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School of Health Sciences

Hospital Outcomes for Older People with Cognitive Impairment and Dementia

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by

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Abstract

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Older people with a diagnosis of dementia are at higher risk of poor outcomes following a hospital admission, such as death and longer lengths of stay. It is not known whether older people with other causes of cognitive impairment are at a similar risk, whether dementia or other cognitive impairments are independent risk factors, and whether staffing levels may differentially influence outcomes.

This work is based on a secondary care dataset of more than 20,000 hospital admissions. The characteristics of older people with acute hospital admissions and their outcomes according to the presence of dementia/cognitive impairment are described, and the associations between dementia/cognitive impairment and mortality, length of stay and readmission investigated. The clinical dataset was linked to data on nurse staffing to understand how varying staffing levels influence mortality and readmission in people with any cause of cognitive impairment.

Cognitive impairment was found to be prevalent in the older hospital population. Patients with cognitive impairment but no diagnosis of dementia had a similar risk of dying in hospital and longer lengths of stay as compared to patients with an existing diagnosis of dementia. There was an independent association between cognitive impairment (with or without a diagnosis of dementia) and higher hospital mortality, longer hospital stays and higher readmissions to hospital after controlling for other significant risk factors. Nurse staffing time per patient above mean values significantly decreased mortality for all patients, with a greater effect for patients with cognitive impairment, as well as reducing readmissions in this group. Increased nursing assistant hours improved mortality rates in patients with cognitive impairment but were significantly associated with increased mortality in cognitively intact patients.

The thesis includes two articles which establish a vulnerable clinical population in hospital and provide estimates of associations with poor outcomes, and a further article which highlights staffing levels as a consideration for modifying care for this patient group. The results provide evidence that although older people with cognitive impairment are at higher risk from worse hospital outcomes, this risk may be modified by appropriate provision of nursing workforce. Further work is required to understand the mechanisms of risk reduction with higher staffing levels for older hospitalised patients with cognitive impairment.

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Research Thesis: Declaration of Authorship

Print name:	Carole Lesley Fogg

Title of thesis:	Hospital Outcomes for Older People with Cognitive Impairment and Dementia: Exploring potentially modifiable risk factors using routinely collected data

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:

    a) Fogg C, Meredith P, Bridges J, Gould GP, Griffiths P. The relationship between cognitive impairment, mortality and discharge characteristics in a large cohort of older adults with unscheduled admissions to an acute hospital: a retrospective observational study. Age and Ageing. 2017 Sep 1;46(5):794-801. doi: 10.1093/ageing/afx022

    b) Fogg C, Griffiths P, Meredith P, Bridges J. Hospital outcomes of older people with cognitive impairment: An integrative review. International Journal of Geriatric Psychiatry 2018 Jun 26; 33:1177-1197. doi: 10.1002/gps.4919

    c) Fogg C, Meredith P, Culliford D, Bridges J, Spice C, Griffiths P. Cognitive impairment is independently associated with mortality, extended hospital stays and early readmission of older people with emergency hospital admissions: A retrospective cohort study.

International Journal of Nursing Studies. 2019 Aug; 96:1-8 doi: 10.1016/j.ijnurstu.2019.02.005.

d) Fogg C, Bridges B, Meredith P, Spices C, Field L, Culliford D, Griffiths P. The association between ward staffing levels, mortality and hospital readmission in older hospitalised adults according to presence of cognitive impairment: a retrospective cohort study. Age and Ageing, published online 24th September 2020 https://doi.org/10.1093/ageing/afaa133

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Definitions and Abbreviations

A&E	Accident and Emergency department
ADL	Activities of daily living
ADRD	Alzheimer's disease and related dementias
AIC	Akaike information criterion
AMI	Acute myocardial infarction
AMTS	Abbreviated mental test score
aOR	Adjusted odds ratio
APACHE II	Acute physiology and chronic health evaluation II
AUROC	Area under the receiver operating characteristic curve
BEHAVE-AD	Behavioural pathology in Alzheimer Disease scale
BI	Barthel index
BIC	Bayesian information criterion
BMI	Body mass index
BPSD	Behavioural and psychological symptoms of dementia
CCI	Charlson comorbidity index
95% CI	95% confidence interval
CI	Cognitive impairment
CIF	Cumulative incidence function
CQUIN	Commissioning for Quality and Innovation
DD	Dementia diagnosis
DSD	Delirium superimposed on dementia
DSM	Diagnostic and Statistical Manual of Mental Disorders
FCE	Finished consultant episode
FIM	Functional independence measure
GP	General practitioner
HAI	Hospital acquired infection
HPPD	Hours per patient day
IADL	Instrumental activities of daily living
IQR	Interquartile range
LOS	Length of stay
MMSE	Mini-mental state examination
MNA	Mini nutritional assessment
MOPRS	Medicines for older people, rehabilitation and stroke
MSSE	Mini suffering state examination scale
MUST	Malnutrition Universal Screening Tool
NA	Nursing assistant (synonym for 'healthcare assistant')
NAHPPD	Nursing assistant hours per patient day
NEWS	National Early Warning Score
NHS	National Health Service
OR	Odds ratio
PHT	Portsmouth Hospitals NHS Trust
POPAC	Person-centred care of older people with cognitive impairment in acute care scale
PU	Pressure ulcer

QUALID	Quality of life in late stage dementia
RN	Registered nurse
RNHPPD	Registered nurse hours per patient day
SBT	Short Blessed Test
SD	Standard deviation
SHMI	Summary of healthcare mortality indicators
SHR	Sub-hazard ratio
SNCT	Safer Nursing Care Tool
UK	United Kingdom
UTI	Urinary tract infection

Chapter 1 Introduction

1.1 Thesis type

This thesis is presented in the '3-paper PhD' format. Three published papers form the main empirical work of the thesis, with a published review of much of the existing literature incorporated into the second chapter. Additional chapters preceding and following the empirical work provide a narrative to the work as a whole.

1.2 Overview of thesis contents

The aim of this work is to expand current knowledge on the association between cognitive impairment in older adults and key outcomes of unscheduled acute hospital care, including an analysis of the influence of nurse staffing on this relationship.

The literature relevant to this work is presented in Chapter 2. This includes a published integrative review of what is known about hospital outcomes for people with cognitive impairment, identifying the type of outcomes observed in previous research and the additional risk of these outcomes experienced by patients with cognitive impairment. This chapter also introduces the knowledge base concerning the impact of low nurse staffing on patient outcomes and discusses why nurse staffing may be particularly relevant for older adults with cognitive impairment. The current process for diagnosing dementia in the UK is then outlined and an introduction to the method of screening for cognitive impairment and dementia in secondary care which is relevant for this research is provided. The chapter concludes with a summary of the evidence gaps and a rationale for the work presented in the thesis.

The specific research questions to be answered, with the related chapters, are:

1. What is the prevalence of cognitive impairment (both with and without an existing diagnosis of dementia) in a large acute hospital population of patients aged 75 and above? (Chapter 4, Paper 1)
2. What are the demographic and clinical characteristics of older adults admitted to hospital and how do those with a dementia diagnosis, differ from those with those who have cognitive impairment but no dementia diagnosis, and from those with no cognitive impairment? (Chapter 4, Paper 1)

3. How do rates of adverse outcomes, such as in-hospital mortality, longer length of stay and new admissions to residential or nursing homes, compare between older hospitalised adults with cognitive impairment and no dementia diagnosis and those with dementia? (Chapter 4, Paper 1)
4. What is the association between cognitive impairment or a diagnosis of dementia and outcomes of hospitalisation, including mortality ((i) in-hospital and (ii) in hospital and within 30 days of discharge), length of stay and risk of readmission within 30 days in older hospitalised patients? (Chapter 5, Paper 2)
5. Are older people with cognitive impairment more likely to be exposed to lower levels of registered nurse (RN) and nursing assistant (NA) staffing? (Chapter 6, Paper 3)
6. Are there differences in the effects of low staffing levels on mortality and re-admission in older patients according to whether they have cognitive impairment? (Chapter 6, Paper 3)

The three empirical research papers are presented in Chapters 4 to 6, reproduced as the published or submitted versions. They are preceded by a more detailed overview of the data source in Chapter 3, which also highlights commonalities and differences in use of the data between the publications.

Paper 1 (Chapter 4) provides a general description of the characteristics and outcomes of older people with an unscheduled admission to hospital according to their cognitive impairment status, and a preliminary analysis of differences in rates of outcomes between people with a dementia diagnosis, people with cognitive impairment and no dementia diagnosis, and people with no cognitive impairment. This study demonstrated that there is a high prevalence of older patients who have cognitive impairment and no dementia diagnosis, and, given the numbers of older patients in hospital, this translates into a significant clinical population. The study also provided evidence that the patients with cognitive impairment and no dementia diagnosis have similar, if not worse, outcomes to those with a known diagnosis of dementia, which is surprising. As this study identified that there is a large group of patients with poor outcomes about which little is known, it was then important to progress this work to understand whether the cognitive impairment is an independent risk factor for the poor outcomes demonstrated, or whether other risk factors provided sufficient explanation.

Paper 2 (Chapter 5) builds on the findings from Paper 1, exploring whether these differences may be partly attributed to cognitive impairment, or whether they may be better explained by other risk factors, focussing on the outcomes of mortality, length of hospital stay and readmission. This study was the first to confirm that cognitive impairment, irrespective of dementia diagnosis, is an independent risk factor for mortality, extended length of stay and early readmission in older hospital patients with an emergency hospital admission. It also adds support to the current evidence that there is an association between patients who have a diagnosis of dementia and these outcomes and that this association seems to be independent of acuity and other factors known to be associated with risk. These findings now led to the question – why do older people with cognitive impairment have poorer outcomes? That is to say, what are the mechanisms by which such patients are put at greater risk, and are there factors within their hospital admission that can be modified which may improve their outlook?

Paper 3 (Chapter 6) focusses on whether nurse staffing levels, a potentially modifiable risk factor for poor outcomes, had a different impact for patients with cognitive impairment as compared to those without. Given that the integrative review highlighted intermediate outcomes which are more common in this population and that such outcomes may be influenced by the in-hospital care received, an examination of the quantity and skill-set of nursing care and its influence on the increased risk in these patients would be useful to establish whether staffing may play a role. This is the first study to describe the associations between RN and NA staffing levels and mortality and readmission in patients with cognitive impairment in an acute, general medical hospital population. Exposure to low staffing was similar, however there appeared to be a greater impact on mortality and readmission for patients with cognitive impairment. Although 'missed care' was not measured in this study, it may be presumed that this may be mediating the relationship between staffing and outcomes and thus partly explain the results. Patients with greater care needs (such as those with cognitive impairment) will, by default, have greater opportunities for 'missed care', and this may be why they benefit more visibly from the availability of higher levels of nursing staff.

Chapter 7 brings together the findings of the three papers and places them in context of the wider literature and current practices. The strengths and limitations of the work as a whole are discussed, and implications for practice and further research are outlined.

The thesis ends with two appendices. Appendix A includes the detailed tables of references for the literature review presented in Chapter 2. Appendix B provides a summary of the variables generated during the data manipulation and analysis process.

Chapter 2 Review of the literature

The background literature review for this thesis summarises what was already known about hospital outcomes for older people identified as having cognitive impairment. It was published as: Fogg C, Griffiths P, Meredith P, Bridges J. Hospital outcomes of older people with cognitive impairment: an integrative review, International Journal of Geriatric Psychiatry, 2018 June 26; 33:1177-1197 (Fogg et al., 2018), and is reproduced in full in the following section. It is followed by an overview of the literature on staffing levels and patient outcomes, and a description of current methods for identifying cognitive impairment and dementia in England.

2.1 Hospital outcomes of older people with cognitive impairment: an integrative review

2.1.1 Introduction

Between 25%-40% of older people admitted to acute hospitals have been diagnosed with dementia, (e.g. Alzheimer’s disease, dementia syndrome according to Diagnostic and Statistical Manual of Mental Disorders (DSM) IV etc), or have evident cognitive impairment due to undiagnosed dementia or another cause (Mukadam and Sampson, 2011, Siddiqi et al., 2006). People with dementia occupy approximately 25% of hospital beds in the UK, stay up to six times longer than other older patients, and have a greater risk of dying in hospital; however outcomes for people with any cause of cognitive impairment (CI) are less well described (Alzheimer's UK, 2016, Briggs et al., 2017). Poor hospital outcomes, e.g. death or new discharge to a residential home, may occur following a series of less frequently reported outcomes which patients with CI may be more likely to experience in hospital. These intermediate outcomes may be an appropriate focus of attention to target nursing and other care and treatment, as, to reduce these outcomes, we must first understand how and why these patients deteriorate in hospital and identify the specific risk factors at patient and hospital level. Knowing how day-to-day clinical and wellbeing outcomes for patients with CI differ from those with no CI during hospitalisation could help us identify specific areas of prevention or care which could improve the journey, and therefore the final outcome, for these patients.

Dementia is significantly underdiagnosed in the community, and delirium and CI often pass undetected in hospital (Sampson et al., 2009, Ryan et al., 2013). A full diagnostic assessment for dementia during an acute hospital admission for all older people is neither appropriate nor feasible. However, simple cognition screening tests can be used to detect CI, e.g. the Abbreviated

Mental Test Score for cognitive function or the Confusion Assessment Method for delirium (Hodkinson, 1972, Folstein et al., 1975, Inouye et al., 1990). Studies of acutely hospitalised older people using systematically applied screening tests for CI have highlighted that a significant proportion do not have a dementia diagnosis, but patients with CI experience rates of hospital outcomes, e.g. mortality, more similar to those of patients with dementia than patients with no CI (Fogg et al., 2017, Reynish et al., 2017). Greater understanding of the outcomes of older people with various causes of CI should inform how we can improve care for the whole population at risk. There are currently no published reviews in this area.

This review aims to summarise existing available evidence about the outcomes of older patients with cognitive impairment admitted to hospital. Specifically, to establish which outcomes have been investigated, the additional risk of outcomes in people with CI, and factors that may influence outcomes.

2.1.2 Methods

2.1.2.1 Integrative review method

Integrative review methodology enables inclusion of a broad range of study designs and non-research literature, e.g. audits and theoretical perspectives (Torraco, 2005, Whittemore, 2005). The method summarises findings with mixed narrative and tabular presentation, identifies common themes in study results and highlights inconsistencies, without numerical synthesis.

2.1.2.2 Data sources and search strategy

MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO and EMBASE, AgeInfo and the Cochrane Library were searched. Terms used (e.g. medical subject headings) to describe the population included: (1) demographic group: “Aged, hospitalised”, “aged hospital patient”, aged, geriatric, senior; (2) clinical group: “cognition disorders”, dementia, “Alzheimer’s disease”, “cognitive impairment”, “cogniti* impair*”, “cognitive defect” “delirium/dementia/amnestic, cognitive disorders”, “frontotemporal dementia”, “dementia vascular”, “dementia, multi-infarction”, “Lewy body dementia”, “dementia, senile”; (3) health service use group: “hospital admission”, hospital*. (See supplementary material). Additional evidence was retrieved by reviewing reference lists, forward citation searches and searching websites of organisations focussing on the care of older people, e.g. Age UK, British Geriatrics Society, Royal College of Nursing, Alzheimer’s Society, Alzheimer’s UK.

2.1.2.3 Criteria for inclusion of evidence

Studies included were those which investigated: (i) outcomes of older people with CI with a hospital admission as a main purpose of the study, or (ii) the contribution of CI to an outcome of interest related to hospitalisation, including other disease outcomes, surgical or medical treatments, or (iii) outcomes of people with CI in Intensive Care Units during hospital admission; where the outcomes occurred during hospitalisation or at discharge. The search was limited to articles published in the last 20 years (since 1997) as these will reflect contemporary service provision, care practices, and up-to-date methods of detecting dementia/CI. Studies which reported on outcomes of Emergency Department visits only, elective surgical patients, patients with delirium with no evidence of prior CI, and those taking place within specialised psychogeriatric units were excluded.

2.1.2.4 Evaluation of evidence

Titles and abstracts were screened for review aims. Full texts were obtained for potentially relevant articles, and screened against eligibility criteria. Screening and data extraction was undertaken by a single reviewer, and decisions checked with a second reviewer in case of uncertainty. The relevance of all included studies was verified by three reviewers. As one of the purposes of this review was to understand which outcomes are being measured for this population in hospital, no formal quality assessment was performed to maintain inclusivity. Methodological issues, e.g. the potential for bias, are indicated in text or tables where appropriate.

2.1.3 Results

1,362 records were identified from database searches, reference lists and website searches. Following review of abstracts and full papers against eligibility criteria. 104 articles were included in the review (Figure 1). The median number of participants was 498 (range 4-3,000,000), mostly of people aged ≥50. Participants cohorts included general inpatients, specific conditions e.g. heart failure or fractures, or with specific clinical interventions, e.g. catheterisation. CI was defined in several ways, e.g. of dementia diagnosis, cognitive spectrum disorder (delirium, dementia or Abbreviated Mental Test (AMT) <8), or other assessments e.g. Short Blessed Test (SBT).

The articles encompass a range of methodologies, e.g. observational studies comparing patients with/without CI; studies in which cognitive status or dementia were evaluated as risk factors for specific outcomes; qualitative studies and audits. A variety of outcomes were explored, mostly in patients with dementia compared to those without, but also in patients with measurable CI regardless of diagnosis. Associations between CI and outcomes were assessed using a variety of covariates, reflecting the study context and data sources available. Articles with more than one outcome are presented in the appropriate tables.

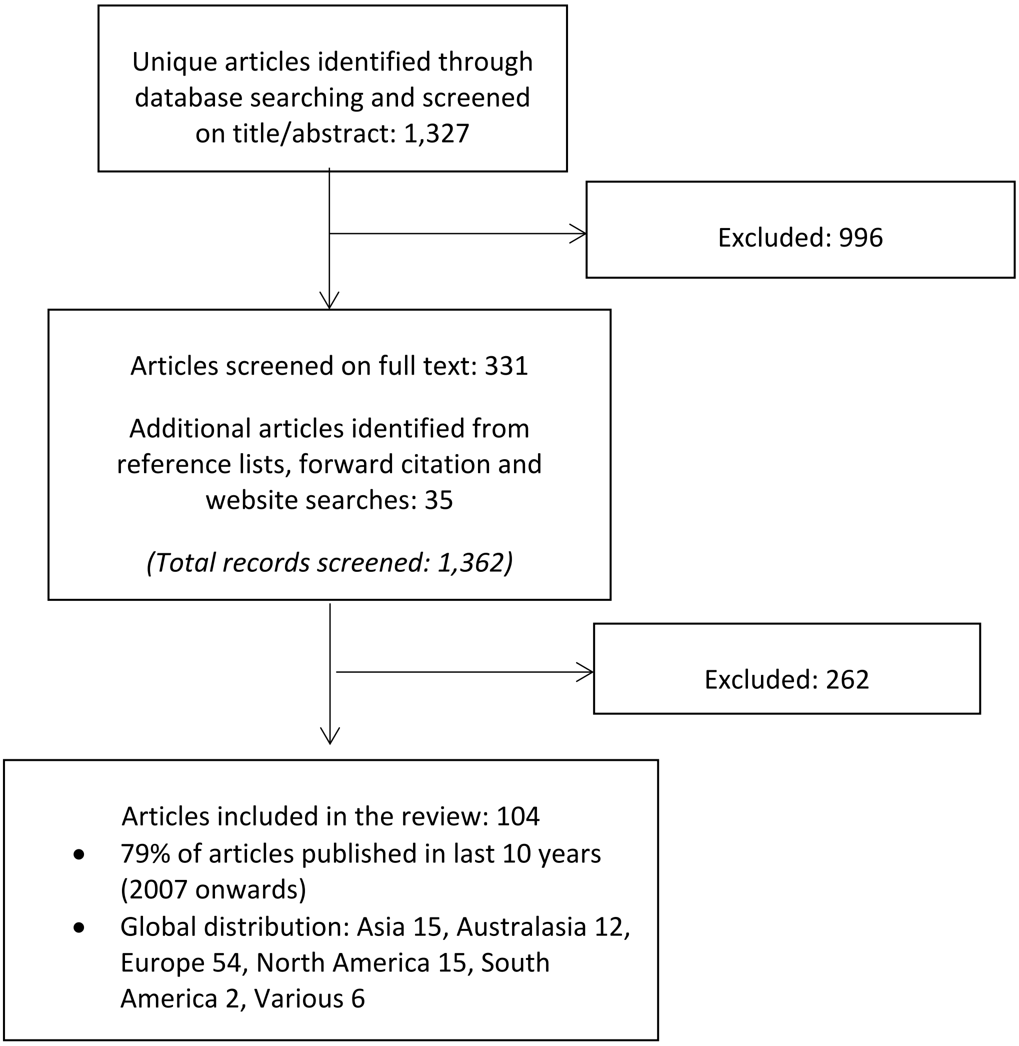

Figure 1 Selection of articles

2.1.3.1 Clinical and patient-centred outcomes during hospitalisation

Patients' experiences of hospital admission

An integrative review summarising 24 papers on patient and carer experience concluded people with dementia are stigmatised in hospitals, and acute care needs and tasks are prioritised over personalised care (Digby et al., 2016) (Table 14). The UK National Audit of Dementia Care found 17% of comments about patient care (collected via a carer questionnaire) described care negatively, and 9% expressed patient did not receive care appropriate to their needs (Royal College of Psychiatrists, 2017). Surveys estimate around 60% of people with dementia are not treated with dignity or understanding whilst hospitalised, and the majority are frightened by the hospital environment (Alzheimer's UK, 2016). Reporting of negative experiences has been observed to follow a model, the 'cycle of discontent', in which poor communication and relationship building between staff and patients/carers lead to expectations not being met, subsequent cycles of identification of poor care and challenge to staff, further deterioration in the relationship and ultimately reporting of poor experiences (Jurgens et al., 2012). It has been observed there are many missed opportunities in hospitals to provide person-centred care and enable a person with dementia to sustain personhood (Clissett et al., 2013). No studies were found that discussed experiences of older patients with any cause of CI.

Behavioural and psychological symptoms of dementia (BPSD)

The prevalence of BPSD symptoms in people with dementia in hospital rises during admission, likely due to unmet needs and distress, and a higher overall BEHAVE-AD score (incorporating BPSD) associated with increased mortality (Sampson et al., 2014). BPSD have been identified as a frequent cause of complications in an Alzheimer Special Acute Care inpatient Unit, with agitation and aggressiveness representing 60% of BPSD events (Soto et al., 2012). A qualitative study identified disruption in routine, e.g. admission to hospital, triggering negative changes in behaviour as the person with dementia attempts to gain control over an unfamiliar environment (Porock et al., 2015).

Malnutrition or dehydration

Older people with dementia are more likely to have a low mini-nutritional assessment (MNA) score and laboratory indices indicating malnutrition at hospital admission, with overall MNA score and sub-score related to dietary habits (MNA-3) significant predictors of death in hospital (Kagansky et al., 2005). Of admitted patients who are already undernourished, those with CI are less likely to meet their required energy and protein intake, achieving <50% of total energy expenditure requirements (Miller et al., 2006). Organisational factors may contribute to decline in nutritional status through lack of availability of adequate nutrition. An audit revealed only 76% of staff considered people with dementia had their nutritional needs met ‘always or most of the time’, and <75% of staff said they could obtain snacks between meals for patients with dementia, who were unable to eat full meals at regular times (Royal College of Psychiatrists, 2017). Fluid intake is also a key indicator of fundamental care in hospital. Assessment of renal conservation of water in older patients showed concentrated urine in 16% of patients, more commonly in patients with confusion and/or dementia, and was related to higher 30-day mortality (Johnson et al., 2015).

Functional or cognitive decline

A meta-analysis identified functional decline (measured by activities of daily living (ADL), instrumental ADLs (IADL), Barthel Index (BI), mobility, functional independence measure (FIM) or

Rankin scale) in hospitalised adults aged ≥65 is independently associated with CI or a dementia diagnosis (Hartley et al., 2017). Further cognitive decline during hospitalisation is associated with an increased risk of functional decline, defined as a loss of ability to perform one or more ADLs without help between admission and discharge (Pedone et al., 2005).

Incident delirium during hospitalisation

The prevalence of delirium in general hospital patients is around 20%, and approximately half these patients have pre-existing dementia (Ryan et al., 2013). Although patients with dementia are more likely to have delirium at admission, dementia increases the likelihood of new-onset delirium (or 'delirium superimposed on dementia' - DSD) during hospitalisation (Ahmed et al., 2014, Pendlebury et al., 2015, Sá Esteves et al., 2016, Travers et al., 2014). Regardless of a dementia diagnosis, lower cognitive scores are associated with increased occurrence of delirium in hospital, and symptoms of greater severity, e.g. disordered attention, orientation, thought organization and memory (Pendlebury et al., 2015, Franco et al., 2010, Bo et al., 2009, Wilson et al., 2005, Voyer et al., 2006). CI and dementia are predictive of delirium occurring prior to or following surgery for fractures of the hip or proximal femur (Muangpaisan et al., 2015, Marcantonio et al., 2000, Wu et al., 2015, Tanaka, 2016). Hospital outcomes including mortality, institutionalisation and length of stay for patients with delirium are worse with pre-existing dementia (Jackson et al., 2016, Fong et al., 2012, Torpilliesi et al., 2010, Avelino-Silva et al., 2017). Dementia was associated with an increased risk of least 1 episode of delirium during the first 3 days of admission in adults aged ≥65, and increased the odds of unanticipated ICU admission or in-hospital death (Hsieh et al., 2015).

Adverse events and complications occurring in hospital

Events occurring during hospitalisation, e.g. urinary tract infections (UTI), pneumonia or gastroenteritis (Hospital acquired infections - HAI), pressure ulcers (PU), adverse drug reactions (ADR) falls and fractures impair recovery by reducing mobility, functional ability and nutritional status, increase care required and extend hospitalisation. CI or dementia leads to an increased risk of falls in hospital (Mecocci et al., 2005a, Härlein et al., 2011), including recurrent falls (Chen et al., 2011) and falls related to impulsive behaviour (Ferrari et al., 2012). In addition, factors identified in >75% of falls in patients with dementia included being in hospital at night, acute disease or symptoms of disease and/or acute drug side-effects (Tängman et al., 2010). Falls may result in fractures, which delay recovery and lengthen hospitalisation. Occurrence of fractures in patients with dementia is associated with hypnotic medicines, specifically short-acting benzodiazepine hypnotics, ultrashort-acting non-benzodiazepine hypnotics, hydroxyzine, risperidone and perospirone (Tamiya et al., 2015). Both medical and surgical inpatients with dementia are at higher risk of four common complications, UTIs, PUs, pneumonia and delirium, and medical patients are also at increased risk from sepsis and 'failure to rescue' (Bail et al., 2013). Pressure ulcers are also more common in patients with CI (Pendlebury et al., 2015). CI was shown to be the most significant risk factor for developing urinary and faecal incontinence (Mecocci et al., 2005a), with 36% and 2% new incontinence at discharge respectively (Furlanetto and Emond, 2016).

Polypharmacy (≥ 5 drugs/day) and dependence for at least 1 ADL were related to occurrence of at least one adverse drug reaction (ADR) in in-patients with dementia (Kanagaratnam et al., 2017). CI in older people is associated with increased HAIs, ADRs, and length of stay ≥7 days (Borenstein et al., 2013). ADRs may be less frequently reported in patients with CI, due to reduced ability to recognise and communicate side effects, leading to unsafe care (Onder et al., 2002). However, older patients with CI may be less likely to use inappropriate medication (as per Beers criteria), thus reducing ADR reporting in this group (Onder et al., 2003). A study exploring the relationship of adverse clinical events (i.e. any acute clinical problem that occurs newly during hospitalization) and mortality in patients with dementia showed at least one adverse clinical event (e.g. electrolyte disorders, hypertensive crisis, fractures or infections) increased the risk of death tenfold (Marengoni et al., 2011). Mild/moderate CI was associated with adverse events defined as 'incidents' (e.g. following an unintended 'accident' in hospital such as a slip or trip, medication error or staff miscommunication), but not subsequent mortality (Watkin et al., 2012).

In-patients with dementia have a higher risk of acute organ dysfunction and severe sepsis, particularly patients with comorbidities such as chronic obstructive pulmonary disease (COPD) (Shen et al., 2012, Liao et al., 2015). Inpatients with COPD and dementia were less likely to be receiving treatment for COPD and to have their lung function assessed, suggesting under-treatment could contribute to poorer outcomes (Frohnhofen et al., 2011).

