drafts and approved the final version.

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**Disclaimer**

The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

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