2.1.3.2 Differences in care during hospitalisation

'Outlying' and bed moves

Pressures on hospital beds lead to older people not always being placed in the most suitable location for their care; known as 'outlying' or 'boarding'. These patients may be moved around the hospital several times until they reach their 'home ward'. Of patients under an Older Person Evaluation Review and Assessment (OPERA) team, who were more likely to be boarding than general medicine patients, those with pre-existing CI were more likely to be moved 3 or times during their hospital admission (Table 15) (Ranasinghe et al., 2017). In a further study, boarding patients with dementia and/or delirium had higher mortality within 48 hours of admission (Perimal-Lewis et al., 2016). Although hospital organisational factors result in night-time bed moves, these were deemed avoidable by 50% of staff surveyed in an audit, and considered detrimental to patient experience (Royal College of Psychiatrists, 2017).

Pain and end-of-life or palliative care

Pain may indicate a new infection, injury or worsening in condition. The prevalence of pain amongst in-patients with CI is estimated at 39%, and is associated with increases in the Behavioural Pathology in Alzheimer Disease Scale (BEHAVE-AD) score, and increased aggression, phobia and anxiety (Sampson et al., 2015). Dementia reduces a patient's ability to describe pain characteristics and changes, thus delaying diagnosis of infections or overtreating with analgesics like opioids, contributing to complications e.g. delirium, bowel problems and lengthened stay (Kelley et al., 2008). There is no current evidence as to whether patients with CI experience more pain during hospitalisation, probably due to difficulties in assessment.

End-of-life patients with dementia have fewer referrals to palliative care and are less prescribed palliative medicines, although no differences were found in one study comparing patients with terminal dementia to terminal heart failure (Sampson et al., 2006, Afzal et al., 2010, Formiga et al., 2007). Whereas invasive interventions were equally utilised in one study, arterial blood gas measurement and catheterisation were more frequent for patients with dementia, and central line placement less used in another study (Afzal et al., 2010, Sampson et al., 2006). Drug withdrawal rates in hospitalised end-of-life patients with dementia were higher than for patients with COPD or heart failure (Formiga and Pujol, 2006). In patients with terminal dementia, only 46% had adequate symptom control, with 13.5% experiencing uncontrolled pain and 51.5% dyspnoeic (Formiga et al., 2007). In an evaluation of suffering at end-of-life in patients with dementia using the Mini Suffering State Examination scale (MSSE), which includes psychological distress, spiritual concerns and physical pain, only 7% of patients died with the lowest level of suffering, with the majority experiencing significant suffering, highlighting insufficient assessment and palliative treatment (Aminoff and Adunsky, 2005).

Inappropriate catheterisation

Catheterisation could indicate deterioration in a person with CI in hospital, a sign of poor care (if inappropriately performed), or reduction in the ability of staff to provide effective care. Presence of CI was related to inappropriate catheterisation in older patients, with 'convenience of care' cited in 50% of cases, and led to a greater decline in ADLs during admission (Hu et al., 2015).

2.1.3.3 Mortality in hospital

Of 11 studies comparing mortality in general in-patients with/without dementia, 8 concluded patients with dementia have an increased risk of death, with estimates varying from adjusted Odds Ratio (aOR) 1.09 [1.03-1.16] to aOR 2.1 [1.0-4.5] (Table 16) (Barba et al., 2012, Marengoni et al., 2011, Draper et al., 2011, Hsiao et al., 2015, Sampson et al., 2009, Guijarro et al., 2010, Oreja-Guevara et al., 2012, Farid et al., 2013, Zuliani et al., 2012, CHKS, 2013). This difference is greater in people >65 years with dementia as compared to older patients (aOR 1.93 [1.55-2.41]) (Draper et al., 2011). In-patients with COPD and dementia have a higher mortality risk (Liao et al., 2015). Moderate and severe CI was associated with mortality after ICU admission, even adjusting for acuity scores (Acute Physiology and Chronic Health Evaluation II (APACHE II)) (Bo et al., 2003). A large cohort demonstrated significant differences in mortality for patients with CI but no diagnosis of dementia as compared to patients with no CI (11.8% vs 9.0%), and a further study showed a difference between ‘all cause’ CI and no CI (13.6% vs 9.0%) (Fogg et al., 2017, Reynish et al., 2017). The presence of CI, regardless of dementia, may independently predict in-hospital mortality, with the highest risk in patients with severe CI (Marengoni et al., 2013, Sampson et al., 2009).

Studies which have not shown a difference in mortality between people with/without dementia include a stratified analysis by occurrence of delirium, and one study excluding patients with sensorial deficits, communication problems or severe acute illness, i.e. a higher mortality risk (Sá Esteves et al., 2016, Zekry et al., 2011, Travers et al., 2014, Avelino-Silva et al., 2017). A systematic review concluded although cognitive function was a predictor of in-hospital mortality in 6 of 12 studies assessed, assessments of physical function and nutrition were also important in older patients (Thomas et al., 2013). In patients aged ≥80, functional status and comorbidities were predictive of poor outcomes, whereas dementia or other CI was not (Zekry et al., 2009, Freedberg et al., 2008). Studies exploring the contribution of CI to mortality have been adjusted for a range of covariates, e.g. functional/ nutritional assessments, comorbidities, laboratory indicators, which influence estimates of effect.

Contradictory findings regarding the contribution of dementia to mortality in patients presenting to hospital with acute myocardial infarction (AMI) could relate to variation in care provision, as patients with dementia report less chest pain and wait longer for treatment, have fewer transfers to intensive or coronary care units, and less frequent provision of invasive interventions (Kimata et al., 2008, Tehrani et al., 2013, Grosmaitre et al., 2013). Dementia was not found to be associated with hospital mortality in patients with stroke, or those with an ICU admission (Saposnik et al., 2012, Pisani et al., 2005).

2.1.3.4 Resource utilisation and discharge destination

Length of hospital stay

In most studies, CI or dementia increased length of hospital stay (LOS) (Fogg et al., 2017, Reynish et al., 2017, Power et al., 2017, Bo et al., 2016, Tropea et al., 2016, Guijarro et al., 2010, Connolly and O'Shea, 2015, Wancata et al., 2003, Li et al., 2013, Annear et al., 2016, Draper et al., 2011, Briggs et al., 2016, Lang et al., 2006, CHKS, 2013) (Table 17). Patients with DSD had longer mean LOS than those with dementia or delirium alone (Reynish et al., 2017). Concurrent dementia extends stays in older patients with hip fracture (Holmes and House, 2000), and haemorrhagic peptic ulcer disease (Murata et al., 2015). However, similar LOS were described in one article, and comorbidities found more predictive of longer hospital stays in another study (Zuliani et al., 2012, Zekry et al., 2009). Discharge after the patient is 'medically fit', due to delays in discharge planning or difficulties in organising residential care, contribute to longer LOS in people with CI (Bo et al., 2016, Timmons et al., 2016), in addition to mental and behavioural manifestations, falls or hospital-acquired complications (Saravay et al., 2004, Chen et al., 2011, Bail et al., 2015). LOS was longer in patients with Parkinsonism-related dementia or vascular dementia than Alzheimer's, and patients with concurrent diabetes mellitus, pneumonia and fall-related hip fracture had more hospital stays of >14 days (Chang et al., 2015).

Costs

Excess costs relating to increased LOS for patients with dementia exceeded £80 million, and dementia estimated to increase the average cost of an admission threefold (UK figures, 2011) (CHKS, 2013, Briggs et al., 2016). CI (dementia or delirium coded during admission) increased costs of hospital stay by 51% in Australia, and 39% for dementia alone (Tropea et al., 2016, Annear et al., 2016). In Ireland, dementia adds 246,908 hospital days per annum, costing €199 million (Connolly and O'Shea, 2015). Dementia was associated with increased treatment costs of $1171 for endoscopic hemostasis of hemorrhagic peptic ulcer (Murata et al., 2015). Patients with dementia experiencing complications accounted for 10.4% of hospital episodes, and 22% of extra costs (Bail et al., 2015). Large numbers of patients with dementia die in hospital, where costs for end-of-life care can be six times higher than hospice/home care (Lane et al., 1998), although appropriate management, e.g. palliative care consultations, reduce pharmacy costs through prescribing changes (Araw et al., 2015).

Discharge to a nursing or residential care home

Patients with CI are frequently discharged to nursing/residential homes (Fogg et al., 2017, Harrison et al., 2017b, Power et al., 2017, Zekry et al., 2009, CHKS, 2013). Dementia predicts of institutionalisation, (odds ratio 2.14 [1.24-3.70]), although less so in ambulatory care sensitive conditions (Draper et al., 2011, Zekry et al., 2009, Harrison et al., 2017a, Kasteridis et al., 2016). However, in stroke patients, no difference in discharge disposition was found between patients with/without dementia (Saposnik et al., 2012). Contributors to nursing home admissions in people with dementia include poor, uncoordinated hospital care, non-cognitive symptoms of dementia, (e.g. depression, agitation and delusions) and aggression as part of BPSD (Leung and Todd, 2010, Wancata et al., 2003, Tochimoto et al., 2015). Discharge planning should include considering the patient's wishes and using multidisciplinary-informed standards for discharge from hospital to a care home, although in an audit, consent to a change in residence was not recorded in >30% of patients, nor evidence of 'best interests' decision making where patients lacked capacity (Brindle and Holmes, 2005, Harrison et al., 2017b, Royal College of Psychiatrists, 2017). 54% of carers' comments regarding discharge/care transfer said discharge was unsafe and poorly planned, which may lead to readmissions due to lack of available support in the discharge location.

2.1.4 Discussion

It appears the presence of cognitive impairment (particularly dementia) in older hospitalised patients influences a variety of clinical and health service outcomes. This is replicated globally, within different healthcare systems and patient populations. Although most studies focus on patients with diagnosed dementia rather than 'all-cause' CI, an increased risk of poor outcomes e.g. in-hospital mortality, delirium, longer LOS and institutionalisation at discharge was common. Higher mortality rates may partly reflect lack of available suitable care at end-of-life, lack of end-of-life care plans e.g. 'do-not-hospitalise' advance directives, or unnecessary transfers from nursing homes (Houttekier et al., 2014a, Houttekier et al., 2014b, Houttekier et al., 2010, Lamberg et al., 2005, Barba et al., 2012). Delays in organising appropriate discharge contribute to lengthened hospital stays, highlighting administrative management and linked services required by these patients may impact on final hospital outcome, as more days in hospital may lead to de-conditioning, and policy changes to health and social care infrastructure have unforeseen impacts (Angunawela et al., 2000).

Patients with CI are at increased risk of new infections in hospital, decline in functional and nutritional status, behavioural symptoms and incontinence. These may be considered 'intermediate' outcomes, precipitating patient deterioration, for example, CI was associated with mortality only in patients who had at least one adverse event in hospital, and dementia associated with mortality only if delirium had occurred (Marengoni et al., 2013, Avelino-Silva et al., 2017). Such adverse clinical events could indicate a 'failure to maintain' patients' basic health needs, leading to further deterioration (Bail and Grealish, 2016). A better understanding of how CI precipitates these events, and what can be done to prevent, detect and reduce their risk would enable development of better care models and improved patient outcomes. The multifactorial nature of these events requires a multilevel approach at seven levels of care - patient, task, staff, team, environment, organisation and institution - to make improvements, and outcomes for hospital dementia care should reflect changes at each of these levels (George et al., 2013). Maintaining clinical and functional status of patients may impact on post-discharge outcomes, e.g. mortality, short-term readmissions, institutionalisation within a year and continued functional decline (Sampson et al., 2013, Joray et al., 2004, Dramé et al., 2011, Dramé et al., 2012). A focus on fundamentals of care, e.g. ensuring nutrition, hydration, skin care and mobilisation of patients and psychological care, may improve intermediate outcomes and reduce in-hospital and post-discharge decline.

The variety of covariates used for adjustment in the articles, and different approaches used to account for the same underlying characteristics (e.g. individual diagnostic groups vs Charlson comorbidity score) may explain variability in study conclusions. For example, functional scores were more significant in predicting mortality than dementia in older patients, but few studies investigating the relationship between CI and mortality adjusted for patient function, suggesting residual confounding. The current trend for including frailty assessments in acute hospital care will provide key information, although it will become difficult to disentangle the relative contributions of frailty and CI, as CI comprises part of commonly used frailty assessments. The majority of studies explored associations between patient characteristics at the beginning of hospital admission with a binary outcome during hospitalisation or outcomes at discharge, not accounting for time-varying covariates, e.g. staffing levels, changes in illness acuity or function. Availability of longitudinal data representing day-to-day care, or outcomes reflecting care processes, are essential to understand more about modifiable risk factors contributing to poor outcomes.

Staffing levels, knowledge and skills are a barrier to provision of best-practice care for people with CI in hospital (Royal College of Psychiatrists, 2017, Tropea et al., 2017). However, studies in this review neither included detailed descriptions of staffing levels and skill mix, staff continuity, training and knowledge, and the general hospital environment, nor took account of these in analyses. Outcomes of value in capturing aspects of care, e.g. patient experience, may require specific questionnaires or assessments, and are not commonly available. For example, the person-centred care of older people with CI in acute care scale (POPAC) measures nursing staff best practice care processes to identify CI and employment of nursing interventions to meet associated needs, and could be useful in evaluating routine care and service developments such as training, as well as an outcome in research (Edvardsson et al., 2013).

No single study included a wide range of care, clinical and wellbeing outcomes. Given the role of intermediate outcomes in influencing catastrophic events such as mortality, a core outcome set for CI focussed on hospital care is required. This could be used to standardise outcomes for interventional and observational studies, improving comparability of studies, and in routine care to improve care quality and enable evaluation of care innovations. Dementia care audits provide a good starting place to develop outcome sets, as they focus on fundamental care that should be in place to prevent negative outcomes. Examples include delirium screening, mobility assessment, nutritional status, pressure ulcers, pain, continence and functioning (Royal College of Psychiatrists, 2017), plus access to services, e.g. liaison psychiatry, speech and language, occupational therapy, social work and continence services, which indicate holistic care (Timmons et al., 2016). Assessments used in long-term institutions such as the quality of life in late-stage dementia (QUALID) scale (Barca et al., 2011), could be useful, as the hospital environment can negatively influence health outcomes, e.g. functional independence and quality of life, through a range of processes (Borbasi et al., 2006).

Limitations

Due to the diffuse questions addressed and limited resources, a single reviewer took decisions on study exclusion and data extraction, involving other reviewers in case of ambiguity. Conclusions would be altered substantively only if a number of large scale studies had been accidentally omitted, which seems unlikely. Trials registers were not searched for on-going studies in this area. Non-English language articles were not included due to translation restrictions. The majority of findings indicate a relationship between CI and outcomes. Although selective publication of significant results is possible, there would have to be several large unpublished studies to substantially change the overview of findings.

Conclusions

Whilst it is important to understand the impact of cognitive impairment on mortality, length of stay and institutionalisation, improvement of care for these patients requires insight into the precipitating factors for intermediate outcomes, e.g. infections, dehydration and functional decline, during hospitalisation. Extrinsic factors, e.g. staffing and environment, need exploration. Core outcome sets which reflect intermediate outcomes in hospital could be developed and used for clinical trials and quality improvements.

2.1.5 Key Points from Integrative Review

- People with cognitive impairment have higher hospital mortality, a higher incidence of delirium and longer hospital stays than patients with no cognitive impairment. In addition, intermediate outcomes such as dehydration, reduction in nutritional status, pain, decline in physical and cognitive function, and new infections in hospital may contribute to poorer final hospital outcomes, but have been less well described than in patients with a formal dementia diagnosis.
- It is important to identify whether older people in hospital have cognitive impairment or an existing diagnosis of dementia, to be aware of their increased susceptibility to adverse events in the hospital environment, and to provide appropriate surveillance for intermediate outcomes to prompt preventative action.
- Further studies of outcomes for people with cognitive impairment in hospital should consider the care environment, such as ward type, staffing and episodes of being located outside their designated ward ('outlying'), as these factors may also influence outcomes.
- Development and use of core outcome sets for people with cognitive impairment is essential to fully understand and describe the patient journey both to evaluate day-to-day care, and for use in observational or interventional research.

2.2 The relationship between staffing levels and patient outcomes

The integrative review in the previous section established that people with dementia have worse overall outcomes of hospitalisation, and it is possible that this may also be the case for other patients with cognitive impairment. It also highlighted that there were no studies published at that time which gathered data on the staffing environment within the settings in which the studies took place. A rationale for including considerations of staffing in examining hospital outcomes of older people with cognitive impairment is presented here.

Understanding the chain of events and contributors leading to adverse outcomes is complex. It is recognised that people with dementia have additional specific needs in hospital, such as increased support with eating, drinking, orientation and help with toileting (Andrews and Christie, 2009, Archibald, 2006a, Archibald, 2006b). Meeting these needs is key to reduce the risk of further deterioration and deconditioning and to assist people to recover from their acute illness. Intermediate outcomes which may be influenced by care provided in hospital and which are more common in people with dementia or cognitive impairment include falls, urinary tract infections, pressure ulcers, pneumonia and sepsis (Mecocci et al., 2005a, Härlein et al., 2011, Bail et al., 2013). All such events make patients care more medically intensive and can lead to longer recovery periods and longer hospital stays. Other potentially care-sensitive consequences of being hospitalised which occur more frequently in patients with dementia include dehydration, functional and cognitive decline, and new onset of urinary or faecal incontinence (Johnson et al., 2015, Hartley et al., 2017, Pedone et al., 2005, Mecocci et al., 2005b, Furlanetto and Emond, 2016). Additionally, pain is known to be associated with poorer outcomes in older hospitalised adults, and may indicate a new infection, injury or a worsening in the patients' condition (De Buyser et al., 2014, Wells N, 2008). The ability of staff to assess and manage pain is reduced in patients with cognitive impairment or dementia, and, whilst it is unknown whether patients with cognitive impairment experience more pain during hospitalisation, undetected pain and inability to describe changes in pain can lead to delayed diagnoses of infections, or overtreatment with analgesics, leading to further hospital-acquired complications such as constipation or delirium (Kelley et al., 2008).

A potential mechanism for poorer outcomes may therefore be influenced by the medical and nursing care available to patients with dementia or cognitive impairment, and their expertise in managing needs specific to this group of patients. Nurse and nursing assistant staffing levels are often planned using tools such as the Safer Nursing Care Tool (SNCT), which reflects average acuity and dependency of patients on the ward, which has been constructed using wide-ranging data but lacks evidence of effectiveness (The Shelford Group, 2014, Griffiths et al., 2020a, Griffiths et al., 2020b). The SNCT also does not address staffing skill mix – i.e. the ratio of nurses to nursing assistants. A recent NHS report describing all aspects of older people's care in acute settings established that there is greater emphasis on expertise of higher-level nurses (Band 6 to 8) involved in older people's care at the 'front' (admissions avoidance and Accident & Emergency departments (A&E)) and 'back' (discharge process) ends of the hospital healthcare pathway, but poorer skill mix in assessment units and care of older people's wards, creating the potential for insufficient care (NHS Benchmarking Network, 2017).

It is well established that there is an association between lower nurse staffing levels and an increased risk of death and other adverse outcomes in general hospital populations (Kane et al., 2007, Shekelle, 2013, Griffiths et al., 2016). Evidence suggests this increased risk may be mediated through 'missed care' – i.e. not carrying out fundamental tasks important for preventing further deterioration of the patient, such as monitoring vital signs and categorising patients according to their acuity and clinical risk (Griffiths et al., 2019, Royal College of Physicians, 2012). Good adherence to vital signs monitoring has been shown to reduce mortality, but lower nurse staffing levels are associated with lower compliance to vital signs observations (Schmidt et al., 2015, Redfern et al., 2019). There is evidence that older surgical populations experience higher rates of 'failure to rescue', i.e. death after experiencing a treatable complication, which may be influenced by hospital resources, attitudes and behaviours (Ghaferi and Dimick, 2016). It is possible that the mechanism of 'missed care', which becomes more frequent when staffing is lower and is in turn associated with increased mortality (Ball et al., 2018), may contribute to the observed increase in failure to rescue events in older people.

Currently, only one study has explored the effects of workforce characteristics on mortality in patients with CI as compared to other patients. It found a 10% increase in the proportion of qualified nursing staff was associated with 10% lower odds of death in surgical patients with Alzheimer's disease and related dementias (ADRD), but only 4% lower odds with those without ADRD (White et al., 2018). Additionally, a study exploring staff perceptions of monitoring vital signs at night has found that staff alter the monitoring schedule for people with dementia to ensure patients have adequate sleep (Hope et al., 2017), suggesting that there may be implicit differentials in care which may mediate poor outcomes, which may in turn be exacerbated by lower staffing levels.

The role of levels of staffing for non-registered nursing staff, e.g. health care assistants or nursing assistants, has been less studied, but it has been suggested that replacement of registered nurses with a greater number of less expensive assistants to increase the workforce may actually increase mortality rates (Griffiths, 2018). Understanding the impact of both registered nurse and nursing assistant staffing levels on key outcomes for hospitalised older people with cognitive impairment is essential, given the current shortages in the nurse workforce and the difficulty in recruiting nurses to work on older people's wards (Royal College of Nursing, 2012).

2.3 The identification of dementia and cognitive impairment in the older hospital population

Dementia is an umbrella term for a set of clinical conditions in which patients exhibit signs and symptoms in common, including memory loss, difficulties with thinking, problem-solving and communication. Patients may also show changes in their personality and behaviours, such as losing inhibitions. Underlying diseases which affect the lead to symptoms of dementia include Alzheimer's disease, vascular dementia, Lewy body disease and fronto-temporal dementia. Each of these diseases has a different pathology, and so appearance of symptoms of dementia ideally need to be further investigated to ascertain whether or not there is underlying disease, to better plan for the patient and families' future by accessing supportive care and preparing people to cope with the trajectory of the disease.

In the UK, the current formal pathway for investigating symptoms of dementia begins with an assessment by the patient's GP, which includes taking a history of their symptoms and their progression, investigations for other possible causes, such as anxiety or infections, and a brief test of memory and cognitive abilities. If there are no apparent physical or mental health conditions which are more likely to explain the symptoms, the GP can refer the patient for further assessment, for example at a memory clinic or with a specialist. Additional more detailed cognitive testing is then performed, and a greater understanding of how the cognitive impairments are impacting on the patient's life, in addition to a Magnetic Resonance Imaging (MRI) or Computerised Tomography (CT) scan to examine the brain for abnormalities. Additionally, GPs are being encouraged to opportunistically case-find people with dementia attending their surgeries, to try and reduce the numbers of people living with undiagnosed dementia.

Despite political impetus and health service incentives in both primary and secondary care in the UK, under-diagnosis of dementia is still widespread, with an estimated diagnosis rate for people aged ≥65 of 68.7% as of March 2019.(NHS Digital, 2019) These low diagnosis rates may be due to the difficulty in diagnosing early stages of dementia, the slow progression of the disease, and reluctance of people or their families to be assessed for symptoms such as memory loss. Cognitive impairment without dementia in older people in the community is also common, estimated at 16.8% in a large Canadian cohort of people aged 65 and above using the modified mini-mental state examination, and 10.7% in an Italian study of people aged 65-84 years (Graham et al., 1997, Di Carlo et al., 2000). Therefore, older patients may be admitted to hospital with previously undetected cognitive impairment, which may or may not be due to dementia. This is significant because it is recognised that people with dementia have higher care needs in hospital, whatever their reason for admission, and it is possible that the wider group of patients with cognitive impairment may also benefit from such additional care (Alzheimer's UK, 2016).

The introduction of a brief screening process for dementia throughout hospitals in England in 2013 provides an opportunity to understand more about the numbers of admitted patients with cognitive impairment (NHS Commissioning Board, 2013). All unscheduled admissions aged ≥75 years, excluding patients with recent strokes or impaired consciousness, should be assessed for a pre-existing diagnosis of dementia, and, where this does not exist, are screened for possible dementia using simple cognitive tests practicable within an acute hospital setting (e.g. the Abbreviated Mental Test Score – AM-TS) (NHS Commissioning Board, 2013, NHS England, 2014, Jackson et al., 2013). If cognitive impairment is identified, further assessments or referrals are required to establish the cause. These may include undiagnosed dementia, or other temporary clinical conditions such as hypoglycaemia, head trauma, infections, altered physiological and biochemical states causing confusion, polypharmacy and dehydration. Such causes may often be treatable, and cognitive capacity regained before discharge. Acute illness is also more likely to trigger delirium in people with underlying cognitive impairments such as dementia, (known as 'superimposed delirium'). Delirium may manifest as increased confusion and disorientation, reduction in alertness and withdrawal (hypoactive delirium) or an increase in alertness with agitation (hyperactive delirium), hallucinations and paranoia, disturbed sleep patterns or changes in behaviour patterns and emotions. The cognitive screening process is therefore weighted towards looking for cognitive changes which have come on over a period of time, rather than an acute change, although it is highly likely that long-term changes may be worsened by the presence of acute illness. If assessments to identify the cause of cognitive impairment are not completed within hospital, the patient's general practitioner (GP) is notified in the discharge letter and requested to arrange further investigations.

Use of data from this screening process provides an opportunity to generate evidence around cognitive impairment and its association with outcomes of older people in hospital. It enables estimates of dementia and cognitive impairment without dementia to be calculated in a naturalistic clinical setting which also reflects the subsequent care arrangements provided for patients in hospital based on the screening results.

2.4 Summary and rationale for thesis

This chapter has described an emerging literature which establishes the presence of cognitive impairment as an important clinical feature requiring attention to ensure person-centered care for older hospitalised adults. Adverse outcomes of unscheduled hospitalisation including mortality, longer lengths of stay, discharge to residential homes and readmission appear more common in people with dementia, but uncertainty remains as to whether dementia is independently related to these outcomes and how the contribution of other common clinical risk factors may alter estimates of risk. Evidence for people with cognitive impairment not diagnosed with dementia is more limited, both in terms of the rates of adverse outcomes, and the independent association of cognitive impairment with the outcome. To be able to plan better hospital care for patients with cognitive impairment, it is important to have an accurate and generalisable estimate of the prevalence of such patients, and to understand whether rates of adverse outcomes for people with cognitive impairment but no diagnosis of dementia are similar to those for patients with dementia. Understanding whether independent associations between dementia/cognitive impairment and outcomes exist is important to identify areas in care that can be targeted for improvement. Research in this area is timely, given the increasing numbers of older people admitted to hospital, and the increasing prevalence of dementia and cognitive impairment in the general population. Furthermore, the potential contribution of variations in nursing staff time to adverse hospital outcomes for people with cognitive impairment has not previously been explored.

In summary, the evidence gaps regarding hospital outcomes of people with cognitive impairment are:

- There are few naturalistic studies available in which cognitive impairment is assessed as part of standard care, with the consequent healthcare pathways and care provided being as a result of knowledge of the identification of cognitive impairment.
- In acute care, we do not know how often routine dementia screening processes detect patients with cognitive impairment and no dementia diagnosis in a large 'real-life' acute hospital population and what the characteristics of this group of patients are.
- There are very few studies which describe rates of adverse hospital outcomes in patients with cognitive impairment and no diagnosis of dementia, and a lack of studies which examine the association with outcomes.
- Existing studies, mostly for cohorts with a diagnosis of dementia, have consisted either of small datasets with a lot of detail of baseline assessments (often including eligibility criteria which exclude many patients), or large routinely available datasets with less detail of assessments and covariates.
- No studies have used appropriate measures of acuity assessment to adjust for relationships with mortality, and other key risk factors such as nutritional assessments are absent.
- There are no studies in a general hospital population of patients with cognitive impairment or a diagnosis of dementia which have collected data relating to the hospital environment, e.g. ward type or staffing levels, and incorporated elements of the healthcare pathway such as ward transfers. It is therefore unknown how lower levels of staffing may influence rates of adverse outcomes in patients with cognitive impairment.

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Chapter 3 Overview of Methods

3.1 Study design

All work in this thesis is based on retrospectively collected data from a large cohort of patients admitted to an acute secondary care hospital in the South of England. A retrospective cohort design was employed for all three papers.

3.2 Description of the dataset

The data used for all analyses in this thesis are derived from a large district general hospital serving approximately 675,000 people, with 1,200 beds.

All data were entered electronically during the routine clinical care of patients, either during direct contact with the patient (for example dementia screening and vital signs observations) or during clerking or clinical coding from the patients' case notes.

Data were subject to data quality checks built into the Trust's data entry system. Data were pseudonymised prior to provision for analyses and provided with unique identifiers to enable separate data tables to be linked. All dates and times were consistently offset to increase anonymity.

Patient records meeting the following criteria were extracted:

- Patient aged 75 years and above;
- With an emergency admission (i.e. an unplanned attendance to hospital resulting in being admitted onto a medical or surgical ward);
- With at least one dementia screening record.

The dementia screening process was introduced as part of the CQUIN, and much emphasis was given to staff training and monitoring of the data throughout the data collection period. This would have enhanced the completeness and accuracy of the data. Audit data showed that approximately 20% of the population aged ≥75 were not screened, mainly for patients admitted with a stroke, admissions to intensive care, end-of-life pathways and patients who died very early in admission or were transferred out. Therefore, the data is considered a good reflection of the population who would be assessed for dementia under normal circumstances.

Data were extracted using Microsoft SQL Server by the data administrator, and the following tables (designated in italics) and variables (listed) were provided in a Microsoft Access database:

- *Patient administrative and outcome details:* patient and admission pseudonymised identifiers (present in all tables), age at admission, sex, admission date and route (e.g. via GP referral or direct attendance to A&E), ward and specialty; overnight stay flag, Charlson comorbidity index (CCI), time of first vital signs observation set and NEWS value, discharge date and specialty, discharge destination, length of stay (days), summary of healthcare mortality indicators (SHMI) diagnosis group; indicators for death in hospital and death within hospital or 30 days of discharge.
- *Dementia assessments:* day of assessment, ward code, assessment deferral reason (if deferred), existing diagnosis of dementia, disturbed behaviour, current delirium, increased forgetfulness over the last 12 months, AMT value, onward referral category.
- *'Not for observation' status:* intervals where standard scheduled observations were not undertaken, usually because the patient is on an End-Of-Life care pathway.
- *Vital signs observations:* NEWS value, pain flag, interval until next observation, presence of confusion.
- *Malnutrition Universal Screening Tool (MUST) assessments:* date and time of assessment, MUST score, Body Mass Index (BMI)
- *Ward transfers:* transfer date, 'to' ward, 'from' ward.
- *Workforce data (derived from eRoster shift data):* study date, ward, registered nurse (RN) hours per patient, nursing assistant (NA) hours per patient, total care hours per patient (RN+NA), skill mix (ratio of RN:NA hours). This data was initially produced for the NIHR Health Services and Delivery Research Programme "Missed Care" study and were available for a 14-month overlap period with the other study data.

3.3 Data manipulation and generation of new variables

Data tables were exported from the Microsoft Access into Stata (College Station, Texas). Versions 13 to 16 were used for data manipulation and analysis during the period of the thesis.

Data were inspected and formatting issues (e.g. dates, text variables, coding of missing values) were addressed. Data were joined to look-up tables to provide descriptive information for coded values where appropriate (e.g. ward names, specialty names, diagnosis codes).

New variables for use in analyses were generated, as described in Appendix B.

3.4 Description of study populations and outcomes

As the objectives and sub-set of the datasets analysed differed between each paper, a summary of study populations, exposures of interest and outcomes is given in Table 1.

Table 1 Summary of populations, exposures and outcomes by Paper

	Paper 1	**Paper 2**	**Paper 3**
Population	Non-elective admissions aged ≥75 with at least one dementia assessment	Non-elective admissions aged ≥75 with at least one dementia assessment who had also been discharged at the date of data extraction	Non-elective admissions aged ≥75 with at least one dementia assessment who had also been discharged within the study period with at least one day of staffing level data available during their hospital admission
Time range	29th January 2014 to 19th October 2015 inclusive	29th January 2014 to 31st March 2017 inclusive	29th January 2014 to 31st March 2015 inclusive
Unit of analysis	Admissions (multiple per patient)	Admissions (first admission per patient)	Admissions (multiple per patient)
Sample size	19,269 admissions in 13,652 patients	21,399 admissions (unique patients)	12,544 patient admissions in 9,643 patients
Main exposure of interest	Cognitive impairment category	Cognitive impairment category	Registered Nurse and Nursing Assistant staffing hours, relative to mean values
Outcome measures	• Length of stay in hospital • Death in hospital • Discharge destination	• Time to discharge (length of stay in days) • Death in hospital • Death in hospital or within 30 days of discharge • Readmission to hospital within 30 days of discharge	• Death in hospital or within 30 days of discharge • Readmission to hospital within 30 days of discharge

3.5 Risk factors used for adjustment in the analysis

As there are many factors that are known to influence the outcome measures (Table 1), it was important to consider other covariates for inclusion in analysis to be able to adjust the multivariable models and reduce confounding in the association between the exposures of interest and the outcomes. Covariates were selected according to:

(i) The use of specific covariates in other studies of outcomes in people with cognitive impairment.

(ii) Covariates with strong evidence of association with the outcomes in the literature.

(iii) The availability of the data in the dataset, and its completeness.

(iv) Input from the Public Patient Involvement group and advisory clinicians/co-authors

The covariates are all generated via the processes of routine data collection, and many are standardised data describing patient characteristics (age, sex) or their pathways through the hospital (admission routes, specialty of care, physical ward location). Others are more reliant on the input of clinical data during care processes (diagnoses, NEWS, CCI, MUST) for which the completeness and accuracy of the data may be more variable.

Factors used for adjustment are as follows:

- *Age group*: mortality increases with age.
- *Sex*: mortality rates in older hospitalised people tends to be lower in female patients.
- *Primary diagnosis group*: it is known that patients with specific diagnostic reasons for admission to hospital have different risks of in-hospital mortality (Aylin et al., 2009, Clinical Indicators Team NHS Digital, 2017). The dataset included groups of similar diagnostic codes. However, the size of the dataset was too small to consider all these groups as individual covariates, so they were further grouped into infections, cancers and system-organ classes with a review from Dr Paul Schmidt, a member of the Clinical Outcomes Research Group at PHT to confirm clinical accuracy and appropriateness.
- *Charlson co-morbidity index (CCI)*: the CCI is a tool which weights particular diagnoses, including congestive heart failure, dementia, pulmonary, liver and renal disease, and cancer, to produce a score (or 'index'). This score is predictive of death in hospital in all patients, and also death after discharge in older acutely hospitalised patients, although it has a weaker association with other outcomes such as 30-day readmission and length of stay (Charlson et al., 1994, Frenkel et al., 2014, Bannay et al., 2016, Sinvani et al., 2019). Accurate compilation of this score is reliant on (i) the relevant diagnoses being known and recorded; (ii) no misdiagnoses, i.e. patients having the correct diagnosis for the correct condition, and not attributing a condition where there is none present. Within the process

of assessment within an acute setting there may be diagnoses that come to light during the admission, and previous diagnoses that may be challenged. However, the diagnoses/diagnostic categories listed in the CCI are generally broad and cover most body systems as groups, so subtle changes in diagnosis within body-systems would not change the overall score. The CCI in the provided data sets was calculated using the same method employed in the SHMI so it is generally based on those diagnoses recorded at the completion of the first Finished Consultant Episode (FCE) in the hospital stay but may alternatively be based on those from the second FCE, where symptoms recorded in the first FCE had later been updated to more specific diagnoses.

- *National Early Warning Score (NEWS) value at admission*: the NEWS is a measure of physiological derangement of the patient, for which higher scores indicate more acutely severe illness, deterioration and a higher risk of death within 24 hours (Smith et al., 2013, Prytherch et al., 2010). The NEWS was adapted with minor modifications from an early warning system developed using in-patient adult data from the same hospital as the data in this thesis is derived from and is applicable to adults aged 16 and above (Royal College of Physicians, 2012). The score requires the measurement of six vital signs observations (temperature, blood pressure, pulse rate, blood oxygen levels, breathing rate and level of consciousness), which are each assigned a score according to their level of derangement from 'normal' values (Royal College of Physicians, 2012). Following training and supervision, healthcare staff mainly use standardised electronic devices to take measurements, the accuracy of which are determined by periodic servicing. Pulse oximeters are used for oxygen saturations and pulse, thermometers for temperature and automatic or manual machines for blood pressure. The level of consciousness is assessed by staff using the AVPU criteria (Alert, Voice, Pain, Unresponsive), for which categories are unlikely to be misclassified. Assessment of breathing rate should be performed by counting the number of inspirations over a 60 second period, and could be subject to variation, but identification of particularly high or low rates which would trigger higher scores is unlikely to be missed by healthcare staff. Scores for each of the parameters then form an overall score which is categorised according to mortality risk. Higher risk categories indicate physiological deterioration and should subsequently be acted upon by clinical staff. Although the full set of vital signs observations and NEWS values was available for the duration of the patients' admissions, only the first recorded value was considered as a covariate, to provide an indication of how acutely unwell the patient was at the point of admission.
- *Malnutrition Universal Screening Tool (MUST) score at admission*: the MUST score is derived from a 5-step screening tool to identify adults who are malnourished, at risk from

malnourishment or obese (British Association for Parenteral and Enteral Nutrition (BAPEN), 2011a). The validity of the tool in comparison to a range of other screening tools has been established (British Association for Parenteral and Enteral Nutrition (BAPEN), 2003). It has been identified as a predictor of mortality in acutely ill older patients in hospital (Stratton et al., 2006). MUST uses three datapoints to form a score (maximum value 6): BMI, unplanned weight loss in the past 3-6 months (% of body weight lost) and if the patient is acutely ill and there has been/is likely to be no nutritional intake for 5 days, with each datapoint scoring 0, 1 or 2 based on increasing risk (British Association for Parenteral and Enteral Nutrition (BAPEN), 2011a). Guidance suggests measurement within the first couple of days of hospital admission and every five days thereafter, to be able to plan appropriate nutritional interventions for the patient to reduce their risk of becoming more unwell or death and to monitor subsequent changes in status.

There are scenarios in which it may be more challenging to gather accurate data to inform the MUST. BMI may be difficult to obtain in acutely ill patients who are unable to stand or sit on weighing scales and unable to stand for height measurement. This is acknowledged within the explanatory booklet for MUST, which provides alternative methods for estimating height and weight based on other body measurements, using previously documented or recalled height and weight, or more subjective criteria to provide a BMI score (British Association for Parenteral and Enteral Nutrition (BAPEN), 2011b). Question 2 regarding weight loss requires accurate knowledge of the patients current and previous weight and an estimation of the weight lost over the last 3 to 6 months. This may be difficult for patients give a precise value, or, if known, to recall, and so this information may need to be sought from relatives or carers or residential home records or retrieved from previous hospital records. It is likely, therefore, that this value may often be estimated, although the value of '0' (no weight loss) may be more accurately assigned than distinguishing between values of 1 and 2 (5-10% loss of body weight and >10% loss respectively). Question 3 uses more contemporaneous knowledge about the patients recent and predicted nutritional intake during hospitalisation, and may be more accurately answered based on questioning the patient or healthcare staff to understand what they have eaten over the last few days, and judging from the patients clinical condition what they are likely to manage to take in during the acute phase of their illness.

- *Presence of pain on first vital signs set*: higher pain scores have been shown to be predictive of 90-day mortality in older patients following emergency department attendances (Hofman et al., 2016) and also of increased length of stay in older hospitalised patients (De Buyser et al., 2014).

- *Route of admission*: admission to hospital via the accident and emergency department reflects a deterioration in the patients' condition which may not have been seen or managed by healthcare professionals in the community and indicates an urgent need for care.
- *Discharge specialty*: the dichotomous variable for discharge specialties to group medical admissions vs those for surgical or trauma/orthopaedic reasons reflects the known lower overall mortality rate for patients attending surgical specialties. Although this may be partly related to the patient's initial reason for admission and allocated diagnostic group, it provides additional adjustment for the different processes of care that occur in the two specialties.
- *Ward transfers*: this covariate was introduced following discussion with the Public Patient Involvement group and with clinical co-authors, who had personal experience of the negative effects of being moved from ward to ward in terms of increasing confusion. The literature also suggests that there may be an increased risk of incident delirium in older patients with more room transfers during admission (Goldberg et al., 2015).

Data for all covariates was >99% complete, apart from the MUST score which was missing in around one third of admissions. The missing MUST scores were missing more frequently in patients who died earlier in their admission or were admitted for only short periods of time, so it was not possible to impute values for missing MUST scores using multiple imputation. An additional variable was therefore generated which placed missing MUST values in a dummy category so that it could be used for sensitivity analysis.

3.6 Public patient involvement

An advert was sent out to local contacts and via mailing lists to advertise for public patient involvement volunteers who were either older persons or relatives/carers for older persons with or without dementia who had experience of an acute hospital admission within the last few years who would be interested in attending a couple of meetings during the course of the PhD, and/or be able to review documents online or by post.

The purpose of the group was to:

- guide and refine the project objectives by discussing whether they were relevant and of interest to patients and carers;
- inform data items to be analysed;

- discuss and interpret the results and identify the relevance and importance of the results to patient care in hospitals for inclusion into the discussion of submitted papers;
- assist with writing and reviewing lay summaries of the research methods and results for the public dissemination and for grant applications.

A group of 11 members of the public, patients and carers from the Portsmouth area volunteered to participate. Examples of their input to this work include:

- drafting and reviewing a lay summary for Age and Ageing for Paper 1;
- supporting an NIHR fellowship application in 2017 by clarifying how and why the work would be important to patients and the public and reviewing the lay summary;
- giving feedback on a poster presented at the Southampton Doctoral Research Conference in 2018 which summarised Paper 1;
- informing covariates of interest for Paper 2 which resulted in the inclusion of ward transfers in the regression model, and a summary of the number and proportion of patients considered to be 'end-of-life' (with vital signs observations stopped) in the cohort characteristics;
- giving ideas for future work, including exploring factors such as Activities of Daily Living and a record of how much patients ate or drank as covariates as these were both felt to be important factors that may influence outcomes from a patient and carer's perspective, especially for patients with cognitive impairment. These data were not available in an electronic form in the dataset but may have helped to explain the results.

3.7 Ethical approval

Use of pseudonymised routinely collected data to explore risk factors for patient outcomes within the Clinical Outcomes Research Group at the Trust (of which I was a member at the time of this research) has ethical approval from the Isle of Wight, Portsmouth and South East Hampshire Research Ethics Committee, reference 08/02/1394. Ethical approval was also given by the University of Southampton Faculty of Health Sciences Ethics Committee in January 2017.

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Chapter 4 Paper 1 – The relationship between cognitive impairment, mortality and discharge characteristics in a large cohort of older adults with unscheduled admissions to an acute hospital: a retrospective observational study

Citation: Fogg C, Meredith P, Bridges J, Gould GP, Griffiths P. The relationship between cognitive impairment, mortality and discharge characteristics in a large cohort of older adults with unscheduled admissions to an acute hospital: a retrospective observational study. Age and Ageing. 2017 Sep 1;46(5)794-801(Fogg et al., 2017)

Candidate's contribution: the candidate (Fogg) designed the study objectives and analysis, performed the analysis and wrote the first and subsequent drafts of the paper. The supervisors (Meredith, Bridges, Griffiths) provided guidance throughout. The lead nurse for the dementia screening process at PHT (Gould) provided background information and context for the dataset, participated in the interpretation of the results and reviewed the final publication.

4.1 Key points

- Patients with dementia have higher in-hospital mortality and longer hospital stays.
- In this study, 11.6% of unscheduled admissions aged ≥75 had cognitive impairment, but no prior dementia diagnosis.
- These patients had a comparable risk of dying in hospital to patients with dementia, and longer lengths of stay.
- Person-centred care such as that used for people with dementia may also be appropriate for these patients.
- Further research is required to explore contributory factors to the poor outcomes in this patient group.

4.2 Abstract

Background

Older people with dementia admitted to hospital for acute illness have higher mortality and longer hospital stays compared to those without dementia. Cognitive impairment is common in older people, and they may also be at increased risk of poor outcomes.

Methods

Retrospective observational study of unscheduled admissions aged ≥75 years. Admission characteristics, mortality rates and discharge outcomes were compared between three groups: i) known dementia diagnosis, ii) cognitive impairment but no diagnosis of dementia, iii) no cognitive impairment.

Results

Of 19,269 admissions (13,652 patients), 19.8% had a dementia diagnosis (DD), 11.6% had cognitive impairment (CI) and 68.6% had neither. Admissions with CI or DD were older and had more females than those with no CI, and were more likely to be admitted through the Emergency Department (88.4% and 90.7%, vs 82.0%) and to medical wards (89.4% and 84.4%, vs 76.8%). Acuity levels at admission were similar between the groups. Patients with CI or DD had more admissions at 'high risk' from malnutrition than patients with no CI (28.0% and 33.7% vs 17.5%), and a higher risk of dying in hospital (11.8% [10.5-13.3] and 10.8% [9.8-11.9] vs (6.6% [6.2-7.0]).

Conclusions

The admission characteristics, mortality and length of stay of patients with cognitive impairment resemble those of patients with diagnosed dementia. Whilst attention has been focussed on the need for additional support for people with dementia, patients with cognitive impairment, which may include those with undiagnosed dementia or delirium, appear to have equally bad outcomes from hospitalisation.

4.3 Introduction

An estimated 850,000 people in the United Kingdom are living with dementia, with an expected rise to over 1 million by 2021 (Dowrick and Southern, 2014). People with dementia are more likely to be admitted to hospital due to acute illness (Toot et al., 2013), and have increased mortality in hospital and after discharge (Sampson et al., 2013, Borson et al., 2013). Contributing factors to mortality include comorbidities, poorer functional and nutritional status (Zekry et al., 2009, Stratton et al., 2006), more severe cognitive impairment (Sampson et al., 2009) and increased risk of delirium (Travers et al., 2014, Ryan et al., 2013). The complexity of their condition requires a high level of resource from a wide range of specialised services to provide appropriate clinical management (Glover et al., 2014, Lakey, 2009). Patients with dementia are more likely to develop hospital-acquired complications, including urinary tract infections, pressure ulcers and pneumonia, which are associated with an eightfold increase in length of stay and a doubling in the estimated mean episode cost (Bail et al., 2015).

A prospective study of dementia diagnostic assessment in a cohort of hospitalised patients aged 70 and above revealed half of the patients with dementia had not received a diagnosis prior to admission (Sampson et al., 2009). Patients without a prior diagnosis may be at additional risk from worsening of their condition in hospital, as they may not benefit from care intended to meet the needs of patients with dementia, e.g. close observation of food and fluid intake, avoidance of sedatives and antipsychotics, reduced movement between wards to avoid further confusion, and beds near clear signage to toilets (Andrews and Christie, 2009, Archibald, 2006a, Archibald, 2006b). To improve identification of dementia patients in hospital and contribute towards improved diagnosis of dementia in the general population, dementia screening became a requirement in hospitals in the UK in 2014. In addition to identifying patients with pre-diagnosed dementia, all unscheduled admissions aged 75 years and above are to be screened for dementia using simple cognitive tests practicable within an acute hospital setting (e.g. the Abbreviated Mental Test Score – AMTS) within 72 hours of admission (NHS Commissioning Board, 2013, NHS England, 2014). If patients are found to have cognitive impairment, further assessments or referrals are required to establish the cause, which may range from mild cognitive impairment, infection or trauma through to severe delirium or dementia.

Although this process improves the systematic detection of patients with dementia in hospital, many patients with cognitive impairment may not be fully assessed until much later during hospital admission, or referred for GP assessment after discharge. There are currently no large-scale data available on the proportion of older patients identified as having cognitive impairment but no prior diagnosis of dementia through this process. It is also not known whether these patients are at increased risk for poor outcomes. Using routinely collected dementia screening data in a large acute district general hospital, we aim to describe the characteristics of this patient group, and to ascertain whether their mortality and length of stay is similar to patients with diagnosed dementia. Such information is essential for planning appropriate clinical services and person-centred care for this group of patients, with the aim of reducing adverse outcomes.

4.4 Methods

Objectives

To estimate the prevalence of cognitive impairment (CI) in patients without a diagnosis of dementia in acute, non-elective hospital admissions of patients aged ≥75 years. To describe clinical characteristics, healthcare pathway, mortality and length of stay according to CI/dementia status.

Design

Retrospective observational study.

Setting

An English district general hospital serving approximately 675,000 people.

Data collection

I. *Dementia screening*

Dementia screening is performed using an electronic hand-held device (Vitalpac®, System C, London) by trained clinical staff. Patients with a known diagnosis of dementia are identified. For patients with no known diagnosis of dementia, the following questions are asked: (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 the answer to one or both of the questions is 'yes', an Abbreviated Mental Test Score (AMTS) is performed. Delirium is also recorded if present in patients with disturbed behaviour. Patients with an AMTS of 8 or below are referred to the General Practitioner (GP) for assessment at discharge.

II. *Patient and health service use*

Demographic data, admission route, admitting specialty, admission and discharge dates, diagnoses (International Classification of Disease 10), death in hospital and discharge destination are entered into the Patient Administration System (PAS) from clinical notes. Vital signs (temperature, systolic blood pressure, pulse, respiratory rate, consciousness level, oxygen saturation, use of supplemental oxygen) are recorded electronically and a National Early Warning Score (NEWS) of 0 to 20 generated (Royal College of Physicians, 2012). The NEWS score indicates the patient's risk of deterioration and death within the next 24 hours. Malnutrition Universal Screening Tool (MUST) scores and Body Mass Index (BMI) are recorded.

Data extraction

Anonymised clinical records data of acute, non-elective admissions aged 75 and above with at least one dementia screening record between 29th January 2014 (initiation of electronic dementia screening system) and 19th October 2015 inclusive were extracted into a Microsoft Access database.

Analysis

Analyses were performed using Stata version 13.1 (StataCorp, College Station, Texas).

Summary statistics were calculated for the steps in the screening pathway. Admissions were categorised into 3 cohorts: (a) known diagnosis of dementia (DD) (recorded at any point during admission), (b) cognitive impairment with no known diagnosis of dementia (CI), defined as a positive response to one/both screening questions (i. disturbed behaviour, ii. forgetful in last 12 months) and an AMTS of 8 or below, (c) no cognitive impairment, defined as a negative response to both screening questions, or a positive response to one/both screening questions and an AMTS of 9 or 10 or no AMTS data available.

Estimates of the prevalence of a dementia diagnosis and cognitive impairment were calculated with 95% confidence intervals. Patient characteristics at admission (age, gender, primary diagnosis according to Summary Hospital-level Mortality Indicator classification (SHMI), NEWS category (Royal College of Physicians, 2012), MUST score (first record), body mass index - BMI), healthcare pathway data (route of admission and specialty) and discharge characteristics (alive/dead, length of stay, discharge destination) were summarised. Statistical tests of differences in proportions (Chi2 - nominal variables; Kruskal-Wallis - ordinal variables) and means/medians (ANOVA/Kruskal-Wallis) were performed. Post-hoc pairwise comparisons with Bonferroni correction were performed for ANOVA and Chi2 results significant at $p<0.05$, and Dunn's test for Kruskal-Wallis.

Ethics

Ethical approval was obtained from the Isle of Wight, Portsmouth and South East Hampshire Research Ethics Committee, reference 08/02/1394.

4.5 Results

Dementia screening

A total of 19,269 admissions (13,652 patients) were screened for dementia (Figure 1), giving a prevalence of diagnosed dementia (DD) of 19.8% (95% CI 19.3 - 20.4, n=3,818). The prevalence of cognitive impairment (CI) (no known dementia) was 11.8% (95% CI 11.1 - 12.0, n=2,232), with an average AMTS of 4.7 (standard deviation 2.7). No cognitive impairment was detected in 68.6% (n=13,219) of admissions.

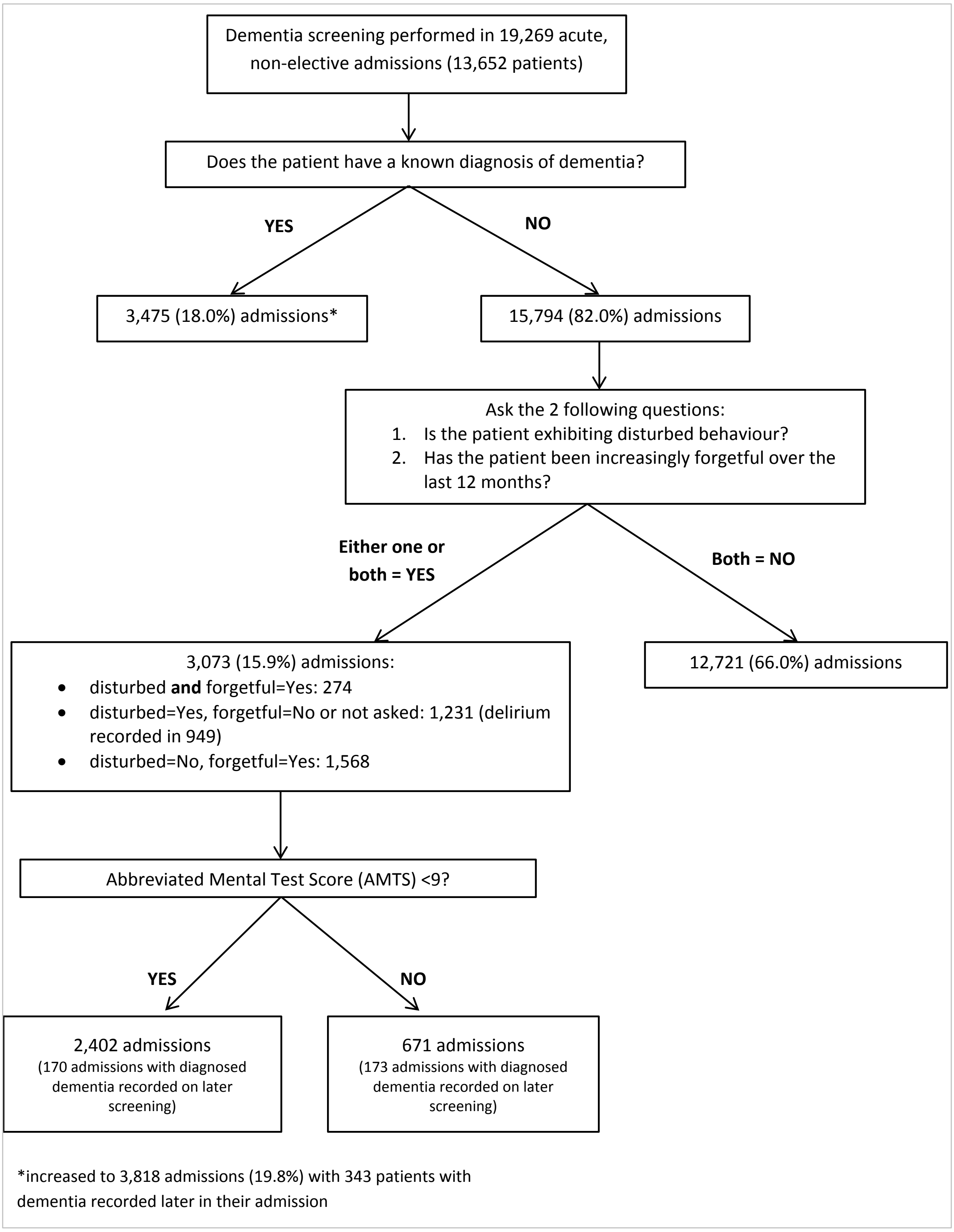

Figure 2 Dementia Screening Process and Results

Characteristics of admitted patients

Demographics of patients with CI or DD were very similar, with a significantly older and more female population as compared to those with no CI (Table 2). Patients with CI or DD were more likely to be admitted through Accident and Emergency (A&E) than those with no CI (88.4% and

90.7% vs 82.0%), and more frequently admitted to Medicine (89.4% and 84.4% vs 76.8% no CI). A primary admission diagnosis of neuropsychiatric disease was more common in patients with CI (10.6%) and DD (9.4%) than those with no CI (2.0%). Delirium was present in 36% (809/2232) of patients with CI. The frequency of admissions for respiratory conditions and conditions related to frailty (falls, fractures and osteoporosis) was similar in all groups, whereas patients with no CI were more likely to be admitted with a primary diagnosis of heart failure, cardiovascular conditions or gastrointestinal disease. There was no significant difference in the acuity category at admission between the groups (Chi2 p=0.113), although patients with DD had significantly higher NEWS values than patients with no CI (Dunn's test p=0.023). 'High risk' MUST scores were significantly more prevalent in admissions with CI or DD than those with no CI (Dunn's test p<0.01), with DD admissions being at most risk (33% vs 28.0% CI, 17.5% no CI). The same was observed with BMI categories, with CI and DD admissions having significantly more underweight patients. A sensitivity analysis showed no differences in patient characteristics according to whether or not a MUST record was available. The majority of omissions occurred in patients with short hospital stays.

Table 2 Characteristics of admissions aged 75 and above according to presence of cognitive impairment or dementia in 19,269 admissions

	No detected CI or known dementia ('no CI') N=13,219 (68.6%)	**CI (AMTS <9) and no known dementia ('CI') N=2,232 (11.6%)**	**Diagnosed dementia ('DD') N=3,818 (19.8%)**	
Demographics				
Age in years (mean, SD)	83.4 (5.6)	86.0 (5.9)	86.2 (5.6)	p<0.001[1]
Aged 75 to 89 years (n, %)	11,041 (83.5%)	1,610 (72.1%)	2,703 (70.8%)	
Aged 90 years and above (n, %)	2,178 (16.5%)	622 (27.9%)	1,115 (29.2%)	
Gender (n, % male)	5,952 (45.0%)	848 (38.0%)	1,445 (37.9%)	p<0.001[2]
Admission details				
Admission route (n, %)				
Emergency – A+E	10,825 (82.0%)	1,972 (88.4%)	3,462 (90.7%)	p<0.001[2]
Emergency – GP	1,281 (9.7%)	182 (8.2%)	301 (7.9%)	
Emergency – Outpatient	179 (1.4%)	10 (0.5%)	5 (0.1%)	
Emergency – Domiciliary	14 (0.1%)	0	1 (0.03%)	
Other	920 (7.0%)	68 (3.1%)	49 (1.3%)	
Admission specialty (n, %)				
Medicine	10,155 (76.8%)	1,996 (89.4%)	3,223 (84.4%)	p<0.001[2]
Surgery	1,793 (13.6%)	49 (2.2%)	227 (6.0%)	
Trauma and Orthopaedics	944 (7.1%)	133 (6.0%)	280 (7.3%)	
ENT and oral surgery	108 (0.8%)	3 (0.1%)	12 (0.3%)	
Gynaecology	19 (0.1%)	1 (0.04%)	0	
Other	200 (1.5%)	50 (2.2%)	76 (2.0%)	
Clinical data on admission (or first record)				
Primary diagnosis classification (n, %)				
Heart failure, cardiovascular	3,205 (26.0%)	273 (13.0%)	481 (13.6%)	p<0.001[2]
system	2,109 (17.1%)	340 (16.1%)	659 (18.7%)	
Respiratory	1,280 (10.4%)	88 (4.2%)	192 (5.4%)	
Gastrointestinal diseases	1,158 (9.4%)	221 (10.5%)	438 (12.4%)	
Falls, fractures, osteoporosis	993 (8.1%)	285 (13.5%)	421 (11.9%)	
Renal/urology	629 (5.1%)	203 (9.6%)	313 (8.9%)	
Rheumatology	419 (3.4%)	111 (5.3%)	138 (3.9%)	
Infectious diseases	420 (3.4%)	93 (4.4%)	142 (4.0%)	
Endocrine/nutritional/blood	417 (3.4%)	52 (2.3%)	43 (1.2%)	
disorder	248 (2.0%)	224 (10.6%)	330 (9.4%)	
Cancer	214 (2.0%)	40 (1.9%)	65 (1.8%)	
Neuropsychiatric disease	214 (2.0%)	76 (3.6%)	124 (3.5%)	
Skin	154 (1.3%)	23 (1.1%)	23 (0.7%)	
Trauma	16 (0.1%)	0	1 (0.03%)	
ENT and eyes	808 (6.6%)	77 (3.7%)	160 (4.5%)	
Female reproductive	*881*	*126*	*288*	
Other				
Missing				
NEWS at admission				
Median (IQR)	1(3)	2(3)	2(3)	p=0.0154[3]
By category:				
Low acuity (0-4)	11,316 (85.9%)	1,888 (84.7%)	3,194 (83.9%)	p=0.113[3]
Medium acuity (5-6)	1,225 (9.3%)	206 (9.2%)	369 (9.7%)	
High acuity (7 and above)	635 (4.8%)	135 (6.1%)	244 (6.4%)	
Missing	*43*	*11*	*3*	
MUST score				
Low risk (0)	7,033 (73.0%)	942 (59.0%)	1,436 (55.9%)	p<0.001[3]
Medium risk (1)	909 (9.4%)	208 (13.0%)	269 (10.5%)	
High risk (2 or more)	1,689 (17.5%)	448 (28.0%)	865 (33.7%)	

	No detected CI or known dementia ('no CI') N=13,219 (68.6%)	CI (AMTS <9) and no known dementia ('CI') N=2,232 (11.6%)	Diagnosed dementia ('DD') N=3,818 (19.8%)	
Missing	*3,588 (27%)*	*634 (28%)*	*1,248 (33%)*	
BMI				
Mean (SD)	25.4 (5.3)	24.5 (5.4)	23.8 (4.7)	p<0.001[1]
By category:				
Underweight (<18.5)	665 (7.3%)	146 (10.8%)	233 (11.3%)	p<0.001[3]
Normal weight (18.5-24.9)	3,999 (44.1%)	648 (47.7%)	1,097 (53.4%)	
Overweight (25-29.9)	2,894 (31.9%)	358 (26.4%)	523 (25.4%)	
Obese (30-39.9)	1,390 (15.3%)	189 (13.9%)	192 (9.3%)	
Morbidly obese (40 and above)	118 (1.3%)	17 (1.3%)	11 (0.5%)	
Missing	*4,153 (31%)*	*874 (39%)*	*1,762 (46%)*	

[1] ANOVA
[2]Chi2
[3]Kruskal-Wallis

Discharge characteristics

More than 60% of admissions with CI or DD stayed at least 1 week (67% and 61%), as compared to patients with no CI (45%) (Table 3). CI patients had significantly longer stays than both of the other groups (post-hoc Dunn's tests p<0.001). More admissions with CI or DD died in hospital than those with no CI (11.8% and 10.8% vs 6.6%), and admissions with CI or DD had a comparable proportion of deaths in hospital (post-hoc Chi2 p=0.201) and a similar mortality rate (22.7 and 22.0 deaths/100 patient months in hospital). The mortality rate of CI patients with delirium was 23.0 deaths/100 patient months [19.2-27.4], compared to 15.9 [11.6-21.3] for CI patients with no delirium. Patients with CI or DD were more likely to be discharged to a nursing or residential home for the first time (11.3% and 16.3%) than patients with no CI (3.5%). Admissions with CI were significantly more likely to be discharged to another hospital location, e.g. a specialist mental health unit or rehabilitation ward, for further care (13.3% vs 8.2% DD, 8.1% no CI).

Table 3 Discharge characteristics according to presence of dementia/cognitive impairment at admission

	No detected CI or known dementia N=12,974 (68.7%)	CI (AMTS <9) and no known dementia N=2,180 (11.5%)	Diagnosed dementia N=3,730 (19.8%)	
Length of stay				
Length of stay (median, IQR)	6 (11)	11 (16)	9 (17)	p<0.001[1]
Length of stay by category:				
Less than 24 hours (0 days)	647 (5.0%)	58 (2.7%)	165 (4.4%)	p<0.001[1]
1-6 days	6,450 (49.7%)	656 (30.1%)	1,309 (35.1%)	
7-13 days	2,763 (21.3%)	567 (26.0%)	840 (22.5%)	
14-27 days	1,946 (15%)	537 (24.6%)	839 (22.5%)	
28 days or more	1,168 (9%)	362 (16.6%)	577 (15.5%)	

	No detected CI or known dementia N=12,974 (68.7%)	CI (AMTS <9) and no known dementia N=2,180 (11.5%)	Diagnosed dementia N=3,730 (19.8%)	
Mortality				
Status at discharge (n, %):				
alive	12,114 (93.4%)	1,922 (88.2%)	3,329 (89.3%)	p<0.001[2]
dead	860 (6.6% [6.2-7.0])	258 (11.8% [10.5-13.3])	401 (10.8% [9.8-11.9])	
Mortality rate/100 person months of admission	18.7 [17.5-20.0] *(4,590 months)*	22.7 [20.0-25.7] *(1,136 months)*	22.0 [19.9-24.3] *(1,821 months)*	
Discharge destination (for patients discharged alive)				
Discharge destination (n, %)				
Usual residence	10,350 (85.4%)	1,361 (70.8%)	2,384 (71.6%)	p<0.001[2]
Nursing/residential home[1]	429 (3.5%)	218 (11.3%)	543 (16.3%)	
Hospice	132 (1.1%)	43 (2.2%)	57 (1.7%)	
Other hospital location	978 (8.1%)	256 (13.3%)	274 (8.2%)	
Other	225 (1.9%)	44 (2.3%)	71 (2.1%)	

Note: N=18,884 admissions (no discharge data for 385 (2.0%) admissions
[1]Kruskal-Wallis
[2]Chi2
[3]where the patient has not previously been in a nursing/residential home

4.6 Discussion

This analysis of 19,269 unscheduled hospital admissions revealed that 11.6% of patients aged ≥75 are cognitively impaired but have no prior diagnosis of dementia. These patients had similar demographics and acuity at admission to patients with dementia. Both groups had high rates of nutritional risk and a significantly higher risk of dying in hospital than patients with no CI. The length of stay for patients with CI was significantly longer than those with a prior diagnosis of dementia, and more patients were discharged to further hospital care.

The significant prevalence of CI in this cohort and their characteristics suggests that undiagnosed dementia in the community is still common, and that systematic detection of CI in hospital should contribute to triggering further assessment (Bradford et al., 2009, Goldberg et al., 2012, NHS England, 2014). Given previous work, it is likely that around 50% of admitted older persons with CI in this cohort may actually have had undiagnosed dementia, with their additional risk of adverse outcomes (Sampson et al., 2009). More than a third of patients with CI in this cohort were delirious when screened, which may indicate pre-existing mild cognitive impairment or dementia (Jackson et al., 2016), and contributes to longer stays in hospital and increased mortality. (Hsieh et al., 2015) Hospital in-patients with CI are predisposed to develop delirium during their stay (Ryan et al., 2013), and so systematic screening for CI should aid identification of patients who would benefit from closer monitoring for delirium and consequent timely management. Although longer hospital stays for patients with CI and DD may have reflected deterioration of the patient's condition due to complications arising during hospitalisation such as infections and falls (Hsieh et al., 2015, Allan et al., 2009), delays in transfer of care to social, rehabilitative or nursing home care is also likely to have increased length of stay (National Audit Office, 2016). This is highlighted by 16% of patients with dementia being discharged to a nursing/residential home, rather than their usual place of residence, and 13% of patients with CI discharged to other hospital locations.

The comparable acuity at admission between the groups in this cohort and the significant numbers of patients with CI and DD who had national early warning scores indicating the need for close monitoring and escalation and the diversity of clinical reasons for admission suggest that many of this population need timely and appropriate in-hospital care. Acute hospitals may have procedures in place to improve care for patients identified as having dementia at admission, which may not currently be employed for patients with CI. Policies for quick assessment and early discharge for patients with dementia shortens length of stay and reduces risk of deterioration in hospital. A 'red tray' system can be used, providing meals on a red tray indicating to staff that patients require extra support with feeding and the tray should not be cleared until the patient has eaten as much as possible. More than one quarter of admissions with CI had high risk MUST scores, highlighting the potential benefit of providing this additional group of patients with assistance at mealtimes, as their CI may have contributed to a worsening in their nutritional status during admission, and consequently increased their mortality risk (Henderson et al., 2008). Symbolic indicators can be used to alert all healthcare and domiciliary staff to the additional needs of the dementia patients, for example a 'forget-me-not' magnet near the bed. Whilst this may improve person-centred care for patients with a diagnosis of dementia, a similar symbol may also benefit those with CI who are still to be further assessed, to increase the opportunities for positive care in the interim. As seen in this cohort, information on a current dementia diagnosis may not be available to staff until later on in the patient's admission, thus leaving a period within which the patient may not have had access to appropriate care. The placement of patients with CI in appropriate wards where staff are more familiar with managing cognitively impaired patients, i.e. Medicine for Older People (MOPRS) wards, may also be important to consider, as the majority of presenting complaints are medical and may be managed in medical wards. Development of 'best practice' for this patient group to impact on clinical outcomes remains a challenge, and it is unclear how many patients may receive individual interventions, although initiatives including specialist medical and mental health units and dementia champions can improve patient and carer satisfaction (Champion, 2014, Wilkinson et al., 2015, Banks et al., 2014, Goldberg et al., 2013).

Limitations of this analysis include the pragmatic nature of the screening system, which has not been validated in acute general hospitals, as well as difficulties in establishing whether a patient had a diagnosis of dementia at the point of hospital admission, which may have led to misclassification of the groups. Delirium was only coded in patients with disturbed behaviour, and may have underestimated patients with hypoactive delirium, although it is likely these patients were included in the CI group. Practical difficulties in weighing and measuring patients may have contributed to missing BMI data in patients with CI and dementia. However, the dataset overall has high rates of completion, and regular audits and training assist accuracy.

4.7 Conclusions

The significant numbers of cognitively impaired older people without a dementia diagnosis admitted to acute hospitals, and their comparable risk of in-hospital death and length of stay to patients with diagnosed dementia, indicates that there is a need to improve identification of this vulnerable population in primary and secondary care. This needs to be combined with improved management in hospital, including vigilance for deterioration and earlier identification of needs at discharge to enable engagement with the necessary services and shorten hospital stay. Further research characterising longitudinal patterns of risk indicators in these patients may inform effective changes in care.

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Chapter 5 Paper 2 - Cognitive impairment is independently associated with mortality, extended hospital stays and early readmission of older people with emergency hospital admissions: a retrospective cohort study

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Candidate's contribution: the candidate (Fogg) designed the study objectives and analysis, performed the analysis and wrote the first and subsequent drafts of the paper. The supervisors (Meredith, Bridges, Griffiths) provided guidance throughout. Additional advice and reviews were provided on statistics (Culliford) and clinical perspectives (Spice).

5.1 Contribution of paper

WHAT IS ALREADY KNOWN ABOUT THIS TOPIC?

- Higher mortality rates and longer lengths of stay have been described in older patients with cognitive impairment in hospital.
- The large and increasing proportion of older adults in hospital with cognitive impairment warrants a clear understanding of whether these are directly related to the presence of cognitive impairment, or occurs as a consequence of factors such as age and comorbidities.

WHAT THIS PAPER ADDS

- Using a large dataset from the UK, we have explored the relationship between cognitive impairment and hospital mortality, 30-day hospital re-admission and length of hospital stay.
- We have demonstrated independent associations between cognitive impairment and increased hospital mortality, longer hospital stays and increased readmissions after controlling for factors including severity of illness, primary diagnosis, nutritional risk scores, age and comorbidities.

5.2 Introduction

Emergency hospital admissions of older people are increasing globally, and are likely to continue to rise given current demographic trends. Older adults now comprise around two-thirds of hospital inpatients, and up to 50% of these patients have some form of cognitive impairment, including that related to dementia (Fogg et al., 2017, Sampson et al., 2009, Reynish et al., 2017, Goldberg et al., 2012, Jackson et al., 2016). This epidemiologic transition needs to be reflected in improved knowledge about hospital outcomes for this group, and subsequently in the evidence base of innovations for appropriate and effective care.

Older adults with a diagnosis of dementia are more likely to die during an emergency hospital admission (Sampson et al., 2009, Marengoni et al., 2013, Hsiao et al., 2015, Oreja-Guevara et al., 2012). However, it is not clear whether dementia is an independent factor leading to increased mortality, or if other aspects of clinical presentation, patient characteristics or care pathways are responsible for the observed outcomes. An integrative review found that known predictors for deterioration and mortality, for example severity of illness, multimorbidity or risk of malnutrition (Smith et al., 2013, Stratton et al., 2006, Henderson et al., 2008, Steventon, 2018), were not consistently adjusted for in observational studies exploring this relationship (Fogg et al., 2018). There is also limited and discrepant information regarding the impact of cognitive impairment in the absence of a diagnosis of dementia on outcomes of hospitalisation. Several large cohorts have described similar frequencies of hospital mortality and lengths of stay in patients with cognitive impairment compared to patients with a diagnosis of dementia, but the role of cognitive impairment as an independent risk factor has not yet been explored (Fogg et al., 2017, Reynish et al., 2017, Connolly and O'Shea, 2015). Additionally, mortality in the post-discharge period and early re-admissions are important outcomes for this population, as these may be influenced by increasing pressure for hospitals to shorten patient stays, and the variability of care available outside acute hospitals.

Understanding whether cognitive impairment is an independent risk factor for poor hospital outcomes could encourage the timely identification of these patients, thereby enabling planning of appropriate care within and outside hospital. Systematic screening to identify cognitive impairment in older hospitalised patients is becoming more widespread in the UK and elsewhere, with the aim of identifying people with potentially undiagnosed dementia, improving rates of dementia diagnosis, planning appropriate post-hospital care and detecting delirium (NHS England, 2014, Alzheimer's Australia, 2014, National Institute for Health and Care Excellence, 2010). If cognitive impairment in the absence of a dementia diagnosis also contributes directly to poor hospital outcomes, appropriate care solutions need to be devised and applied.

This study aimed to identify whether, after adjustment for known risk factors for poor outcomes, including primary diagnosis, severity of illness, age, comorbidities and risk of malnutrition, there are independent associations between cognitive impairment (with or without a diagnosis of dementia) and each of: mortality (in-hospital or within 30 days of discharge), days until hospital discharge, and readmission to hospital within 30 days of discharge.

5.3 Methods

Study Design

A retrospective cohort study using pseudonymised, routinely collected electronic healthcare records.

Study Setting

A district general hospital in England, with a catchment of approximately 675,000 people.

Study Population

Acute, non-elective incident admissions of people aged ≥75 with at least one cognitive screening performed (>80% coverage), who were admitted and discharged between 29th January 2014 and 31st March 2017 inclusive.

Data Sources

I. Cognitive screening

Patients aged ≥75 with unscheduled admissions were routinely screened for cognitive impairment as part of clinical care by trained staff, and results recorded using an electronic tool (CareFlow Vitals, System C, London). Patients with an existing diagnosis of dementia were identified from their medical history. In the absence of a diagnosis of dementia, the following screening questions were completed, based on clinical assessment, history from the patient, the patient's carers or relatives, or from accessing 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 the answer to one or both questions was 'yes', an Abbreviated Mental Test Score (AMTS) was performed. If the patient was exhibiting disturbed behaviour, delirium was assessed and recorded.

II. Administrative and clinical information

Demographic data, details of admission and discharge (dates, route, primary diagnosis, specialty, ward), ward transfers, date of death (up to 30 days after discharge) and diagnoses (International Classification of Disease 10) were recorded in the Patient Administration System. Vital signs and other clinical assessments were recorded electronically on CareFlow Vitals, which generated a National Early Warning Score (NEWS) value indicating severity of illness (Royal College of Physicians, 2012).

Data extraction and statistical analysis

Pseudonymised electronic records were extracted from operational databases and stored in Microsoft Access. Stata MP version 15.1 (StataCorp, College Station, Texas) was used to link datasets on an anonymous identifier and perform analyses.

The primary explanatory variable was derived from cognitive screening data, categorising admissions into 3 groups: (1) ‘dementia’: a known diagnosis of dementia, (2) ‘cognitive impairment’: a positive response to one/both screening questions (i. disturbed behaviour, ii. forgetful in last 12 months) and an Abbreviated Mental Test Score of 8 or below with no known diagnosis of dementia, (3) ‘no cognitive impairment’: a negative response to both screening questions, or a positive response to one/both screening questions and an Abbreviated Mental Test Score of 9 or 10. Potential confounders that were controlled for in analyses are described in Table 4. Throughout the remainder of this paper, the term “patients with cognitive impairment” refers to patients with cognitive impairment **without** a diagnosis of dementia.

Table 4 Description of covariates

Variable description	Categorisation
Patient demographics	
Age	5-year age bands: 75-79, 80-84, 85-89, 90-94, ≥95
Gender	Male, female
Clinical characteristics	
Primary diagnosis group, based on Clinical Coding System (CCS) bundles (Clinical Indicators Team NHS Digital, 2017)	System-organ classes, with the exception of codes relating to ‘infection’ which were grouped as a separate category, regardless of organ system
Charlson co-morbidity index (CCI)	CCI 0=1; CCI 1-5=2; CCI>5=3 as per Summary Hospital Mortality Indicator (SHMI) categorisation (Clinical Indicators Team NHS Digital, 2017)
National Early Warning Score (NEWS) value at admission	Severity of illness categories: NEWS value 0-4=low; NEWS value 5-6=medium; NEWS value ≥7=high (Royal College of Physicians, 2012)
Malnutrition Universal Screening Tool (MUST) score at admission	0=low risk, 1=medium risk, ≥2=high risk (British Association for Parenteral and Enteral Nutrition (BAPEN), 2011)
Presence of pain on first vital signs set	Yes, No
Health service characteristics	

Variable description	Categorisation
Route of admission	"Emergency - Accident and Emergency Department" and "Other" – which includes Emergency – GP, outpatient, other NHS provider etc.
Discharge specialty	Gynaecology, medicine, surgery, trauma and orthopaedics, other

Data completeness for covariates was above 99%, apart from the Malnutrition Universal Screening Tool score, missing in 31.3% (n=6,688) of admissions. To maintain sample size and reduce selection bias, the primary analysis included a dummy category to represent missing Malnutrition Universal Screening Tool values, and a sensitivity analysis using only records with available Malnutrition Universal Screening Tool data was performed. Binary variables were analysed using logistic regression, i.e. death within hospital, death within hospital or within 30 days of discharge, and re-admission to hospital within 30 days of discharge. Categorical variables with similar levels of association in several categories in univariable analysis, such as discharge specialty, were re-grouped for multivariable analysis. A forward stepwise regression approach was used for multivariable analysis, first entering variables most significant in univariable analysis, and utilising the Akaike and Bayesian information criteria (AIC, BIC) to assess variable contribution to model fit by only maintaining inclusion of variables which decreased the Information Criteria in both cases. Interactions between the primary explanatory variable (cognitive impairment category) and covariates (age, severity of illness (National Early Warning Score value), Malnutrition Universal Screening Tool and comorbidity) were explored by comparing the model with both covariates with a nested model including the interaction term (or terms when considering three-way interactions) and applying the Likelihood Ratio test to determine if interactions were candidates for inclusion. However, the same inclusion criteria of improving model fit as measured by AIC/BIC were then applied. The Area Under the Receiver Operating Characteristic curve (AUROC) was calculated for final models to provide a measure of usefulness of the model in predicting the outcome.

The association between cognitive impairment and length of hospital stay was explored using a Fine and Gray model for competing risk analysis for the 'time-to-discharge' from hospital, with in-hospital death as the competing risk, using Akaike and Bayesian Information Criteria to assess model fit (Hutchings et al., 2018). As the majority of deaths and discharges occurred in the first three months of a hospital stay, follow-up duration was censored at 91 days. Regression modelling of the effect of covariates on the cumulative incidence function (CIF) were performed with the Fine and Gray semiparametric proportional hazard model for the subdistribution hazards. Proportionality of hazards was assessed by examining Schoenfeld residuals.

Patient and Public Involvement

A group of patients and carers with recent experience of hospitalisation informed the selection of descriptive characteristics and outcomes, including ward transfers and indications of end-of-life. They will be involved in writing a lay summary of the results and identifying avenues for dissemination to patients and the public.

Ethics

Ethical approval was obtained from the Isle of Wight, Portsmouth and South East Hampshire Research Ethics Committee, reference 08/02/1394. Consent from participants was not required for this study.

5.4 Results

Cohort characteristics

Demographic, clinical and health service characteristics of the 21,399 eligible incident admissions are described in Table 5. Twenty-seven percent of patients (5,774/21,399) were found to be cognitively impaired at screening, of which 61.5% (n=3,547) had an existing diagnosis of dementia and 38.5% (n=2,227) did not. The mean age of the cohort was 84 years; 56.9% of patients were female. The Malnutrition Universal Screening Tool score was medium or high in 29.5% of the cohort, 54.7% had a Charlson score of 6 or more and 13.3% had a National Early Warning Score value in the medium or high risk categories on the first set of recorded vital signs. Most patients (87.6%) were admitted to medical wards, including 21.6% to Medicine for Older People, Rehabilitation and Stroke (MOPRS) wards. Of the cohort, 6.3% (n=1,343) were placed on end-of-life (EOL) pathways during admission, such that subsequent vital signs observations were not mandated. Patients with dementia were the least likely to have two or more ward transfers during their admission (35.4%), whereas those with cognitive impairment were the most likely (48.0%).

Table 5 Cohort characteristics

	Total		**Dementia**		**Cognitive impairment (no dementia diagnosis)**		**No Cognitive impairment**	
	N=21,399		**n=3,547**		**n=2,227**		**n=15,625**	
Demographics								
Mean Age (Standard Deviation)	84.4	(5.8)	86.4	(5.8)	86.4	(5.9)	83.6	(5.7)
Female (n, %)	12,171	56.9%	2,217	62.5%	1,368	61.4%	8,586	55.0%
Clinical characteristics[1]								
Reason for admission (n, %)								
Cardiovascular disorders	4,766	22.4%	472	13.4%	315	14.2%	3,979	25.7%
Infection	4,472	21.0%	928	26.3%	628	28.3%	2,916	18.8%
Trauma, orthopaedics and injury	2,951	13.9%	625	17.7%	378	17.0%	1,948	12.6%
Gastrointestinal disorders	2,107	9.9%	210	6.0%	84	3.8%	1,813	11.7%
Rheumatology	1,299	6.1%	296	8.4%	209	9.4%	794	5.1%
Neurological and psychiatric disorders	1,488	7.0%	480	13.6%	275	12.4%	733	4.7%
Respiratory disorders	1,214	5.7%	138	3.9%	58	2.6%	1,018	6.6%
Endocrine, metabolic, blood disorders	761	3.6%	138	3.9%	93	4.2%	530	3.4%
Genitourinary disorders (including renal)	835	3.9%	114	3.2%	72	3.3%	649	4.2%
Cancer	635	3.0%	39	1.1%	52	2.3%	544	3.5%
Adverse events related to substances/medical procedures	366	1.7%	32	0.91%	20	0.90%	314	2.0%
Ear, nose, throat and eyes	160	0.75%	13	0.37%	5	0.23%	142	0.92%
Dermatological disorders	101	0.48%	18	0.51%	16	0.72%	67	0.43%
Other	96	0.45%	20	0.57%	13	0.59%	63	0.41%
missing	*148*		*9*		*24*		*115*	
Charlson Comorbidity Index (n, %)								
0	6,136	29.0%	257	7.3%	606	27.4%	5,273	34.1%
1 to 5	3,462	16.3%	119	3.4%	301	13.6%	3,042	19.7%
6 or more	11,595	54.7%	3,147	89.3%	1,306	59.0%	7,142	46.2%
missing	*206*		*24*		*14*		*168*	
Median[2] NEWS value (inter-quartile range)	1	(3)	1	(3)	1	(3)	1	(3)
NEWS severity of illness category[2] (n, %)								
Low	18,503	86.7%	3,037	85.9%	1,922	86.4%	13,544	86.9%
Medium	1,823	8.5%	294	8.3%	179	8.1%	1,350	8.7%
High	1,022	4.8%	206	5.8%	123	5.5%	693	4.5%
missing	*51*		*10*		*3*		*38*	

	Total N=21,399		Dementia n=3,547		Cognitive impairment (no dementia diagnosis) n=2,227		No Cognitive impairment n=15,625	
MUST category (n, %)								
Low	10,368	70.5%	1,275	55.8%	940	60.3%	8,153	75.0%
Medium	1,424	9.7%	244	10.7%	192	12.3%	988	9.1%
High	2,919	19.8%	767	33.6%	426	27.3%	1,726	15.9%
missing	*6,688*		*1,261*		*669*		*4,758*	
Pain[2] (n, %)	4,255	20.0%	513	14.8%	338	15.3%	3,404	21.9%
missing	*166*		*89*		*14*		*63*	
Confusion[2] (n, %)	2,984	14.1%	1,723	49.8%	630	28.5%	631	4.1%
missing	*172*		*87*		*15*		*70*	
Healthcare processes								
Admitted through emergency department (n, %)	17,550	82.0%	3,154	88.9%	1,946	87.4%	12,450	79.7%
Admission ward (n, %)								
Surgical	2,657	12.4%	269	7.6%	120	5.4%	2,268	14.5%
Medicine - Medicine for Older People, Rehabilitation and Stroke (MOPRS)	4,620	21.6%	1,567	44.2%	904	40.6%	2,149	13.8%
Medicine - other	14,122	66.0%	1,711	48.2%	1,203	54.0%	11,208	71.7%
Two or more ward transfers during admission[3]	8,820	41.2%	1,254	35.4%	1,069	48.0%	6,497	41.6%
Vital signs observations stopped during admission[4] (n, %)	1,343	6.3%	407	11.5%	227	10.2%	709	4.5%
Discharge specialty								
Medicine	16,441	76.8%	2,923	82.4%	1,859	83.5%	11,659	74.6%
Surgery	2,352	11.0%	204	5.8%	57	2.6%	2,091	13.4%
Trauma and Orthopaedics	1,712	8.0%	305	8.6%	176	7.9%	1,231	7.9%
Other	722	3.4%	99	2.8%	132	5.9%	491	3.1%
ENT and Oral Surgery	151	0.71%	16	0.45%	2	0.09%	133	0.85%
Gynaecology	21	0.10%	0	0%	1	0.04%	20	0.13%

[1] percentages are expressed as a proportion of known values for characteristics with missing data
[2] first set of vital signs observations on admission
[3] does not include transfer from Medical Assessment Unit to initial admission ward
[4] patient removed from requirement for regular observations according to Royal College of Physicians schedule, for example due to end-of-life care pathways

Description of outcomes

There were 1,704 deaths in hospital (8.0% of the cohort) (Table 6). Patients with cognitive impairment had the highest in-hospital mortality (12.6%), the longest lengths of stay (median 12 days) and the highest readmission rates (10.3%). Patients with a diagnosis of dementia had the highest mortality in the period covering hospitalisation and 30 days following discharge (20.8%).

Table 6 Description of outcomes by category of cognitive impairment

	Total N=21,399		**Dementia** n=3,547		**Cognitive Impairment (no dementia diagnosis)** n=2,227		**No Cognitive Impairment** n=15,625	
Died in hospital (95% CI)	1,704	8.0% (7.6% to 8.3%)	413	11.6% (10.6% to 12.7%)	281	12.6% (11.3% to 14.1%)	1,010	6.5% (6.1% to 6.9%)
Died in hospital or within 30 days of discharge (95% CI)	2,746	12.8% (12.4% to 13.3%)	737	20.8% (19.5% to 22.2%)	406	18.2% (16.6% to 19.9%)	1,603	10.3% (9.8% to 10.7%)
Length of stay (median, inter-quartile range)	6 (13)		10 (19)		12 (18)		5 (11)	
	N=19,695		n=3,134		n=1,946		n=14,615	
Readmitted to hospital within 30 days of discharge (95% CI)	1,519	7.7% (7.3% to 8.1%)	286	9.1% (8.1% to 10.2%)	201	10.3% (9.0% to 11.8%)	1,032	7.1% (6.6% to 7.5%)

Association between cognitive impairment and mortality

Patients with cognitive impairment and those with a diagnosis of dementia had significantly increased risks of mortality both during hospitalisation and within 30 days of discharge in univariable (Table 7) and multivariable analyses (Table 8). Interactions between the cognitive impairment category and both the Malnutrition Universal Screening Tool score and Charlson scores were present (all likelihood ratios significant at $p \leq 0.005$). However, including interaction terms in the stepwise regression did not improve the parsimony of the multivariable model (death in hospital AIC 10288 vs 10286, BIC 10511 vs 10732, for full model vs full model with interactions respectively; death within 30 days AIC 13754 vs 13761, BIC 13993 vs 14222), and so were excluded from the model. For both categories of cognitive impairment and dementia, the odds of mortality increased with increasing severity of Malnutrition Universal Screening Tool and increasing levels of co-morbidity. The Area Under the Receiver Operating Characteristic curve for the model for death within hospital was 0.76, and 0.77 for death in hospital or within 30 days, indicating moderate ability of the model to predict patient mortality in this population. The sensitivity analysis including only patients with a Malnutrition Universal Screening Tool score available showed only minor differences in the adjusted Odds Ratios.

Association between cognitive impairment and readmission

Patients with cognitive impairment or a dementia diagnosis had a significantly higher risk of readmission within 30 days of discharge in univariable (Table 7) and multivariable analyses (Table 8). The Area Under the Receiver Operating Characteristic curve for the multivariable model was 0.58, indicating low of ability of the model to predict readmission.

Table 7 Univariable logistic regression of predictors of (i) death in hospital, (ii) death in hospital and within 30 days of discharge and (iii) readmission within 30 days (for patients discharged alive from hospital)

		Death in hospital N=21,399			Death in hospital and within 30 days of discharge N=21,399				Readmission within 30 days of discharge N=19,695[1]		
Characteristic	**N**	**Odds ratio**	**95% CI**	**p-value**	**Odds ratio**	**95% CI**	**p-value**	**N**	**Odds ratio**	**95% CI**	**p-value**
Cognitive impairment	21,399							19,695			
No cognitive impairment*		1.0			1.0				1.0		
Dementia		1.91	1.69 to 2.15	<0.001	2.29	2.08 to 2.53	<0.001		1.32	1.15 to 1.52	<0.001
Cognitive impairment (no dementia diagnosis)		2.09	1.82 to 2.40	<0.001	1.95	1.73 to 2.20	<0.001		1.52	1.30 to 1.78	<0.001
Demographics											
Age group	21,399							19,695			
75-79 years*		1.0			1.0				1.0		
80-84		1.27	1.09 to 1.48	0.002	1.32	1.17 to 1.50	<0.001		1.03	0.89 to 1.20	0.663
85-89		1.62	1.39 to 1.88	<0.001	1.57	1.39 to 1.77	<0.001		1.08	0.93 to 1.25	0.335
90-94		1.96	1.67 to 2.31	<0.001	2.06	1.81 to 2.34	<0.001		1.32	1.12 to 1.56	0.001
95 and above		2.60	2.10 to 3.21	<0.001	2.57	2.15 to 3.06	<0.001		1.37	1.07 to 1.75	0.012
Sex	21,399							19,695			
male*		1.0			1.0				1.0		
female		0.82	0.74 to 0.90	<0.001	0.80	0.74 to 0.87	<0.001		0.95	0.86 to 1.06	0.359

		Death in hospital N=21,399			Death in hospital and within 30 days of discharge N=21,399				Readmission within 30 days of discharge N=19,695[1]		
Clinical characteristics											
Charlson comorbidity score	21,193							19,515			
zero*		1.0			1.0				1.0		
1 to 5		1.08	0.89 to 1.32	0.415	1.09	0.93 to 1.27	0.311		1.06	0.89 to 1.25	0.512
6 or more		2.43	2.12 to 2.77	<0.001	2.72	2.44 to 3.03	<0.001		1.36	1.20 to 1.54	<0.001
Diagnostic group	21,251							19,569			
cardiovascular disorders*		1.0			1.0				1.0		
Infection		1.71	1.49 to 1.97	<0.001	1.88	1.67 to 2.12	<0.001		1.11	0.94 to 1.31	0.202
Cancer		3.06	2.45 to 3.83	<0.001	5.61	4.67 to 6.75	<0.001		1.31	0.95 to 1.81	0.105
Endocrine, metabolic and blood disorders		0.79	0.57 to 1.08	0.140	1.23	0.97 to 1.54	0.089		1.34	1.01 to 1.77	0.040
Neurological and psychiatric disorders		0.58	0.44 to 0.76	<0.001	0.84	0.68 to 1.02	0.082		0.97	0.76 to 1.22	0.771
Respiratory disorders		1.54	1.24 to 1.90	<0.001	1.85	1.55 to 2.20	<0.001		1.15	0.90 to 1.48	0.256
Gastrointestinal disorders		0.73	0.59 to 0.90	0.004	0.81	0.68 to 0.97	0.022		1.00	0.81 to 1.23	0.982
Genitourinary disorders (including renal)		1.66	1.31 to 2.11	<0.001	1.97	1.62 to 2.40	<0.001		0.92	0.67 to 1.26	0.598
Dermatological disorders		1.22	0.61 to 2.45	0.569	1.62	0.94 to 2.78	0.082		1.61	0.83 to 3.13	0.162
Rheumatology		0.36	0.25 to 0.50	<0.001	0.64	0.51 to 0.81	<0.001		1.51	1.22 to 1.88	<0.001
Trauma, orthopaedics and injury		0.63	0.52 to 0.77	<0.001	0.76	0.64 to 0.89	0.001		1.14	0.96 to 1.37	0.143

		Death in hospital N=21,399			Death in hospital and within 30 days of discharge N=21,399			Readmission within 30 days of discharge N=19,695[1]			
Adverse events to substances/medical procedures or devices		0.57	0.34 to 0.95	0.032	0.58	0.37 to 0.89	0.012		1.28	0.87 to 1.89	0.208
ENT, eyes and other		0.20	0.07 to 0.54	0.001	0.50	0.29 to 0.86	0.012		0.89	0.53 to 1.50	0.673
NEWS category	21,348							19,661			
low*		1.0			1.0				1.0		
medium		2.91	2.54 to 3.35	0.003	2.59	2.31 to 2.92	<0.001		1.33	1.12 to 1.59	0.002
high		5.00	4.29 to 5.84	<0.001	4.25	3.70 to 4.89	<0.001		1.24	0.96 to 1.59	0.098
Confusion on first vital signs set	21,227							19,583			
no*		1.0			1.0				1.0		
yes		1.93	1.71 to 2.18	<0.001	2.12	1.92 to 2.34	<0.001		1.29	1.11 to 1.48	0.001
Pain on first vital signs set	21,233							18,930			
no*		1.0			1.0				1.0		
yes		0.91	0.80 to 1.04	0.152	0.86	0.78 to 0.96	0.006		0.98	0.86 to 1.12	0.762
MUST category	14,711							13,533			
Low*		1.0			1.0				1.0		
medium		1.40	1.12 to 1.74	0.003	1.76	1.49 to 2.07	<0.001		1.07	0.87 to 1.32	0.527
high		3.95	3.47 to 4.49	<0.001	4.40	3.96 to 4.89	<0.001		1.13	0.96 to 1.33	0.132
Health service characteristics											
Admission route	21,399							19,695			

		Death in hospital N=21,399			Death in hospital and within 30 days of discharge N=21,399				Readmission within 30 days of discharge N=19,695[1]		
GP/ outpatients etc*		1.0			1.0				1.0		
Accident and emergency		0.97	0.85 to 1.10	0.622	0.90	0.81 to 0.99	0.033		1.22	1.05 to 1.41	0.007
Discharge specialty	21,399							19,676			
ENT and oral surgery*		1.0			1.0				1.0		
gynaecology		3.07	0.56 to 17.0	0.198	3.32	0.94 to 11.7	0.063		No events	-	-
medicine		2.87	1.17 to 7.00	0.021	2.33	1.23 to 4.43	0.010		4.09	1.30 to 12.9	0.016
surgery		1.74	0.70 to 4.31	0.234	1.49	0.77 to 2.87	0.232		3.53	1.11 to 11.2	0.032
trauma and orthopaedics		1.30	0.52 to 3.27	0.576	1.07	0.55 to 2.09	0.838		3.40	1.06 to 10.8	0.039
other		0.96	0.36 to 2.57	0.936	1.14	0.57 to 2.30	0.714		5.39	1.67 to 17.4	0.005

*Reference category
[1]Number of patients discharged alive from hospital

Table 8 Multivariable logistic regression results for cognitive impairment and death in hospital, within 30 days of discharge, and readmission within 30 days (for patients discharged alive from hospital)[1]

	Death in hospital N=21,143[2]			Death in hospital and within 30 days of discharge N=21,028[2]			Readmission within 30 days of discharge N=19,481[2]		
Characteristic	**Adjusted Odds ratio**	**95% CI**	**p-value**	**Adjusted Odds ratio**	**95% CI**	**p-value**	**Adjusted Odds ratio**	**95% CI**	**p-value**
Cognitive impairment									
No cognitive impairment[α]	1.0			1.0			1.0		
Dementia	1.34	1.17 to 1.55	<0.001	1.66	1.48 to 1.86	<0.001	1.21	1.04 to 1.40	0.014
Cognitive impairment (no dementia diagnosis)	1.78	1.52 to 2.07	<0.001	1.67	1.46 to 1.90	<0.001	1.47	1.25 to 1.73	<0.001
Demographics									
Age group (years)									
75-79[α]	1.0			1.0			[γ]		
80-84	1.25	1.06 to 1.47	0.008	1.31	1.15 to 1.49	<0.001	-	-	-
85-89	1.54	1.32 to 1.81	<0.001	1.51	1.32 to 1.72	<0.001	-	-	-
90-94	1.85	1.56 to 2.21	<0.001	2.00	1.72 to 2.30	<0.001	-	-	-
95 and above	2.35	1.87 to 2.92	<0.001	2.37	1.94 to 2.89	<0.001	-	-	-
Sex									
male[α]	1.0			1.0			[β]		
female	0.82	0.73 to 0.91	<0.001	0.79	0.72 to 0.86	<0.001	-	-	-

Clinical characteristics									
Charlson comorbidity score									
zero$^{\alpha}$	1.0			1.0			1.0		
1 to 5	1.03	0.84 to 1.26	0.763	1.06	0.90 to 1.26	0.483	1.06	0.89 to 1.25	0.521
6 or more	1.85	1.60 to 2.13	<0.001	2.04	1.81 to 2.29	<0.001	1.28	1.12 to 1.46	<0.001
NEWS severity of illness category									
low$^{\alpha}$	1.0			1.0			1.0		
medium	2.39	2.06 to 2.77	<0.001	2.22	1.95 to 2.53	<0.001	1.35	1.12 to 1.63	0.001
high	3.57	3.02 to 4.23	<0.001	3.22	2.75 to 3.76	<0.001	1.25	0.97 to 1.62	0.088
Pain on first vital signs set									
no$^{\alpha}$	**			1.0			$^{\beta}$		
yes	-	-	-	1.22	1.08 to 1.37	0.001	-	-	-
MUST category									
low$^{\alpha}$	1.0			1.0			$^{\beta}$		
medium	1.18	0.94 to 1.48	0.157	1.52	1.28 to 1.82	<0.001	-	-	-
high	2.86	2.50 to 3.28	<0.001	3.30	2.94 to 3.71	<0.001	-	-	-
missing	1.33	1.17 to 1.51	<0.001	1.35	1.21 to 1.50	<0.001	-	-	-
Health service characteristics									
Admission route									
GP/ outpatients etc$^{\alpha}$	***	-	-	1.0			$^{\gamma}$	-	-
Accident and emergency	-	-	-	0.86	0.77 to 0.97	0.012	-	-	-

Discharge specialty									
non-medicine[α]	1.0			1.0			γ		
medicine	1.53	1.30 to 1.80	<0.001	1.50	1.31 to 1.71	<0.001	-	-	-

[1] Diagnostic groups were adjusted for in the analysis, and were retained in the two final mortality models, but not in the re-admission model.

[2] Number of observations in final model

[α] Reference category

[β] Not included in final model due to non-significance in univariable regression

[γ] Not included in final model due to AIC/BIC assessment

Association between cognitive impairment and length of stay

In the univariable Fine and Gray model, the cumulative incidence function of time to discharge, with death in hospital as a competing risk, was significantly lower (i.e. longer time to discharge) for patients in the cognitive impairment and dementia groups than those with no cognitive impairment (Gray test p-value <0.001) (Figure 2). This relationship was maintained after adjustment in the multivariable model for patients with cognitive impairment (subhazard ratio 0.66, 95% confidence interval 0.63-0.69) and dementia (subhazard ratio 0.80, 95% confidence interval 0.76-0.83) (Table 9).

Table 9 Competing risks regression analyses of demographic and clinical predictors of time to discharge[1]

	Univariable analysis for time to discharge			**Multivariable analysis for time to discharge N=20,933[2]**		
Characteristic	**Sub-hazard ratio**	**95% CI**	**p-value**	**Sub-hazard ratio**	**95% CI**	**p-value**
Cognitive impairment						
No cognitive impairment $^{\alpha}$	1.0			1.0		
Dementia	0.69	0.66 to 0.71	<0.001	0.80	0.76 to 0.83	<0.001
Cognitive impairment (no dementia diagnosis)	0.62	0.60 to 0.65	<0.001	0.66	0.63 to 0.69	<0.001
Demographics						
Age group (years)						
75-79 $^{\alpha}$	1.0			1.0		
80-84	0.90	0.86 to 0.93	<0.001	0.92	0.89 to 0.96	<0.001
85-89	0.77	0.74 to 0.80	<0.001	0.84	0.80 to 0.87	<0.001
90-94	0.71	0.69 to 0.74	<0.001	0.78	0.75 to 0.82	<0.001
95 and above	0.64	0.60 to 0.68	<0.001	0.74	0.69 to 0.79	<0.001
Sex						
male $^{\alpha}$	1.0			1.0		
female	1.03	1.00 to 1.06	0.059	1.05	1.02 to 1.08	<0.001
Clinical characteristics						
Charlson						
zero $^{\alpha}$	1.0			1.0		
1 to 5	1.00	0.96 to 1.04	0.917	0.98	0.94 to 1.02	0.337
6 or more	0.70	0.68 to 0.73	<0.001	0.76	0.73 to 0.78	<0.001
NEWS category						
low $^{\alpha}$	1.0			1.0		
medium	0.69	0.66 to 0.73	<0.001	0.68	0.64 to 0.72	<0.001
high	0.54	0.50 to 0.58	<0.001	0.54	0.50 to 0.58	<0.001
Pain on first vital signs set						
no $^{\alpha}$	1.0			1.0		
yes	0.94	0.91 to 0.97	<0.001	0.95	0.91 to 0.98	0.003

	Univariable analysis for time to discharge			Multivariable analysis for time to discharge N=20,933[2]		
Characteristic	**Sub-hazard ratio**	**95% CI**	**p-value**	**Sub-hazard ratio**	**95% CI**	**p-value**
MUST category						
low [α]	1.0			1.0		
medium	0.74	0.70 to 0.78	<0.001	0.77	0.73 to 0.81	<0.001
high	0.50	0.48 to 0.52	<0.001	0.55	0.53 to 0.58	<0.001
missing	1.05	1.02 to 1.09	0.003	1.11	1.07 to 1.15	<0.001
Health service characteristics						
Admission route						
General Practice/ outpatients etc [α]	1.0					
Accident and emergency	0.97	0.94 to 1.01	0.130	[β] -	-	-
Discharge specialty						
non-medicine [α]	1.0			1.0		
medicine	1.19	1.15 to 1.22	<0.001	1.36	1.31 to 1.41	<0.001

[1] Diagnostic groups were adjusted for in the analysis but not presented
[2] Number of observations in final model
[α] Reference category
[β] Not included in final model due to non-significance in univariable regression

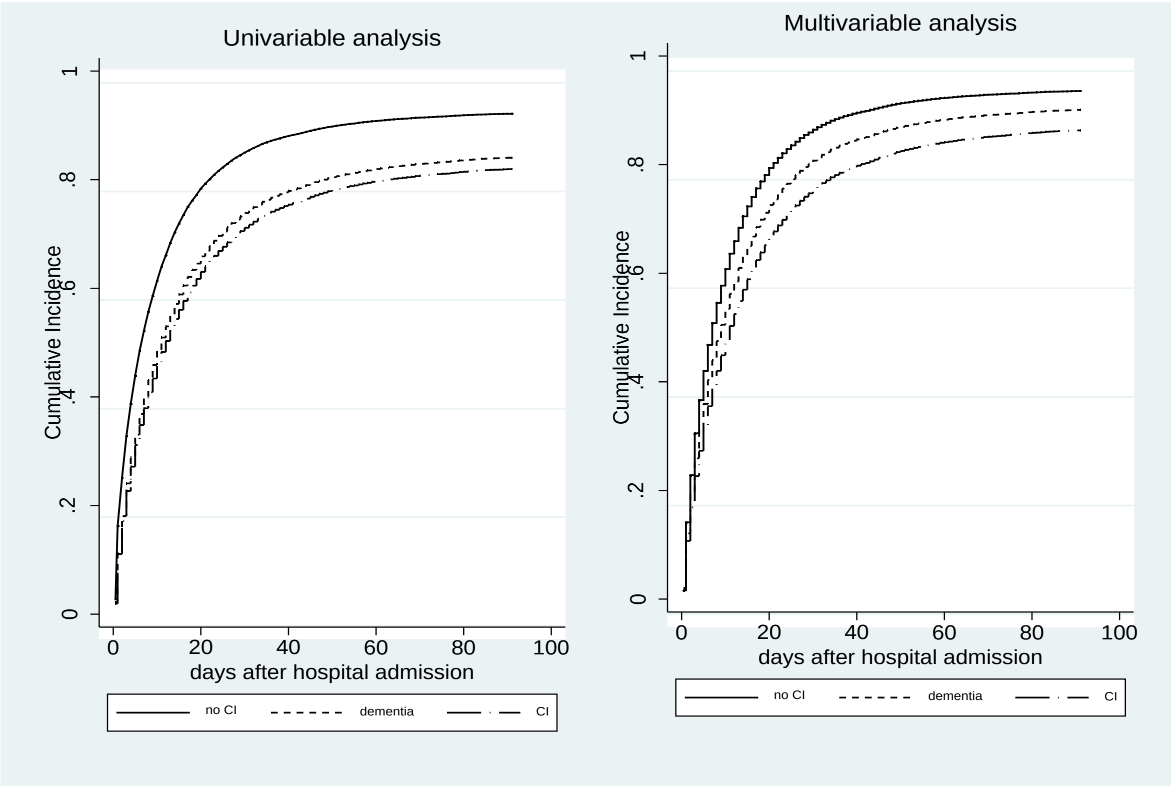

Figure 3 Unadjusted and adjusted cumulative incidence function for time to discharge according to cognitive impairment category

5.5 Discussion

This study aimed to assess whether older patients admitted to hospital with cognitive impairment are at higher risk from poor outcomes than those with normal cognition, after adjustment for known risk factors. We found independent associations between cognitive impairment and increased mortality, both within hospital and including 30 days after discharge, increased time until discharge from hospital, and increased readmission within 30 days of discharge. This was also the case for patients with a diagnosis of dementia. Additionally, the risks of mortality in hospital, re-admission and extended hospital stay were higher in patients with cognitive impairment alone than in those with a diagnosis of dementia.

In previous research, an association between cognitive impairment and poor outcomes could not be ascertained due to key missing covariates and small sample sizes. This study highlights that patients with cognitive impairment are at considerably greater risk than those with normal cognition, taking into account other key factors which influence these outcomes.

Possible mechanisms for the increased risks observed in patients with cognitive impairment include differences in effective care for people with cognitive impairment in hospital, and intrinsic mechanisms which place these patients at higher risk of deterioration. Variations in care that may disadvantage patients with dementia have been described in the literature for patients with a known diagnosis of dementia include reduction in routine monitoring for deterioration (Hope et al., 2017), increased time waiting for investigations (Griffiths et al., 2014), and under-treatment of concurrent conditions such as chronic obstructive pulmonary disease (Frohnhofen et al., 2011). It may be the case that such variations also apply to the wider group of cognitively impaired patients, especially given that these patients appeared to have even worse outcomes than those already known to have dementia. Higher rates of potentially preventable complications, including urinary tract infections, pressure ulcers, pneumonia and delirium, have been identified in hospitalised patients with dementia, and may provide areas of focus for nursing care for all patients with cognitive impairment (Bail et al., 2013). Our study also highlighted that patients with cognitive impairment were the most likely to have two or more ward moves during their hospital stay, whereas those with dementia had the least moves, possibly because staff may have endeavoured not to further disorientate them and risk onset of delirium or other behavioural issues. It is possible that knowing patients had a diagnosis of dementia also impacted on other areas of care in a positive manner, which may have contributed to our finding that patients in the cognitive impairment group had worse outcomes than patients with a diagnosis of dementia, as the cognitive impairment group is not yet recognised as a 'high-risk' group of patients.

The elongated stays in hospital and higher rate of readmissions experienced by patients with cognitive impairment and no diagnosis of dementia are key areas for future examination, as they lead to further deconditioning and dependence for patients and increase hospital costs. Using an instrument such as Comprehensive Geriatric Assessment during admission, and monitoring rates of functional and cognitive decline as hospital performance indicators may be useful to better understand their care needs and how we can best assist maintenance of their function and independence whilst in hospital and support appropriate holistic discharge planning (Ellis et al., 2011). It is interesting that patients with a diagnosis of dementia seemed to fare better in relation to these outcomes, possibly due to their diagnosis enabling focussed assessment and advanced care planning prior to or during hospitalisation, enabling quicker discharge and appropriate community care provision. However, the increased risk of mortality when including the 30 days after discharge was very similar for all cognitively impaired patients, suggesting that although care pathways may differ according to known diagnoses, the impact of acute illness and hospitalisation on these patients is equally significant.

The current emphasis on screening older patients for cognitive impairment in hospital to detect possible cases of dementia and refer to memory assessment clinics (NHS England, 2014, National Collaborating Centre for Mental Health, 2018) may need to be bolstered by clear guidelines on additional assessments and hospital care for those that are identified. These could explicitly include patients with cognitive impairment, who have not yet been assessed for dementia. What this would actually comprise is currently uncertain – although 'best practice' guidelines for patients with dementia, including prevention of delirium, may be considered (Alzheimer's UK, 2016, National Institute for Health and Care Excellence, 2010), there is limited evidence that these are effective in improving outcomes such as mortality (Goldberg et al., 2013). People with a known diagnosis of dementia have lower conveyance rates to hospital (Pocock H et al., 2018), and although admission avoidance is not appropriate in all cases, assessment of cognitive impairment in the community is important to identify people who may benefit from community-based care where possible. Achieving this may require additional support for people with cognitive impairment in the community, who, without a diagnosis of dementia, would not benefit from the services of Dementia Care Co-ordinators or other interventions (National Collaborating Centre for Mental Health, 2018). Although hospitals do refer patients with cognitive impairment for monitoring in General Practice within six weeks of discharge, it is unknown how often this referral is acted upon, and the high rate of re-admissions in this group suggests that this may be too long an interval prior to General Practitioner re-assessment, both for cognitive issues and for concurrent medical conditions.

Strengths and Limitations

This study utilised a large dataset reflective of routine care in a general district hospital, which has comparative mortality and performance statistics representative of similar institutions in NHS England. The demonstration of known predictors of mortality in the final models increase confidence in the validity of the data and the study conclusions as regards the additional independent risk posed by presence of cognitive impairment and dementia. In contrast to previous literature, the use of a competing risks model to evaluate length of stay removes biases introduced by considering death as a form of discharge. Data on frailty or function, which have also been related to poor outcomes (Kojima et al., 2018, Dani et al., 2018), were not available as these are not currently measured systematically or electronically as part of routine care. Missing Malnutrition Universal Screening Tool score data was unavoidable, as this assessment should be performed within 24 hours of admission, thus missing those with early mortality and shorter lengths of stay, as illustrated by the 'missing' category. However, the sensitivity analysis showed that when the same covariates were included in the final model, Odds Ratios and Area Under the Receiver Operating Characteristic Curve were very similar and these results did not alter the main conclusions. The follow-up period was limited to 30 days, but this is more reflective of outcomes of acute care, and outcomes are therefore not overly diluted by differing community care pathways. Although the cohorts were grouped based on characteristics at admission (as in the majority of other studies), occurrence of delirium during the admission would be an important mediator to assess in future work.

Patients with hypoactive delirium may possibly have been misclassified as non-cognitively impaired in this study as this is often undetected in routine practice, and, as these patients are known to have worse outcomes, may have reduced the effect sizes between groups. Due to the broad nature of the cognitive screening pathway and its "real-life" implementation in routine clinical practice, other sources of misclassification between exposure groups are possible, for example patients with undiagnosed non-amnestic dementia may have been classified as non-cognitively impaired, and systematic differences in response to the question regarding memory loss over the last 12 months associated with the responder (patients vs carer/relative). However, the purpose of the screening process is to identify those with a current diagnosis of dementia, and to provide a broad screen to identify other patients who may be undiagnosed or benefit from further assessment. The results of the study do suggest that the screening process is indeed identifying a large cohort of older patients with additional vulnerability to poor hospital outcomes.

5.6 Conclusions

This study demonstrated an independent association of cognitive impairment and dementia with poorer outcomes for older adults in hospital. Furthermore, patients with cognitive impairment and no diagnosis of dementia experienced poorer outcomes than those with dementia, thus representing a high-risk patient group with high costs. Whilst increased risks of hospitalisation for people with dementia are widely recognised and consequently can be acted upon, older patients with cognitive impairment may be largely undetected unless routine screening is in place. There is now a need to understand more about the mechanisms leading to these outcomes, including the relative contributions of intrinsic pathological pathways of deterioration, and extrinsic factors relating to context of care received, such as workforce arrangements, transfers of care, availability and content of care at home. Combined with systematic, enhanced recognition of cognitive impairment, future research may enable development of informed interventions for modification of care in hospital to improve care for this vulnerable group of older people.

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Chapter 6 Paper 3 - The association between ward staffing levels, mortality and hospital readmission in older hospitalised adults, according to presence of cognitive impairment: a retrospective cohort study

Citation: Fogg C, Bridges J, Meredith P, Spice C, Field L, Culliford D, Griffiths P. The association between ward staffing levels, mortality and hospital readmission in older hospitalised adults, according to presence of cognitive impairment: a retrospective cohort study. *Age and Ageing*, *published online 24th September 2020 https://doi.org/10.1093/ageing/afaa133*

Candidate's contribution: the candidate (Fogg) designed the study objectives and analysis, performed the analysis and wrote the first and subsequent drafts of the paper. The supervisors (Bridges, Meredith, Griffiths) provided guidance throughout. Additional advice and reviews were provided on statistics (Culliford) and clinical perspectives (Spice, Field).

6.1 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.

6.2 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.

6.3 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 (Fogg et al., 2018, Fogg et al., 2019). 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 (Bail and Grealish, 2016, Morandi et al., 2017). 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 (Royal College of Nursing, 2012 , Lintern S, 2019). 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 (Lakey, 2009).

Research in general hospital populations has established an association between lower nurse staffing levels and increased risk of death and other adverse outcomes (Kane et al., 2007, Shekelle, 2013, Griffiths et al., 2016). The evidence is consistent with a causal relationship, with plausible mechanisms including lower adherence to observation schedules, medication errors and hospital-acquired complications (Recio-Saucedo et al., 2018, Griffiths et al., 2019, Griffiths et al., 2018). 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 (Barker et al., 2016). 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 (Aiken et al., 2017). 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 (Aiken et al., 2017, Bail et al., 2013).

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 (White et al., 2018). 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 (Hope et al., 2017). Additionally, nursing staff have expressed a lack of knowledge and training in caring for older patients with cognitive impairments (Griffiths et al., 2014, Dewing and Dijk, 2016).

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.

6.4 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 (The Shelford Group, 2014, Griffiths et al., 2019). 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 (Griffiths et al., 2019). 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 (Wasserstein and Lazar, 2016). 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 10.

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).

Table 10 Description of covariates

Variable description	Categorisation
Patient demographics	
Age	5-year age bands: 75-79, 80-84, 85-89, 90-94, ≥95
Gender	Male, female
Clinical characteristics	
Cognitive impairment	Defined as any patient with a known diagnosis of dementia, or with an AMTS of ≤8 during the cognitive screening process. Patients not meeting these criteria was classified as ‘no cognitive impairment’.
Primary diagnosis group, based on Summary Hospital Mortality Indicator (SHMI) Clinical Coding System (CCS) bundles (original diagnoses use International Classification of Disease 10)	System-organ classes, with the exception of codes relating to ‘infection’ which were grouped as a separate category, regardless of organ system.
Charlson co-morbidity index (CCI)	CCI 0=1; CCI 1-5=2; CCI>5=3
National Early Warning Score (NEWS) value at admission	Severity of illness categories: NEWS value 0-4=low; NEWS value 5-6=medium; NEWS value ≥7=high
Malnutrition Universal Screening Tool (MUST) score at admission	0=low risk, 1=medium risk, ≥2=high risk
Health service characteristics	
Route of admission	“Emergency - Accident and Emergency Department” and “Other” – which includes Emergency – GP, outpatient, other NHS provider etc.
Ward transfers	Two or more ward transfers during admission (yes/no) (does not include transfer from Medical Assessment Unit to initial ‘home’ ward)
Discharge specialty	Medicine (includes medical specialties and medicine for older people), non-medicine (includes surgery, trauma and orthopaedics)

Ethics

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

6.5 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 11) 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.

Table 11 Description of patient and staffing characteristics according to the presence of cognitive impairment

	Cognitive impairment		**No cognitive impairment**		**Total**	
STAFFING CHARACTERISTICS						
Summary of staffing hours above/below the mean summarised by admission (median, IQR):						
RN HPPD	0.117	0.490	0.113	0.556	0.114	0.531
NA HPPD	0.220	0.518	0.226	0.528	0.225	0.512
Total CHPPD	0.326	0.755	0.330	0.868	0.329	0.826
Total days in hospital	65,968		95,854		161,822	
Days with staffing below the mean (n, %):						
RN HPPD	27,531	41.7%	40,421	42.2%	67,952	42.0%
NA HPPD	21,448	32.5%	32,934	34.3%	54,382	33.6%
Total CHPPD	22,692	34.4%	34,735	36.2%	57,427	35.5%
PATIENT CHARACTERISTICS[1]						
Number of admissions (n)	4,159		8,385		12,544	

	Cognitive impairment		No cognitive impairment		Total	
Aged 85 and above (n, %)	2,569	61.8%	3,504	41.8%	6,073	48.4%
Male sex (n, %)	1,550	37.3%	3,754	44.8%	5,304	42.3%
First admission NEWS categorised as high risk (n, %)	277	6.7%	408	4.9%	685	5.5%
Charlson comorbidity score of 6 or above (n, %)	3,298	79.5%	4,177	50.3%	7,475	60.0%
MUST categorised as high risk (n, %)	871	30.0%	1,085	17.2%	1,956	21.3%
Days stay by ward type (n, %):						
Medical	11,434	19.2%	29,916	35.0%	41,350	28.5%
Older persons	31,431	52.6%	20,258	23.7%	51,689	35.6%
Surgical	9,837	16.5%	24,942	29.1%	34,779	23.9%
MAU	7,002	11.7%	10,451	12.2%	17,453	12.0%
HEALTHCARE CHARACTERISTICS						
Admitted via the Emergency Department (n, %)	3,624	87.1%	6,607	78.8%	10,231	81.6%
2 or more ward transfers during admission (n, %)	1,742	41.9%	3,563	42.5%	5,305	42.3%
Under medical specialty at discharge (n, %)	3,437	82.6%	6,136	73.2%	9,573	76.3%

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 12 with plots of associations in Figure 3. 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).

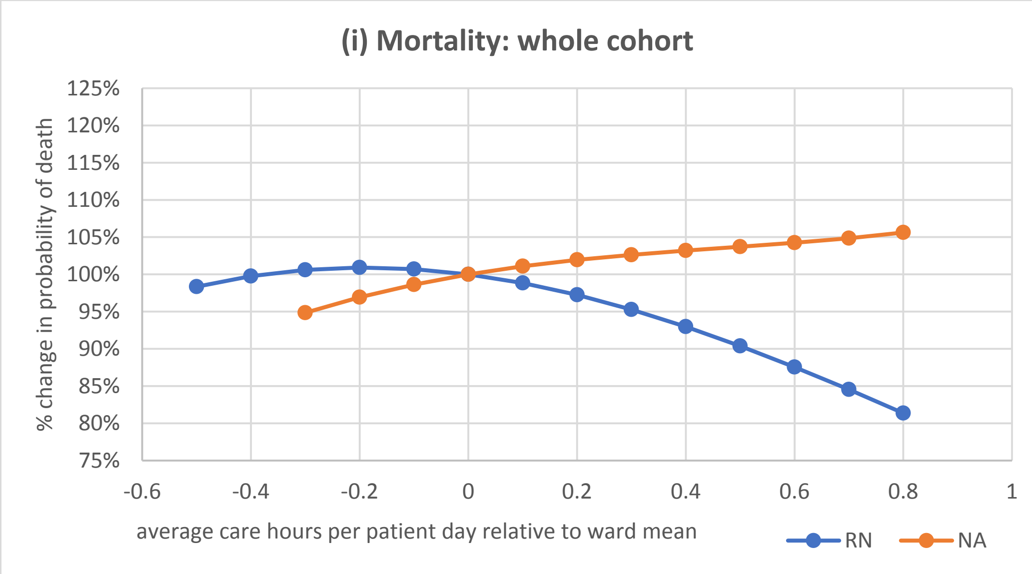
The odds of readmission decreased when patients were exposed to levels of RN staffing above the mean, with a statistically significant association in patients with CI (Table 12, Figure 3 iv-vi). An 0.5 hour increase in RNHPPD reduced the odds of readmission in patients with CI by 6% (OR 0.94 [0.82-1.06]), 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).

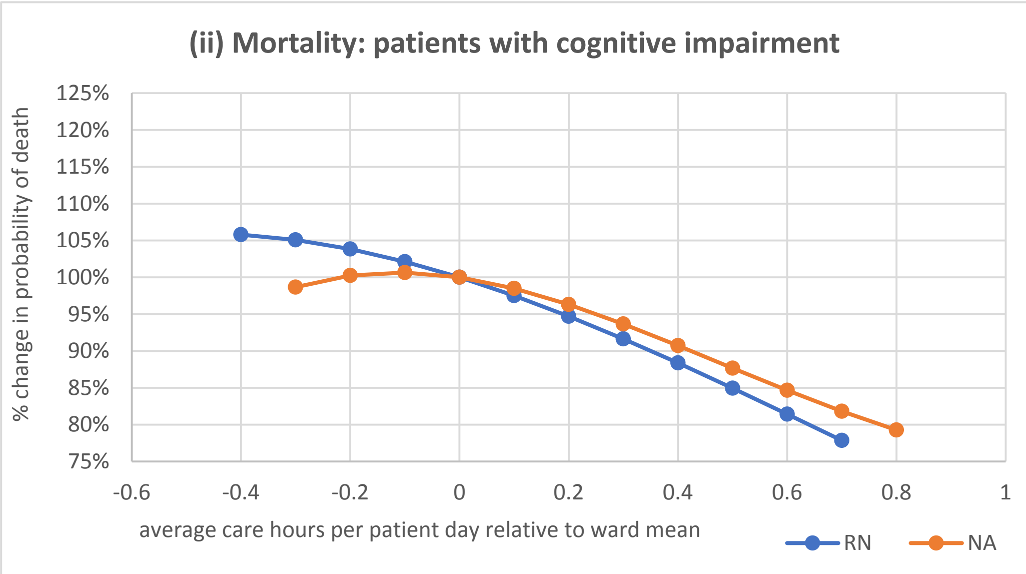
Table 12 Multivariable models for the association between average staffing levels above/below the mean and outcomes of mortality and readmission

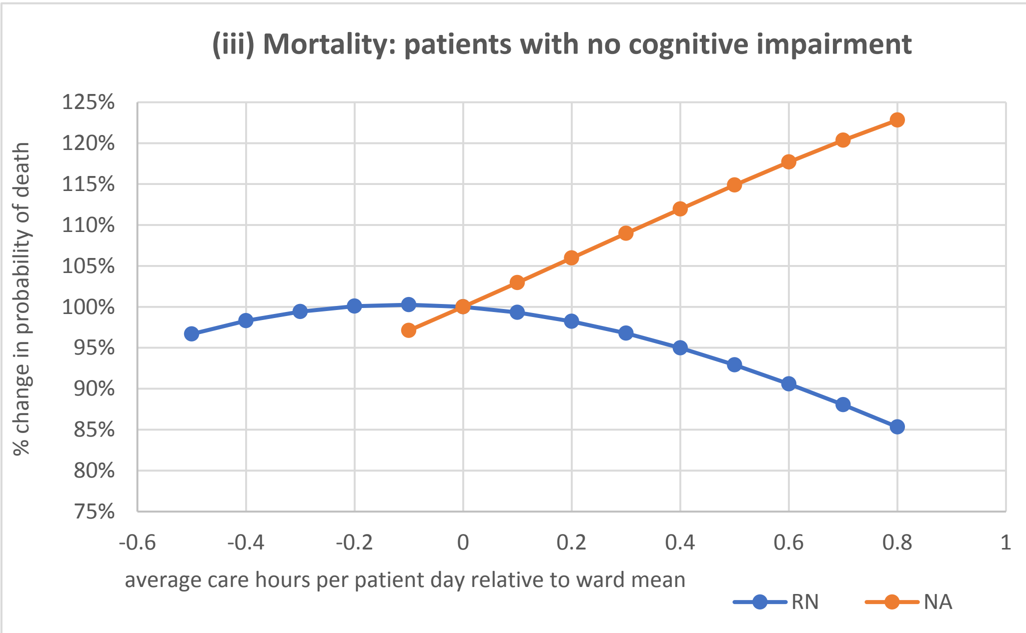
	RN/NA CHPPD average above/below the mean and mortality in hospital and within 30 days of discharge OR [95% CI], p-value			RN/NA CHPPD average above/below the mean and readmission to hospital within 30 days of discharge OR [95% CI], p-value		
Characteristics	**Total patient group**	**Patients with cognitive impairment**	**Patients with no cognitive impairment**	**Total patient group**	**Patients with cognitive impairment**	**Patients with no cognitive impairment**
RN CHPPD linear term	0.91 [0.79-1.05] p=0.200	0.79 [0.60-1.04] p=0.098	0.95 [0.79-1.15] p=0.606	0.97 [0.83-1.13] p=0.695	1.02 [0.78-1.33] p=0.892	0.97 [0.81-1.17] p=0.758
Quadratic term	0.79 [0.67-0.92] p=0.002	0.81 [0.58-1.14] p=0.222	0.81 [0.67-0.98] p=0.028	0.85 [0.73-1.00] p=0.050	0.72 [0.52-0.98] p=0.039	0.95 [0.78-1.15] p=0.594
Cubic term	1.04 [1.01-1.07] p=0.009	1.05 [0.98-1.12] p=0.186	1.03 [1.00-1.07] p=0.045	1.03 [1.00-1.06] p=0.020	1.06 [1.01-1.12] p=0.016	0.99 [0.95-1.05] p=0.975
NA CHPPD linear term	1.12 [0.91-1.39] p=0.267	0.90 [0.60-1.34] p=0.589	1.34 [1.01-1.77] p=0.039	1.02 [0.82-1.27] p=0.868	1.07 [0.74-1.56] p=0.715	0.96 [0.73-1.27] p=0.795
Quadratic term	0.86 [0.61-1.22] p=0.409	0.65 [0.33-1.25] p=0.195	0.99 [0.63-1.57] p=0.977	1.31 [0.91-1.88] p=0.150	1.41 [0.70-2.85] p=0.333	1.23 [0.79-1.90] p=0.362
Cubic term	1.11 [0.95-1.30] p=0.179	1.31 [1.01-1.70] p=0.045	0.95 [0.75-1.21] p=0.695	0.82 [0.65-1.02] p=0.076	0.81 [0.53-1.24] p=0.336	0.85 [0.64-1.13] p=0.265
Cognitive impairment present	1.50 [1.32-1.70] p<0.001	N/A	N/A	1.34 [1.16-1.53] p<0.001	N/A	N/A
Age (years)						
75-79[1]	0	0	0	-	-	-
80-84	1.23 [1.04-1.45] p=0.015	1.08 [0.74-1.59] p=0.689	1.40 [1.14-1.73] p=0.009	-	-	-
85-89	1.47 [1.25-1.74] p<0.001	1.20 [0.83-1.75] p=0.338	1.69 [1.37-2.09] p<0.001	-	-	-
90-94	1.68 [1.40-2.02] p<0.001	1.46 [0.99-2.16] p=0.057	1.93 [1.51-2.47] p<0.001	-	-	-
≥95	1.86 [1.43-2.40] p<0.001	1.77 [1.10-2.86] p=0.020	2.41 [1.65-3.52] p<0.001	-	-	-
Sex						
Male[1]	0	0	0	-	-	-
Female	0.77 [0.69-0.86] p<0.001	0.63 [0.50-0.78] p<0.001	0.80 [0.69-0.93] p=0.004	-	-	-
NEWS						
Low[1]	0	0	0	0	0	0

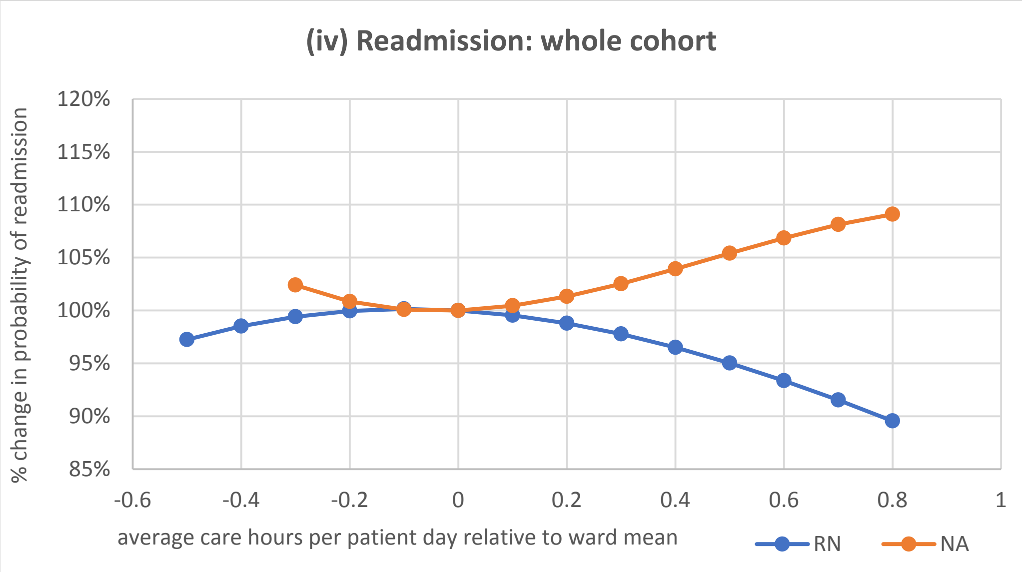
	RN/NA CHPPD average above/below the mean and mortality in hospital and within 30 days of discharge OR [95% CI], p-value			RN/NA CHPPD average above/below the mean and readmission to hospital within 30 days of discharge OR [95% CI], p-value		
Characteristics	**Total patient group**	**Patients with cognitive impairment**	**Patients with no cognitive impairment**	**Total patient group**	**Patients with cognitive impairment**	**Patients with no cognitive impairment**
Medium	2.09 [1.78-2.46] p<0.001	1.83 [1.31-2.55] p<0.001	2.28 [1.84-2.82] p<0.001	1.15 [0.94-1.42] p=0.179	1.18 [0.84-1.66] p=0.334	1.13 [0.87-1.47] p=0.361
High	3.22 [2.66-3.88] p<0.001	2.60 [1.81-3.73] p<0.001	3.62 [2.81-4.68] p<0.001	1.30 [0.99-1.69] p=0.051	1.26 [0.84-1.90] p=0.264	1.33 [0.94-1.88] p=0.108
Charlson score						
0[1]	0	0	0	0	0	0
1-5	1.12 [0.90-1.39] p=0.311	1.49 [0.66-3.35] p=0.333	1.23 [0.95-1.59] p=0.115	1.06 [0.86-1.31] p=0.579	1.02 [0.65-1.59] p=0.945	1.09 [0.86-1.38] p=0.491
6+	1.89 [1.62-2.21] p<0.001	1.38 [0.85-2.24] p=0.195	2.19 [1.81-2.65] p<0.001	1.29 [1.11-1.51] p=0.001	1.00 [0.75-1.33] p=0.983	1.44 [1.19-1.73] p<0.001
MUST score						
Low[1]	0	0	0	-	-	-
Medium	1.47 [1.19-1.82] p<0.001	1.35 [0.86-2.13] p=0.188	1.45 [1.10-1.91] p=0.009	-	-	-
High	2.69 [2.34-3.10] p<0.001	2.98 [2.26-3.92] p<0.001	2.63 [2.17-3.19] p<0.001	-	-	-
Missing	1.28 [1.17-1.48] p<0.001	1.36 [1.03-1.79] p=0.028	1.28 [1.06-1.54] p=0.010	-	-	-
Ward transfers						
None or 1[1]	0	0	0	0	0	0
2 or more	0.46 [0.41-0.52] p<0.001	0.36 [0.28-0.46] p<0.001	0.56 [0.48-0.67] p<0.001	1.19 [1.04-1.36] p=0.013	1.13 [0.91-1.41] p=0.256	1.22 [1.02-1.45] p=0.028
Route of admission via emergency department	0.84 [0.73-0.98] p=0.026	0.98 [0.71-1.36] p=0.907	0.81 [0.67-0.98] p=0.026	-	-	-

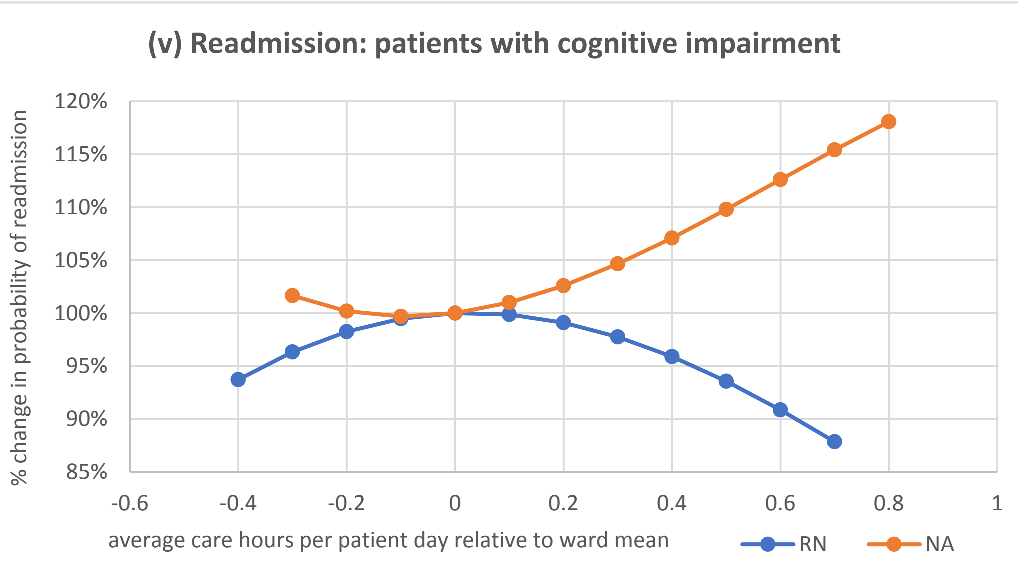
Figure 4 Graphs of predicted probabilities of mortality and readmission by cognitive impairment status

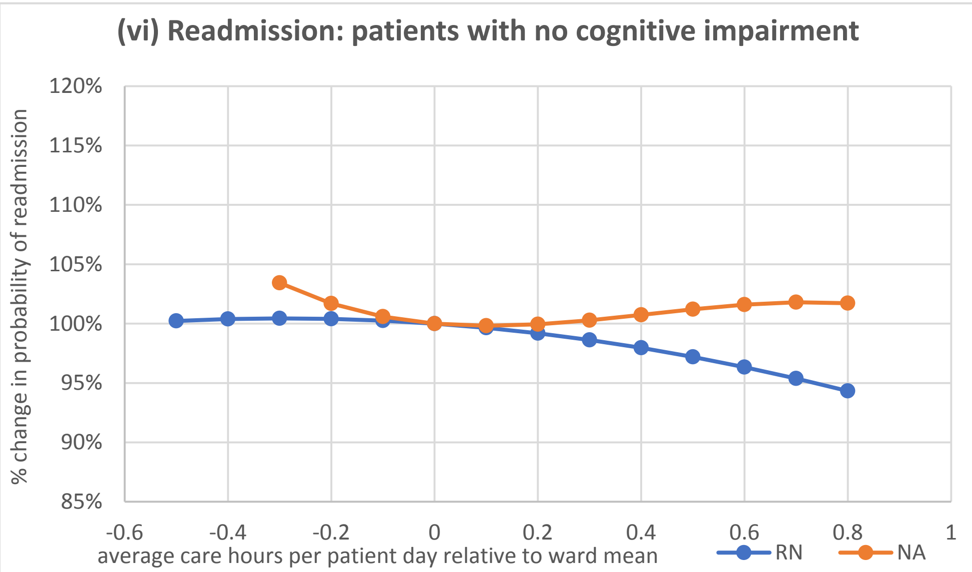

(i) Mortality: whole cohort
% change in probability of death
125%
120%
115%
110%
105%
100%
95%
90%
85%
80%
75%
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
average care hours per patient day relative to ward mean
RN
NA


(ii) Mortality: patients with cognitive impairment
% change in probability of death
125%
120%
115%
110%
105%
100%
95%
90%
85%
80%
75%
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
average care hours per patient day relative to ward mean
RN
NA


(iii) Mortality: patients with no cognitive impairment
% change in probability of death
125%
120%
115%
110%
105%
100%
95%
90%
85%
80%
75%
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
average care hours per patient day relative to ward mean
RN
NA


(iv) Readmission: whole cohort
% change in probability of readmission
120%
115%
110%
105%
100%
95%
90%
85%
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
average care hours per patient day relative to ward mean
RN
NA


(v) Readmission: patients with cognitive impairment
% change in probability of readmission
120%
115%
110%
105%
100%
95%
90%
85%
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
average care hours per patient day relative to ward mean
RN
NA


(vi) Readmission: patients with no cognitive impairment
% change in probability of readmission
120%
115%
110%
105%
100%
95%
90%
85%
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
average care hours per patient day relative to ward mean
RN
NA

6.6 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 (White et al., 2018). 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 (Cummings, 1999, Griffiths et al., 2018). 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 (Sager et al., 1996, Sands et al., 2002).

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 (The Shelford Group, 2014, Improvement;, 2018). 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 (Griffiths, 2020 *in press*).

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 (The Health Foundation The King's Fund and the Nuffield Trust, 2018). 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 (Griffiths et al., 2019). 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 (Griffiths et al., 2019). 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 (Wood et al., 2018).

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 (Redfern et al., 2019).

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.

6.7 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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Chapter 7 Discussion

This chapter provides a summary of the key findings of the research in this thesis followed by a discussion of the findings. The key methodological strengths and limitations are then outlined, and the implications of the findings for policy in the light of these. Potential topics for future research are highlighted, and overall conclusions drawn.

7.1 Summary of key findings

The research aimed to quantify the prevalence of cognitive impairment in older hospitalised adults, to describe and compare characteristics of patients with cognitive impairment and those without, and to explore associations between cognitive impairment and adverse outcomes. It also sought to investigate how previously described associations between staffing levels and hospital outcomes may be reflected in this patient cohort.

The key findings can be summarised as follows:

- A significant proportion of older people with emergency admissions have cognitive impairment but have not been diagnosed with dementia. (Paper 1)

- Patients with cognitive impairment not diagnosed with dementia have a similar risk of dying in hospital and longer lengths of stay than patients with a dementia diagnosis, and higher rates of new discharge to a nursing/residential home than patients without any cognitive impairment. (Paper 1)

- Cognitive impairment (both with and without a diagnosis of dementia) is independently associated with a higher risk of death in hospital and within 30 days of discharge, longer hospital stays and a higher risk of readmissions after controlling for factors including severity of illness, primary diagnosis, nutritional risk scores, age and comorbidities. (Paper 2)

- Older patients with cognitive impairment appear to be exposed to similar registered nursing care hours and nursing assistant care hours as those without, so the additional risk of poor outcomes is unlikely to be related to differences in levels of care between groups. (Paper 3)

- Increased registered nurse hours per patient day relative to the mean was associated with reduced mortality, and this effect was greater in patients with cognitive impairment. It also had a positive effect on reducing readmissions. Conversely, increased nursing assistant hours appeared to increase the risk of mortality in patients with no cognitive impairment. (Paper 3)

7.2 Discussion of key findings

This research has identified that patients with cognitive impairment and no diagnosis of dementia constitute a significant proportion of the older hospital population, who are as susceptible to poor outcomes as patients with a diagnosis of dementia (Paper 1). Furthermore, this group of patients are at an increased risk of hospital mortality and readmissions and longer lengths of stay, which are associated with the presence of cognitive impairment (Paper 2). The findings also suggest that this additional risk is potentially modifiable, as it is associated with nurse staffing levels (Paper 3).

The independent association between cognitive impairment and adverse outcomes combined with the considerable numbers of older adults with cognitive impairment in hospital suggests that having a systematic way of identifying these at-risk patients is useful, as long as it could inform the delivery of targeted and appropriate person-centred care. It is likely that the group of patients with cognitive impairment and no dementia diagnosis may have similar care needs to patients who have been diagnosed with dementia but may not receive the person-centred care that they need during admission. Identification of dementia as a risk factor for poor outcomes is widely known, and there is extensive literature describing how patients with dementia could be managed in hospital. Strategies include a clear indication of the patient's dementia diagnosis to all healthcare staff by using a 'forget-me-not' flower shaped magnet in a visible place near the bed (the symbol used by Dementia Friends), close observation of food and fluid intake, avoidance of sedatives and antipsychotics, reduced movement of the patient between wards to avoid further confusion, clear signage to toilets, strategies for effective communication, person-centred care and a proactive and inclusive approach to family carers (Andrews and Christie, 2009, Archibald, 2006a, Archibald, 2006b, Goldberg et al., 2013, Harwood et al., 2018). The high risk of delirium in hospitalised people with dementia can be ameliorated with multicomponent interventions aimed at minimising risk factors, such as sleep deprivation, immobility, visual and hearing impairments and dehydration (Hshieh et al., 2015, Inouye et al., 1999). Such interventions are also important to reduce long-term effects of delirium, including further progression of a decline in cognitive impairment (Inouye et al., 2016). However, inclusion of all people with cognitive impairment, or specific evidence to guide the care of people with cognitive impairment but without a dementia diagnosis, is lacking. The similarity in rates of adverse outcomes in patients with cognitive impairment compared to those with a diagnosis of dementia in this research suggests that recognising cognitive impairment as an important risk factor in emergency admissions is important, as it could enable extension of targeted care implemented for people with dementia to all older people identified with cognitive impairment, and thus improve outcomes. The finding that one third of the group of patients with cognitive impairment and no dementia diagnosis had delirium at the point of screening further supports extension of care to this group, as enabling proactive detection, management and prevention of delirium may be an effective way of improving outcomes in this group.

Despite existing guidance on best practice for hospital care for people with dementia, published evidence demonstrating effect on hard outcomes is scarce. A randomised controlled trial of an intervention comprising specialist wards in which guidance has been implemented did not show improvements in mortality, length of stay or readmission (Goldberg et al., 2013). However, interventional studies to demonstrate the beneficial effects on good practice may be hard to implement, as they need to include a wide scope of environmental changes, care practices and staff behaviours which may be hard to deliver consistently according to the needs of the patients (Goldberg et al., 2014). Additionally, it is recognised that individuals enrolled in clinical trials in standard care arms often have better outcomes than those receiving non-trial standard care, particularly where standard care may become 'protocolised' within the trial (Braunholtz et al., 2001). Furthermore, although mortality is considered a 'hard' outcome and often used as a primary endpoint in trials, it may be considered less appropriate in a population that often has high levels of multimorbidity and frailty and may be in their final years of life. Provision of the best care for the patients' needs in order to meet outcomes appropriate to those identified in individual care plans, for example maintaining independence at home or avoiding further re-admissions to hospital, may be a more patient-centered focus for future prospective observational or interventional research.

This work has identified that people with cognitive impairment are at higher risk from readmission. This indicates that, in addition to improvements in hospital care, informing the patient's GP at discharge and ensuring the 'closing of the loop' in terms of follow-up assessments and care is essential to prevent further deterioration after discharge and consequent readmission. This information, together with other key information from hospital assessments, for example comprehensive geriatric or frailty assessments, could be important in increasing prioritisation for such patients to access higher levels of community care earlier, and could be initiated whilst in hospital. However, a mixed-methods evaluation of patients who had been identified for further investigation found screening did not necessarily lead to follow-up by their GP, and that patients/carers were often not aware that they had been screened, or what purpose the results of screening had in their care (Burn et al., 2019). This work indicates that communication of risks in all people with cognitive impairment to the GP and families/carers is essential. Reducing hospital admissions in people with dementia due to the additional risks of hospitalisation is well recognised. An evaluation of conveyance rates following emergency ambulance attendance for older people within the catchment population of the hospital cohort used in this thesis found people with a diagnosis of dementia were 9% less likely to be conveyed to hospital, adjusting for other clinical characteristics (Lofthouse-Jones C et al., 2018). It is unknown whether or not this is the case for people with cognitive impairment and no diagnosis of dementia, and access to alternative community services or pathways may be prioritised for people with a known diagnosis of dementia, resulting in other vulnerable patients with cognitive impairments still being taken to hospital. Ensuring that information about the patients' cognitive status is passed at discharge to general practitioners and subsequently available to emergency clinicians may help to reduce readmissions. Availability of the information to community healthcare providers and social care teams may also enable earlier intervention with appropriate care packages, with the potential to reduce hospital readmissions, delayed discharges and lengths of stay (Spiers et al., 2019).

The association between increased staffing levels above the mean and reduced mortality and readmissions in patients with cognitive impairment provides evidence that outcomes for these patients can be improved. The stronger association in patients with cognitive impairment compared to those without may be in part explained by the greater challenges in providing basic care to patients with cognitive impairment. A large cross-sectional study across 33 hospitals in Germany found that staff reported care challenges (such as sleeping disturbance, fending off nursing and wound care, pulling out infusion needles and catheters and moving out of the ward) with increasing frequency as cognitive impairment worsened (Hendlmeier et al., 2019). Additional staffing resource may help to anticipate, prevent and manage such additional care needs. Lower nurse staffing may lead to worse outcomes through missed care leading to intermediate negative outcomes such as medication errors, urinary tract infections, falls, pressure ulcers and critical incidents (Recio-Saucedo et al., 2017). Although research has focussed on 'failure to rescue' of patients who are deteriorating, a narrative that may be more applicable to the needs of older people, especially those with cognitive impairment, is the concept of 'failure to maintain' (Bail and Grealish, 2016). This model suggests that tasks such as vital signs monitoring and administering treatment are being prioritised over other, equally essential, fundamental care activities including toileting, mobilisation, assistance with personal hygiene and skin and mouth care, and that this could be exacerbated by underlying staffing deficits. The subsequent functional decline of the patient leads to reduction in food and fluid intake, getting out of bed, bowel and bladder function, and ultimately the development of hospital-acquired complications such as urinary tract infections, pressure areas, delirium, pneumonia and falls, which in turn lead to poorer overall outcomes.

In addition to basic care, providing person-centred care for people with dementia has been identified as a challenge by both staff and caregivers (Clissett et al., 2013). The proportion of staff receiving dementia-care specific training remains low, and even when trained, staff still feel their skills are not sufficient (Scerri et al., 2019). It may be that more adequately trained nursing staff and potentially greater use of specialist nurse roles in dementia care may be a positive step towards providing care which may improve outcomes, and that such care roles should be extended to patients with any cause of cognitive impairment (Griffiths et al., 2015). However, although educational interventions for patients with delirium or dementia can improve staff knowledge, there is insufficient evidence to conclude the interventions lead to improved patient outcomes, and changes in care may only occur with concurrent senior leadership and alignment of ward priorities to value person-centred care approaches (Handley et al., 2017). Furthermore, a realist evaluation in two UK hospital wards, one configured as 'dementia ward' and one with nursing assistants, supported by dementia specialist nurses, working across hospital, highlighted that additional resource may not be enough to be able to deliver person-centred care, and that competing tasks, risk aversion and the perception of dementia care as an less skilled role also need to be addressed (Handley et al., 2019). Therefore, hospital cultural factors may also require review, even if the nursing workforce can be adjusted to meet care needs.

The weaker, non-significant association between increased nursing assistant hours and reduced mortality shown in Paper 3, compared to the stronger association with increased nurse staffing, does support a change in workforce planning for these patients in their day-to-day care on the wards. A UK audit of workforce and older people's care show that the nursing staff have a richer skill mix in assessment units and discharge teams, but a lower skill mix with greater use of nursing assistants on care of older people wards (NHS Benchmarking Network, 2017). This suggests that the way the workforce is currently conceptualised for older people's care may not be the best model, and that further work should focus on a more detailed evaluation of patients' needs and how they can be best met.

7.3 Methodological strengths and limitations

7.3.1 Data source

All data were derived from a single hospital site, and therefore reflect a single institutional approach to screening and care of older adults and staffing policies, which may differ to approaches implemented in other institutions. However, given that this hospital was following current national guidance on dementia screening and is a 'typical' example of a large, non-teaching district general hospital based on national mortality comparisons, the results may be generalisable to other Trusts.

7.3.2 Use of routinely collected data

All analyses used data which had been collected during the routine care of patients within a standard NHS setting. There are several advantages in using this type of data to answer the research questions posed. The availability of such data enabled the construction of a dataset which was both 'broad' and 'long' – i.e. it contained more than 10,000 individual records with a wide range of key variables available for analysis – one of the richest datasets available on this topic. The assembly of such a prospective dataset would not have been possible within the time frame or budget of a doctorate. The large numbers of participants in the dataset and the relatively high rates of outcomes enabled inclusion of all the relevant available covariates in the analyses whilst still providing precise estimates for the associations of interest. Use of routine data also reduces selection bias that may be present in prospective research studies in this area, for example the lack of inclusion of patients that die soon after admission or are more difficult to consent for participation, who may have particular characteristics or be more likely to exhibit particular outcomes, thus systematically reducing the representativeness of the research sample. Similar datasets have been used previously for other studies, and the data management team preparing this specific dataset were very familiar with the provenance of the data and the data extraction process, with standardised methods for extraction and data checking. There was no 'free text' data used – all variables were numeric or coded.

There are limitations to using this retrospectively collected routine data source, as compared to using data collected prospectively specifically for the purposes of research. The completeness and accuracy of the data is dependent on the level of staff training and time available to input the data and may be influenced by gaps in data recording by clinical staff and time pressure to code large volumes of written notes electronically. However, the coding of data such as admission and discharge dates, procedures and diagnoses, deaths and readmissions have particular significance as these data are used for national reporting and calculating costs and reimbursements, so are closely quality controlled. The use of real-time electronic systems with data entry prompts and quality checks for vital signs, nutritional assessments and dementia assessments does in part improve data completeness, but work pressure and up-to-date training and auditing may influence accuracy.

A further limitation of using a retrospective dataset is that the researcher has to use available information, rather than being able to determine which data are collected prospectively. Examples of covariates that would have been useful to have in this research include information on the patients' functional state, for example regarding their mobility and ability to self-care, particularly in Paper 2, as lack of information about these factors may have led to residual confounding of the association between cognitive impairment and the outcomes. Additionally, in Paper 3, there were no data available concerning other formal and informal support available for patients, for example medical staff, dementia care workers, occupational therapists, speech and language therapists, dieticians and physiotherapists. These additional staff may be assigned in preference to patients with cognitive impairment, according to their availability and the patients' needs, thereby leading to the false conclusion that higher levels of nursing staff are associated with reduced mortality in patients with cognitive impairment, whereas the apparent benefits of additional nursing time may actually reflect higher levels of additional supportive staff being available (i.e. generally better staffed wards across all disciplines).

Despite these recognised limitations associated with the use of routinely collected data, analysis of this large, naturalistic dataset has been beneficial in providing an insight into what is happening to older people with cognitive impairment in hospital.

7.3.3 The cognitive screening process

The cognitive screening process routinely employed in secondary care, on which the results of this work are based, has both strengths and limitations.

The categorisation of patients into cognitive status groups according to data generated in routine care across a whole hospital is a strength of this work, in that it represents a real-life clinical situation, with care subsequent to the screening reflecting that which would be provided routinely, thus providing a more valid estimate of outcomes than those which might occur during a prospective research study prone to selection and performance bias. Cognitive screening and subsequent care process in this study forms a 'black box' – the act of doing the screening is a proactive one and may presumably lead to changes in care, but exactly how this happens is unknown. It is possible that, given staff knowledge and training in the management of people with dementia, outcomes for patients with a dementia diagnosis may have improved as a result of systematic identification of these patients through screening. This may in turn explain why the outcomes of people with cognitive impairment and no dementia diagnosis appeared comparable to those with a dementia diagnosis.

A limitation of the process relates to the assumed accuracy of the data recorded during the dementia screening pathway, which has then been used to determine the cognitive impairment categories. For example, there may have been missing or inaccurate data available to staff to determining whether the patient already had a dementia diagnosis, and it assumes that the Abbreviated Mental Test (AMT) was used in an appropriate way at the right time for the patient, with data recorded accurately. Inaccuracies in the data would have led to misclassification of cognitive impairment categories, which would in turn lead to under- or over- estimates of prevalence of patients in each of the cognitive groups. However, changes in the dementia diagnosis status throughout the admission were mitigated for by using information from any repeat assessments during the admission, which increased the number of patients group with a dementia diagnosis. In Paper 3, a single 'cognitive impairment' group was used as a covariate, combining the patients with cognitive impairment and no dementia diagnosis and patients with a dementia diagnosis, as it was likely that many patients in the 'cognitive impairment, no dementia diagnosis' group actually had undiagnosed dementia. Considering the whole group of patients with cognitive impairment also enables application of the results to the wider context in which patients may not be differentiated into subgroups and removes the issue of potential misclassification between the 'diagnosis of dementia' and 'cognitive impairment with no dementia diagnosis' groups.

After establishing whether or not the patient has a known diagnosis of dementia, for those that do not, the major decision points of the screening process are firstly the screening questions (increased forgetfulness over last 12 months, disturbed behaviour), followed by use of the AMT if one or both answers was yes. The AMT is a recommended tool for a preliminary assessment of cognitive impairment in hospital, which assesses orientation, memory, attention and basic cognitive skills over 10 questions. However, the AMT is only intended to be a screening tool, with a meta-analysis in hospital inpatients giving a sensitivity of 81% and specificity of 84% for underlying dementia with a cut-off of <7 (Jackson et al., 2013). Given the lower sensitivity of the test, the cut-off set for cognitive impairment in the implementation of the AMT in the algorithm used in the Trust of <9 was chosen to improve sensitivity. It is unknown, however, how the AMT performs in a situation in which patients with an existing dementia diagnosis are already removed from the screening pool, but additional screening questions (as per above) have been added.

However, clinically, these were considered to be patients that warranted further investigation for cognitive impairment as per the CQUIN guidance, as they may have undiagnosed dementia.

There is therefore the potential for misclassification of patients between the three cognitive impairment categories in this study. It is to be noted that the categories reflect those created by the clinical cognitive screening and care process and are not definitive diagnoses. Firstly, the 81% sensitivity of the AMT for detecting dementia at <7 would mean that approximately 20% of people with an underlying diagnosis of dementia would not be identified as cognitively impaired and would be misclassified as having no cognitive impairment. However, the use of a higher cut-off level in the screening process may have ameliorated this. Secondly, given the 84% specificity of the AMT for dementia (and at a lower cut-off level), it is possible that patients with no cognitive impairment could have been misclassified as having cognitive impairment. A recent review concludes there is no good evidence concerning the AMT use for mild cognitive impairment, despite its frequent use in this setting, so the actual level of potential misclassification remains unknown (Hwang et al., 2019). This misclassification would have had the effect of lowering the rates of adverse outcomes in the group with cognitive impairment because people not at risk were included, therefore reducing the differences between the cognitively impaired and the non-cognitively impaired group. This in turn potentially reduces the odds ratios describing the associations between cognitive impairment and outcomes. This differential misclassification would be unlikely to alter the substantive study conclusions, as it would tend to weaken associations which may have been stronger without misclassification.

Thirdly, the AMT could only be performed if a patient was alert and able to answer questions. The patients who did not have an AMT could have had reduced arousal related to hypoactive delirium, and at higher risk from mortality, thereby producing an underestimate of the mortality rates in the group with cognitive impairment (Todd et al., 2017). However, staff were encouraged to re-visit patients who were not able to be screened in the first few days of their admission, so those with reduced arousal who survived the initial admission period could have been assessed later in their admission. No cut-off for the date/time of assessment was introduced in the analysis to ensure a cohort of maximum size, but this may have misclassified such patients, if they had then recovered from their delirium and no longer appeared cognitively impaired at the later time of assessment. Lastly, there are other situations in which the AMT score may have been affected by individual patient factors unrelated to cognitive impairment, for example issues with understanding the English language or culture, visual or auditory impairments and other behaviours which may result in lack of co-operation in answering the questions. Incorrect answers may have led to cognitively intact patients being misclassified as cognitively impaired. However, as the AMT was only used following the initial screening questions regarding behaviour and recent memory loss, this potential misclassification would hopefully have been reduced.

7.3.4 Outcome measures

Although the rate of patients discharged to residential homes was described in Paper 1, it was not possible to retain this as an outcome of interest in the subsequent analyses as data quality for the variable which described where the patient entered hospital from was not considered to be accurate enough to be certain whether indicated discharge to a nursing/residential home was a new or permanent event. However, the outcomes presented in Papers 2 and 3 are objective, reliable outcomes with important implications for patients.

7.3.5 Covariate data

In comparison with other published analyses, the dataset used for this work had a more complete set of covariates known to influence hospital outcomes, thus reducing the possibility of misinterpretation of results due to unmeasured confounders.

However, for adjustment of potential confounders to be effective, it is important that the data for the covariates used are valid – i.e. that the instruments measure what they are supposed to measure. An appraisal of the validity of the measurement of several of the covariates (NEWS, CCI and MUST) is outlined in the methods (Section 3.3.5). Although there may be individual-level inaccuracies in the way in which the NEWS and CCI measures were generated, their association with mortality was clear in all of the logistic regression models which used mortality as the outcome. This is reassuring in that these covariates gave the expected results, and therefore adds support to the use of these covariates in the models in this population.

Given the way in which the datapoints to calculate the MUST score are obtained, there is the potential for greater inaccuracies to occur in the most vulnerable patients who are unable to be measured and may not be able to recall relevant information. This may create a subjective bias in healthcare staff assigning higher MUST scores to patients they assess as being more poorly or at higher risk from nutritional deterioration based on other available information, and thus the use of MUST as a covariate adjusting for mortality risk may have explained more of the variance in the model than was actually warranted. However, in the multivariable analysis in Papers 2 and 3, the MUST retained an association with mortality, with odds ratios significantly higher for a score of 1 or ≥2 than the baseline (score 0).

The high proportion of missing MUST data was of concern as this is an important risk factor for mortality in hospital. Overall, 31.3% of data were missing in the Paper 2 analysis (6,688/21,399), and as this is greater than the 'rule of thumb' of 10% generally advised for missing covariates, approaches to deal with the missing data had to be considered. The likely pattern of missingness of the data was investigated. Examination of the proportions of missing MUST by age and sex showed that the proportions of missing values were almost identical to the overall proportions of patients within each category for age, sex, CCI and NEWS. There was a slightly higher proportion of missing MUST in patients with a dementia diagnosis (36%, vs 30% and 31% for the other categories). There was little variation in missing MUST values according to whether or not patients were discharged alive. However, there were more missing values in patients with shorter lengths of stay (62% of missing MUST values in admissions with <7 days stay, which represented only 46% of admissions). The MUST may be more likely to be missed in admissions with less than 7 days stay due to the time taken to organise and perform a MUST assessment, and other clinical priorities. Furthermore, amongst the observed MUST values, the proportion of 'high' scores increases as the length of stay increases, with around 54% of patients in the 'low' category staying <7 days compared to only 26% of patients in the 'high' category, so it is likely that the missing MUST values may contain more 'low' than 'high' scores. Therefore, we cannot consider the MUST data to be missing completely at random, as the missingness mechanism is likely to be related to inferential associations that were explored in the model.

Given that complete-case analysis in this situation is likely to be biased, it was necessary to use another strategy to maintain the whole sample in the analysis. One strategy would be to use a multiple imputation model to model the missing values of MUST. However, there may also be other unmeasured covariates that would have been more plausibly associated with the missingness pattern than the outcome variable of length of stay, which would lead to an imputation model being unlikely to be helpful in correcting bias. Additionally, there were no other covariates in the regression model that seemed to be related to the pattern of missing MUST values. The second strategy of using a missing indicator category within the MUST covariate was used, as this is a commonly used technique to handle partially observed covariates and recent research suggests that its use can provide valid inferences for outcome regression, given certain assumptions (Blake et al., 2020). Sensitivity analyses were also performed comparing the missing indicator dataset with the complete-case analysis. There was little difference in the multivariate regression odds ratios between the two methods, and so the variable with the missing indicator was included in all presented analyses to reduce potential bias from complete case analysis, maintain a larger sample size and obtain more precise confidence intervals.

7.3.6 Statistical models

The primary purpose of the regression models used in Papers 2 and 3 was to establish whether or not there were associations between cognitive impairment and negative outcomes of hospitalisation (Paper 2) and RN/NA care hours per patient day and adverse outcomes (Paper 3). As the study designs for both analyses are observational, the models can only provide evidence supporting an association between these exposures and outcomes of interest. To explore associations, regression models were used, in which variables were added using a forward stepwise method, putting in the variables with the stronger associations in univariable analysis and those with known associations with mortality first (after the main exposure of interest) and then using the Akaike/Bayesian Information Criteria to establish the most parsimonious model. However, acknowledging that there is uncertainty over whether a forwards or backwards approach is optimal, the model was verified by using a backwards stepwise approach. Although stepwise selection can be criticised for not always selecting the best combination of variables, the large sample size and high event rate in this analysis should have reduced potential bias of estimates and instability in the model. Bootstrapping techniques could have been considered to increase confidence in the final model.

The models demonstrated independent associations between cognitive impairment and mortality and readmission, and subsequently staffing levels and these outcomes. Given the large sample size and narrow confidence intervals, it is unlikely that these associations could also have occurred due to chance. A larger group of covariates had been included in these analyses than in previous literature, reducing the possibility of residual confounding, although this could be an alternative explanation for the results. However, the independent association of cognitive impairment and adverse outcomes when other variables were controlled for suggests that this association is not simply an artefact cause by relationships between cognitive impairment and other variables related to mortality, such as age. Ways in which bias may have been introduced in relation to measurement of the covariates have been previously discussed, and hard outcomes were selected to avoid bias in the measurement of outcomes. Evidence for a causal association between cognitive impairment and adverse outcomes, and the role of the workforce in this relationship, is supported by components of the Bradford Hill criteria (Hill, 1965). Although the odds ratio for the association between cognitive impairment and outcomes was small, it was consistent across models and also reflected findings in other literature (Griffiths et al., 2019). The findings also met the criteria of temporality with cognitive impairment and variations in workforce being present before the measured outcome. Furthermore, the workforce analysis demonstrated a dose-response relationship and is clinically plausible, indicating a potential area for intervention.

In Paper 2, the Area Under the Receiver Operating Characteristic curve was also presented to assess the potential performance of the model in classifying mortality and readmission in this population. Whilst the mortality model gave good discrimination, the readmission model did not, suggesting that if there was interest in constructing predictive models for readmission in the future, data for additional variables should be considered.

Although there were multiple admissions for some patients included in Paper 3, the focus of the analysis was to explore the relationship between the exposure of differing levels of workforce on outcomes. A model using only the first admission per patient could have been used, but this would have significantly reduced the sample available, and led to less precise estimates of effect. However, the non-independence of the observations could have led to an overestimate of significance. The observed associations between staffing and patient outcomes could therefore be an artefact of this lack of independence, so precise estimates and p values could be viewed with caution and would benefit from replication in other settings.

Regardless of the limitations identified in this section, the results of the analyses are consistent with other evidence, and the scope of the dataset enabled a more confident estimate of the association between cognitive impairment and adverse outcomes.

7.4 Implications for policy and practice

The key findings of this work, considered in light of the limitations, have the following implications for policy and practice.

- Maintaining policies for screening for cognitive impairment as part of standard care for older adults with unscheduled admissions is important to identify at-risk patients and provide appropriate person-centred care. However, the additional risk of readmission for these patients need to be clearly communicated to community healthcare and social services together with the results of screening, to prompt timely follow-up, provision of community services and advance care planning where required.
- Extending of care or policies intended for hospitalised people with dementia to all patients with cognitive impairment identified through screening may improve outcomes, especially those intended to prevent, detect and manage delirium.
- Acknowledging that outcomes for this population are amenable to change, and that a potential area for change may be adjustment of the current staffing model for older people’s care by increasing staff numbers, increasing the proportion of trained registered nurses or providing additional training to nursing assistants.

7.5 Recommendations for future research

The higher risk of hospital outcomes for people with cognitive impairment observed in this work may occur following a series of less frequently reported outcomes which patients with cognitive impairment may be more likely to experience in hospital. These intermediate outcomes may be an appropriate focus of attention to target nursing and other care and treatment, as, to reduce the frequency of death and unnecessary readmissions, we must first understand how and why these patients deteriorate in hospital and identify the specific risk factors at patient and hospital level. Although the outcomes of mortality, length of stay and readmission examined in this thesis are important outcomes, they would be more meaningful if they could be linked to intermediate outcomes occurring during hospitalisation which may be care-sensitive and therefore possible to modify. This greater understanding would also enable the multi-component interventions to be developed and tested in interventional studies or implemented via quality improvement activities.

Such research would require prospective data collection, either built into the electronic patient record, or as a separate entity. As there is currently no core outcome set for assessing interventions in hospital care for people with cognitive impairment, this could either be a focus of research, or adapting existing measures for older people such as the proposed Hospital-Associated Complications of Older People (HAC-OP) outcome measure (Mudge et al., 2019). This combines well-recognised hospital-associated complications in older people, namely delirium, functional decline, incontinence, falls and pressure injuries, and demonstrates a graded association between the HAC-OP and length of stay, admission to a residential or nursing home and 6-month mortality. The patient public involvement group proposed activities of daily living (ADL) as a particularly important outcome for patients and carers/relatives, as declining ADLs have such a large impact on the informal care patients need when they go home. Such outcome sets should also include measures relating to patient and carer experience, and staff experience of providing care.

It would also be of interest to use the current dataset to further explore patterns of decline in patients with cognitive impairment as compared to those without, to see where there may be other areas for intervention. For example, a study exploring staff perceptions of monitoring vital signs at night has found that staff alter the monitoring schedule for people with dementia to ensure patients have adequate sleep (Hope et al., 2017). This conflict between providing person-centred care and maintaining scheduled clinical protocols may result in the possibility of deterioration not being detected in a timely manner and could be explored empirically to see how often it is occurring and how the missed observations mediate mortality in patients with cognitive impairment.

Given the observed associations between outcomes for patients with cognitive impairment and staffing, qualitative and/or ethnographic work to understand how RNs and NAs work together to care for patients with cognitive impairment at different levels of staffing may help to inform remaining questions around optimising staff numbers and skill mix for these patients.

A greater understanding of what happens to patients with cognitive impairment after discharge and which factors better predict readmission for this population would be useful, and if anything further can be done prior to discharge to reduce readmissions by understanding what is 'working' when there is higher nurse staffing, and which community care may be effective.

7.6 Conclusions

This work has identified that there is a large group of patients who are admitted to hospital who have cognitive impairment but no formal diagnosis of dementia. Characteristics and outcomes for these patients have rarely been presented in previous literature, and this is the first study to clearly identify an independent excess risk of mortality and other adverse outcomes in this group. These results suggest that the whole population of people with cognitive impairment should be regarded as a vulnerable group, not just patients with a current dementia diagnosis. The improvements in mortality and readmission rates in patients with all-cause cognitive impairment seen with greater care hours available from nursing staff indicates that adverse outcomes from hospitalisation are not necessarily intrinsic to having cognitive impairment and may be partly be ameliorated with appropriate care.

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Appendix A Tables of references for integrative review

Table 13 Clinical and patient-centred outcomes during hospitalisation

Authors, year	Country	Population	Study design	Main results
Patients' experience of hospital admission				
Digby 2016	various	Patients with dementia and their carers' in the acute setting.	Integrative review	People with dementia stigmatised in hospitals; acute care needs and tasks prioritised over personalised care; relatives/carers are not as involved in the patient's care or decisions regarding their relative as they could be.
Royal College of Psychiatrists 2017	United Kingdom	Patients with dementia in the acute setting.	National audit	17% of comments about patient care collected via a carer questionnaire described care as generally poor, or alternative negative comment. 9% of comments expressed that the patient did not receive care appropriate to their needs.
Alzheimer's UK 2016	United Kingdom	Carers of patients with dementia in the acute setting.	Survey and Freedom of Information requests	Almost 60% of respondents felt the person with dementia they know wasn't treated with dignity or understanding while in hospital, 92% said hospital environments are frightening for the person with dementia.
Jurgens 2012	England	35 family carers of confused older patients.	Qualitative interviews	Development of 'cycle of discontent' model: poor communication and relationship building between staff and patients/carers led to expectations from the patient/carer not being met, and subsequent cycles of identification of poor care by carers, challenge to staff, further deterioration in the relationship and reporting of poor experience occurring
Clisset 2013	United Kingdom	34 patients with dementia admitted to acute general medical, health care for older people, and orthopaedic wards, family carers and co-patients	Non-participant observations, qualitative interviews	Person-centred care was observed, but there were more opportunities to sustain personhood, according to Kitwood's five domains of person-centred care - identity, inclusion, attachment, comfort and occupation.
Behavioural and psychological symptoms of dementia (BPSD)				
Sampson 2014	UK	230 patients aged 70+ with dementia admitted to hospital for acute medical illness	Prospective cohort	The prevalence of BPSD symptoms in people with dementia in hospital rose from 62% at baseline, to 75% during the admission, with 43% being moderately/severely troubling to staff. The overall BEHAVE-AD score was in turn associated with an increase in mortality: aOR 1.11 [1.01-1.20], p=0.022
Soto 2012	France	6,299 patients with dementia admitted to an Alzheimer Special Acute Care inpatient Unit	Observational study	BPSD was the most frequent cause of complications, with agitation/aggressiveness representing 60% of BPSD events
Porock 2016	UK	34 patients admitted to acute hospital care, and 32 carers	Qualitative study - interviews	Disruption in routine, for example admission to hospital, has a negative impact on a person with dementia, and can trigger changes in behaviour as the patient attempts to gain control over their unfamiliar environment.

Malnutrition or dehydration				
Kagansky 2005	Israel	414 patients aged 75+ admitted to geriatric ward, including 107 patients with dementia.	Prospective cohort	People with dementia were more likely to have a low MNA at admission: OR 3.85 [1.55 - 9.59], as well as laboratory indices of malnutrition such as albumin, transferrin and the urea:creatinine ratio. The MNA score and the sub-score related to dietary habits (MNA-3) were significant predictors of death in hospital, with scores <7.5 increasing the risk of death 2.05-fold.
Miller 2006	Australia	68 patients aged 70+ admitted to orthopaedic ward for lower limb fracture, 50% with cognitive impairment (as per SPMSQ)	Prospective cohort	Cognitively impaired participants and those without cognitive impairment consumed, mean (95% CI) respectively, 3661 kJ/day (3201, 4121) versus 4208 kJ/day (3798, 4619) and 38 g (33, 44) versus 47 g (41, 52) protein/day. Cognitively impaired participants consumed mean (95% CI) 48% (43, 53) of estimated total energy expenditure and 78% (69, 87) of estimated protein requirements.
Royal College of Psychiatrists, 2017	UK	Patients with dementia in the acute setting.	National audit	24% of staff did not think that people with dementia had their nutritional needs met always or most of the time, and less than 75% of staff said that they could obtain finger foods or snacks between meals for patients with dementia.
Johnson 2015	Sweden	256 patients admitted to acute hospital care	Prospective cohort	Concentrated urine present in 16% of the patients, and more common in patients with confusion and/or dementia. 30-day mortality was higher in patients with fluid retention compared to those who were euhydrated: 21% vs 8% p<0.03.
Functional or cognitive decline				
Hartley 2017	Various	Adults 65+ with acute admission to hospital and have information on dementia/cognitive scores on admission, with 54,637 patients available for quantitative synthesis	Systematic review and meta-analysis	Functional decline in hospitalised adults aged 65 and above is associated with cognitive impairment (RR 1.64 [1.45-1.86]), and a diagnosis of dementia (RR 1.36 [1.05-1.76])
Pedone 2005	Italy	9,061 older patients admitted to hospital.	Prospective cohort	During admission, 4% of patients with CI at admission and 1.3% of those without CI experienced functional decline: OR 2.4 [1.7-3.5], p<.001. Cognitive decline was strongly associated with an increased risk of functional decline: OR 16.0 [10.8-23.6], p<.001.
Incident delirium during hospitalisation				
Ryan 2013	Ireland	311 general hospital inpatients	Point prevalence study	Prevalence of delirium was higher in patients with pre-existing dementia: 50.9% of delirious patients, OR 15.33, p<0.001
Ahmed 2014	various	2338 older medical inpatients	Systematic review and meta-analysis	Dementia increased risk of delirium: OR 6.62 [4.3-10.19]

Sa Esteves 2016	Portugal	270 male patients aged 65+ admitted to a medical ward	Prospective cohort study	The rate of delirium was increased with people with dementia compared to those without: 29.5% vs 7.1% , p<0.001
Travers 2014	Australia	493 patients aged 70+, with (n=102) and without (n=391) dementia	Prospective cohort study	Dementia increased the risk of developing delirium during hospitalisation, from 4.8% to 14.7%: OR 4.8, p<0.001
Pendlebury 2015	UK	503 patients with acute admission to hospital (308 patients 65+ with covariate information)	Prospective cohort study	The risk of delirium on admission or during hospitalisation was increased by dementia OR 2.08 [1.10-3.93], p=0.024 and low cognitive score (MMSE and AMTS) OR 5.00 [2.50 to 9.99], p<0.0001.
Franco 2010	Colombia	291 geriatric patients in medical wards	Nested case-control in prospective cohort	Median mini-Mental State Examination (MMSE) score 24.23 in patients who didn't develop delirium during admission, vs 20.65 in those who did (p=0.0001)
Bo 2009	Italy	252 patients 70+ with emergency admissions to hospital.	Prospective cohort	Greater cognitive impairment associated with incident delirium (p<0.001)
Wilson 2005	UK	100 patients aged 75+ admitted to an acute medical ward	Prospective cohort	Lower Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) was related to an increased incidence of delirium: OR 3.26 [1.18-9.04] p=0.023
Voyer 2006	Canada	104 patients aged 65+ admitted to acute care	Prospective cohort	Prevalence of delirium increased with decreasing cognitive ability: mild CI: 50% , moderate CI: 82%, severe CI: 86%
Muangpaisan 2012	Thailand	80 patients with fall-related hip fracture	Prospective cohort	Modified IQCODE score significantly different between delirium and non-delirium groups: median 3.5 vs 3.2, OR 4.5 [1.2-16.9] p=0.024
Marcantonio 2000	U.S.A.	126 patients aged 65+ admitted emergently for hip fracture repair	Prospective cohort	Pre-fracture cognitive impairment was related to occurrence of delirium following surgery: RR 2.5 [1.6-3.9]
Wu 2015	China	130 patients aged 65+ attending hospital for hip fracture repair	Prospective cohort	Preoperative MMSE scores were negatively associated with higher incidences and greater severity of postoperative delirium: median MMSE of 18.1 (delirium) vs 24.3, p<0.001
Tanaka 2016	Japan	152 patients aged 70+ for proximal femoral fracture surgery	Prospective cohort	Dementia predictive of perioperative delirium: OR 3.55 [1.35-9.30]
Jackson 2016	various	27 studies examining predictors of delirium	Systematic review	Hospital outcomes including mortality, institutionalisation and length of stay for patients with delirium are also worse if there is pre-existing psychiatric morbidity such as dementia.
Fong 2012	U.S.A.	771 persons with Alzheimer's disease in the community, of whom 367 were hospitalised	Prospective cohort	Incidence of delirium in hospital was 25% (n=194). Patients with delirium had a higher risk of death within 1 year (15.5% (30/194) vs 9.2% (16/173))
Torpilliesi 2010	Italy	2,340 patients admitted to a Rehabilitation and Aged Care Unit	Prospective cohort	DSD and poor functional status are stronger predictors than dementia alone of adverse clinical outcomes (length of stay, institutionalisation).

Avelino-Silva 2017	Brazil	1,409 acute hospital admissions of patients aged 60+	Prospective cohort	Of the 549 patients with dementia, 66.8% (n=367) had DSD. DSD was independently associated with in-hospital mortality, HR 2.14 [1.33-3.45] p = 0.002, whereas dementia alone was not.
Hsieh 2015	U.S.A	260 patients aged 65+ with an acute admission to hospital	Prospective cohort	Dementia was associated with an increased risk of occurrence of least 1 episode of delirium during the first 3 days of admission in adults aged 65 and above, and subsequently increased the odds of unanticipated ICU admission or in-hospital death: aOR 8.07 [1.91-34.14].
Adverse events and complications occurring in hospital				
Mecocci 2005	Italy	13,729 patients aged 65+ admitted to medical or geriatric wards	Prospective cohort	Cognitive impairment was found to be the most significant risk factor for: (i) pressure ulcers: OR 4.9 [2.4–9.9], (ii) development of new faecal incontinence: OR 6.3 [3.0-13.0], (iii) urinary incontinence: OR 5.3 [2.3-12.0], (iv) falls: OR 1.6 [1.2–2.3].
Harlein 2011	Germany	9,246 patients aged 65+ admitted to 37 hospitals, with 1,276 (13.8%) rated as cognitively impaired	Secondary analysis of point prevalence studies	Cognitive impairment leads to an increased risk of falls in hospital: 12.9% with CI vs 4.2% without CI; aOR 2.1 [1.7-2.7]
Chen 2011	Australia	408 patients aged 70+ admitted to hospital	Retrospective case control.	Dementia was significantly associated with recurrent falls. Recurrent fallers had significantly lower MMSE scores than single fallers and non-fallers (17.3 ± 6.7, 20.2 ± 6.2, 24.0 ± 5.1, respectively, p < 0.01); and a larger proportion of recurrent fallers had MMSE <18 than in the other two groups (54.1%, 34.4% and 10.8%, respectively, p < 0.01). Patients with recurrent falls were more likely to have significantly lower scores in the 'registration', 'attention and calculation', 'recall' and 'praxis' domains of the MMSE than single fallers.
Ferrari 2012	U.S.A.	233 patients aged 65+ with a documented in-patient fall	Retrospective descriptive study	Falls related to impulsive behaviour are more common in patients with cognitive impairment.
Tangman 2010	Sweden	223 patients admitted to a ward in a psychogeriatric hospital ward	Prospective fall registration study and case-note review	91 (41%) of patients fell, with a total of 298 falls. More than three quarters of falls had one of the following precipitating factors: being in hospital at night (between 9pm and 7am), having an acute disease or symptoms of disease and/or acute drug side-effects
Tamiya 2015	Japan	817 with in-hospital fracture, 3,158 controls	Matched case:control study (national inpatient database)	Increased risk of fractures in patients taking short-acting benzodiazepine hypnotics, OR 1.43 [1.19 – 1.73]; p<0.001, ultrashort-acting non-benzodiazepine hypnotics OR 1.66 [1.37 – 2.01]; p<0.001, hydroxyzine, OR 1.45 [1.15 – 1.82]; p=0.001, risperidone and perospirone, OR 1.37 [1.08–1.73]; p=0.010.
Bail 2013	Australia	426,276 overnight hospital episodes in patients aged 50+, matched 1 patient	Retrospective cohort study	Hospitalised medical and surgical patients with dementia were at higher risk of four common complications than medical/surgical patients without

		with dementia:4 patients without dementia		dementia: (i) UTIs med: RR 1.79 [1.70-1.90], surg: RR 2.88 [2.45-3.40], (ii) pressure ulcers med: RR 1.61 [1.46-1.77] surg: RR 1.84 [1.46-1.31] (iii) pneumonia med: RR 1.37 [1.26-1.48] surg: RR 1.66 [1.36-2.02], (iv) delirium med: RR 2.83 [2.54-3.15] surg: RR 3.10 [2.31-4.15]. Medical patients were also at higher risk from sepsis RR 1.34 [1.15-1.57] and failure to rescue RR 1.24 [1.02-1.33].
Pendlebury 2015	UK	503 patients with acute admission to hospital (308 patients 65+ with covariate information)	Prospective cohort study	Prior dementia and low cognitive score is associated with incident delirium in hospital, and delirium in turn increased the risk of falls, (OR 4.55 [1.47 - 14.05], p=0.008), incontinence of urine (OR 3.76 [2.15 - 6.58], p<0.0001) incontinence of faeces (OR 3.49 [1.81 – 6.73], p=0.0002) and catheterisation (OR 5.08 [2.44 - 10.54], p<0.0001).
Furlanetto 2016	Australia	100 patients aged 65+ with dementia/CI, ambulant and continent pre-admission	Retrospective case-note review	57% had either urinary or faecal incontinence (or both) at some point during admission, with 36% and 2% respectively had new incontinence at discharge
Kanagaratnam 2017	France	293 patients with dementia syndrome admitted to an acute geriatric care unit within a hospital	Prospective cohort	Polypharmacy (≥ 5 drugs/day) (OR: 4.0, 95% CI: 1.1–14.1) and dependence on at least 1 activity of daily living (ADL) (OR: 2.6, 95% CI: 1.1–6.5) were related with ADRs
Borenstein 2013	USA	214 adult Medicare beneficiaries admitted to hospital, mean age 75 years	Prospective cohort	Cognitive impairment is associated with an increase in hospital acquired infection, ADRs and length of stay >7 days) OR 2.32 [1.24 - 4.37]
Onder 2002	Italy	16,296 patients admitted to 81 hospitals (GIFA study)	Prospective surveys	An ADR was recorded in 232/4,883 (4.8%) patients with cognitive impairment (AMT score<7) and in 744/12,043 (6.2%) patients cognitively intact: aOR 0.70 [0.60-0.83]. However, neuropsychiatric complications were significantly increased in patients with CI (aOR 2.23 [1.40-3.54]).
Onder 2003	Italy	5,734 patients aged 65+ admitted to 81 hospitals (GIFA study)	Prospective surveys	Patients with cognitive impairment had a lower risk of using inappropriate medication, as defined by the Beers criteria: OR 0.77 [0.64–0.94]
Marengoni 2011	Italy	1,332 patients aged 65+ admitted to general medicine or geriatric wards	Prospective cohort	Dementia on its own was associated with an increase in hospital mortality (OR 2.1 [1.0-4.5]). The addition of at least one adverse clinical event (defined as any acute clinical problem that newly occurred during hospitalisation e.g. delirium, urinary tract infection, fever, anaemia, pneumonia, electrolyte disorders, atrial fibrillation, heart failure or acute renal failure) had an additive effect on mortality, increasing the OR to 20.7 [6.9-61.9].
Watkin 2012	U.K.	710 patients aged 70+ with emergency medical admission	Prospective cohort	AEs were associated with mild/moderate CI (OR 3.61 [1.72-7.61], p=0.01) and dementia (OR 2.18 [1.10-4.32], p=0.03). AEs were not subsequently associated with mortality: hazard ratio (HR) 1.01 [0.53–1.93], p=0.596.

Shen 2012	Taiwan	41,672 patients 65+ with inpatient claim in health insurance database, including 3,487 with dementia	Retrospective cohort	Patients with dementia have a higher risk of acute organ dysfunction (aOR 1.32 [1.19-1.46]) and severe sepsis (aOR 1.5 [1.32-1.69]).
Liao 2015	Taiwan	15,539 hospitalised patients with COPD, including 1,406 with dementia	Retrospective matched cohort	Patients with chronic obstructive pulmonary disease (COPD) with dementia had increased mortality (aOR 1.38 [1.10-1.72]). This may partly be explained by the increased odds of severe sepsis (aOR 1.38 [1.10-1.72]) and acute respiratory dysfunction (aOR 1.39 [1.09-1.77]).
Frohnhofen 2011	Germany	1,424 patients with COPD admitted to a geriatric ward, including 740 patients with dementia	Prospective cohort	Whereas 42% (287/684) of patients with no dementia were receiving no treatment for their COPD, 64% (195/307) of patients with moderate/severe dementia had no treatment (p<0.01). Patients with dementia were also less likely to have lung function tests completed successfully: OR: 2.80 [1.18–6.60] for mild and OR 4.92 [2.03–11.91] for moderate to severe dementia.

Table 14 Outcomes reflecting differentials in care during hospitalisation

Authors, year	**Country**	**Population**	**Study design**	**Main results**
'Outlying' and bed moves				
Ranasinghe 2017	Australia	300 patients under Older Person Evaluation Review and Assessment (OPERA) team, age and sex matched with 300 patients under general physician care	Retrospective matched cohort	Outlying patients and those with 3+ bed moves were more likely to be OPERA patients than general medicine patients, (47.7% vs 31.3%, p<0.001 and 22.3% vs 8%, p<0.001 respectively). Of those with 3+ moves, OPERA patients were more likely to have prior cognitive impairment (OPERA 70.1% vs general medicine 36.4%, p=0.005). OPERA patients were also more likely to be discharged to residential care or to die than those under general medicine (38.8% vs 9.1%, p=0.009)
Perimal-Lewis 2016	Australia	6,367 inpatients with dementia and/or delirium	Retrospective descriptive study	'Outlier' patients had higher mortality within 48 hours of admission: OR 1.973 [1.158-3.359], p=0.012
Royal College of Psychiatrists, 2017	United Kingdom	Patients with dementia in the acute setting.	National audit	Night-time bed moves were reported as being avoidable in half of staff surveyed.
Pain and end-of-life or palliative care				
Sampson 2015	UK	230 patients with an unplanned hospital admission with AMTS <8/10.	Prospective cohort	Pain was reported in 38.5% of patients during hospitalisation. Pain at movement and at rest was associated with an increase in the Behavioural Pathology in Alzheimer Disease Scale (BEHAVE-AD) score (adjusted coefficient 0.20 [0.07-0.32], p=0.002 and 0.41 [0.14-0.69] p=0.003 respectively), aggression (adjusted coefficient 0.16 [0.09-0.23], p<0.001 and 0.16 [0.02-0.30] p=0.023 respectively) and phobia/anxiety (adjusted coefficient 0.04 [0.01-0.07], p=0.021 and 0.11 [0.04-0.17] p=0.001 respectively).
Kelley 2008	U.S.	4 patients aged 70+ with dementia and pain	Prospective case series	Patients with dementia may be unable to describe the characteristics and associated features of their pain; less able to alert staff to the presence of side effects from pain medicines; and unable to discern variations in the level of pain or compare their current pain to their experience of the day or hours before.
Sampson 2006	UK	100 hospital inpatients aged 70+ who died in hospital, 35% with a diagnosis of dementia recorded	Retrospective case-note review	Patients with dementia had significantly fewer referrals to palliative care, (9% vs 25%, p=0.042) and less frequent prescription of palliative medicines, (28% vs 51%, p=0.026), than those without. Patients with dementia were more likely to have arterial blood gases checked and to be catheterised, but less likely to have a central line placed. Families were involved in discussing limiting procedures to the same extent (60% vs 53%, p=0.353).

Afzal 2010	Ireland	75 patients aged 65+ who died in hospital, 24% with dementia	Retrospective case-note review	Patients with dementia had significantly fewer referrals to palliative care, (22.2% vs 62.5%, p=0.007) less frequent prescription of palliative medicines, (33.3% vs 68.8%, p=0.017) and carers were less involved in decision making (50.0% vs 87.5%, p=0.006). There was no difference in the receipt of invasive interventions according to cognitive status.
Formiga 2007	Spain	102 patients aged 65+ who died from dementia (36%) or heart failure in hospital	Case-note review and carer interviews	No differences between provision of palliative care and withdrawal of drug therapy. In the opinion of the caregiver, adequate symptom control was only present in 46% of patients with dementia, and patients experienced uncontrolled pain and dyspnoea in 13.5% and 51.5% respectively
Formiga 2006	Spain	293 patients aged 65+ who died from dementia (46%), heart failure or COPD in hospital	Retrospective case-note review	Rates of drug withdrawal in end-of-life patients with dementia in hospital was higher than those with COPD (p<0.01) or heart failure (p<0.002)
Aminoff 2005	U.S.	71 patients with end-stage dementia, admitted to a geriatric ward in a general hospital	Prospective cohort	The Mini Suffering State Examination scale (MSSE) increased during hospitalisation from 5.62 +/- 2.31 to 6.89 +/- 1.95 (p < 0.001). 63.4% and 29.6% of patients died with a high and intermediate level of suffering, respectively with only 7% dying with a low level of suffering.
Inappropriate catheterisation				
Hu 2015	Taiwan	321 patients aged 65+ with a urinary catheter placed during first 24 hours of hospital admission	Prospective cohort with propensity matched analysis	Inappropriate catheterisation was defined as NOT meeting one of the six criteria: neurogenic bladder dysfunction (where intermittent catheterisation is not possible), urinary retention or bladder outlet obstruction, medication instillation or bladder irrigation, conditions warranting accurate measurement of urinary output, perioperative management, open sacral or perineal wounds with a need for urinary diversion in incontinent patients. Patients with CI (measured by SPMSQ) were more likely to be inappropriately catheterised than those with no CI (65.3% vs. 52.6%; p = 0.02). , with the rationale of ‘convenience of care’ being reported in almost 50% of cases and leading to a greater decline in ADLs during admission.

Table 15 Mortality in hospital

Authors, year	**Country**	**Population**	**Study design**	**Main results**
Barba 2012	Spain	45,757 patients admitted from nursing homes to acute hospitals	Retrospective cohort	17.3% of patients died during hospitalization, 2442 (30.91%) of them in the first 48 hours. Dementia was an independent predictor of mortality: adjusted Odds Ratio (aOR) 1.09 [1.03-1.16]
Marengoni 2011	Italy	1,332 patients aged 65 and above admitted to general medicine or geriatric wards	Prospective cohort	9.4% of patients with dementia died in hospital, versus 4.9% of patients without dementia. Dementia was associated with in-hospital death adjusted Odds Ratio (aOR) 2.1 [1.0-4.5]. Having dementia and at least one adverse clinical event during hospitalization increased mortality; aOR 20.7 [6.9-61.9].
Draper 2011	Australia	253,000 patients aged 50+ admitted to hospital, including 20,793 with dementia.	Retrospective cohort.	Mortality rates higher for people with dementia across all age groups, with a higher risk in the patients aged 50-64. Estimates range from aOR 50-64 years: 1.93 [1.55-2.41] to aOR 85+ years [1.09-1.16]. Overall aOR 1.25 [1.20-1.31].
Hsiao 2015	Taiwan	32,649 elderly patients with dementia and 32,649 controls.	Retrospective propensity score-matched cohort study.	Higher in-hospital mortality rates for people with dementia at 90 days: aOR 1.97 [1.71-2.27]
Sampson 2009	UK	617 patients aged 70+ with an emergency medical admission	Prospective cohort study	Higher mortality rates for people with DSM IV diagnosis of dementia: aOR 2.09 [1.10-4.00]. Increasing mortality rates with reduction in Mini-mental state examination (MMSE) (increasing severity of cognitive impairment): MMSE 16-23 aOR 1.34 [0.60-3.15]; MMSE 0-15 aOR 2.62 [1.28-5.39]
Guijarro 2010	Spain	>3 million hospital discharge records of patients aged 65+, including n=40,482 with dementia	Retrospective cohort study	Intra-hospital mortality rate was greater for patients with dementia compared to those without dementia (19.3% vs. 8.7%). Dementia was an independent predictor of mortality: aOR 1.77 [1.72-1.82]
Oreja-Guevara 2012	Taiwan	41,672 patients aged 65+, including 3,487 with dementia, with a hospital admission	Retrospective cohort study	Dementia was associated with an increased risk of hospital mortality: aOR 1.28 [1.10-1.48]
Farid 2013	France	331 acute patients with cardiovascular disease, age 70+	Prospective cohort	Patients with cognitive impairment had increased mortality HR 2.04 [1.32-3.15]
Zuliani 2011	Italy	51,838 patients aged 60+ admitted to hospital, 4,466 with a diagnosis of dementia	Retrospective cohort study	Mortality rate 7.8% in patients with no dementia, versus 10.5% in patients with dementia, p=0.001.

Caspe Healthcare Knowledge Systems (CHKS) 2013	UK	UK-wide hospital episode statistics of people aged 45+	Retrospective analysis	In 2011, standardised excess mortality rate in patients with dementia estimated at 7.5%.
Liao 2015	Taiwan	COPD inpatients with (n=1,406)/without dementia (n=5,334)	Retrospective cohort study	Increased risk of mortality for patients with (COPD) with dementia vs no dementia: 4.8% vs 2.3%, aOR 1.69 [1.18-2.43]
Bo 2003	Italy	659 inpatients aged 65+ with an ICU admission during hospitalisation	Prospective cohort	Moderate-to-severe CI (measured with the Short Portable Mental Status Questionnaire - SPMSQ) was associated with increased mortality (p<0.001)
Fogg 2017	UK	19,269 acute hospital admissions of 13,652 patients aged 75+	Retrospective cohort study	Patients with cognitive impairment (no dementia diagnosis) and those with a dementia diagnosis have a higher risk of dying in hospital than patients with no cognitive impairment: 11.8% [10.5–13.3] and 10.8% [9.8–11.9] versus 6.6% [6.2–7.0].
Reynish 2017	UK	10,014 emergency admissions of patients aged 65+, including 38.5% with a cognitive spectrum disorder (CSD) – delirium, dementia, or AMT<8	Prospective cohort study	Higher mortality in patients with cognitive spectrum disorder (CSD) (delirium, known dementia or Abbreviated Mental Test (AMT) <8/10) than those with no CSD: 13.6% vs 9.0%
Marengoni 2013	Italy	1,201 inpatients in internal medicine and geriatric wards	Prospective cohort study	Cognitive impairment (measured by Short Blessed Test - SBT) was associated with increased mortality, and this association increased as severity of CI increased: overall OR 3.1 [1.1-8.6]; moderate impairment: OR 2.7 [1.00-7.96], severe impairment: OR 4.2 [1.29-13.78].
Sa Esteves 2016	Portugal	270 male patients aged 65+ admitted to a medical ward	Prospective cohort study	Mortality rates of patients with/without dementia were similar: 12.1% vs 7.1%; P = 0.204
Zekry 2011	Switzerland	444 hospitalised patients aged 75+	Prospective cohort	No association between dementia (HR 0.65 [0.26-1.62]), or cognitive impairment (HR 1.08 [0.29-3.99]) and in-hospital mortality in univariate analyses.
Travers 2014	Australia	493 patients aged 70+, with (n=102) and without (n=391) dementia	Prospective cohort study	No difference between mortality rates of people with/without dementia: 5% vs 9%, p=0.58
Avelino-Silva 2017	Brazil	1,409 patients aged 60+ with acute admission to a geriatric ward	Prospective cohort study	Mortality rates were 8% for patients without delirium or dementia, 12% for patients with dementia alone, 29% for patients with delirium alone, and 32% for patients with delirium superimposed on dementia (DSD) (Pearson Chi-square = 112, p < 0.001). DSD and delirium alone were independently associated with in-hospital mortality: hazard ratios ratios (HRs) of 2.14 [1.33-3.45], p = 0.002 and 2.72 ([1.77-4.18], p < 0.001, but o association between dementia and in-hospital mortality was found in patients who did not experience delirium during hospitalisation: HR 1.69 [0.72-2.30], p = 0.385.

Thomas 2013	Various	Prospective studies consisting of persons aged 65 and older that evaluated the association between at least one health-related participant characteristic and mortality within a year in multivariable analysis.	Systematic review, including 28 studies in hospitals	Cognitive function associated with in-hospital mortality in 6 of 12 studies (50%).
Zekry 2009	Switzerland	435 hospital patients aged 80+	Prospective cohort	There was no association between presence or severity of dementia or cognitive impairment and mortality in multivariate analysis: patients with dementia: 3.9% vs 6.3% with MCI and 5.8% with normal cognition, p=0.641. Clinical dementia rating (CDR) 0.5-1: OR 0.83 [0.07-9.59], CDR 2-3: OR 1.28 [1.12-13.52]
Freedberg 2008	U.S.A.	Hospitalised patients aged 85+ and above with/without cognitive impairment (100 in each group)	Matched cohort on age and date of admission.	Cognitive impairment was not associated with increased mortality in multivariate analysis: HR 3.99 [0.42-37.90]
Kimata 2008	Japan	Older patients with (n=62) and without dementia (n=1,775) with acute myocardial infarction (AMI)	Prospective cohort	Dementia had no association with increased mortality: 17.7% vs 11.1%, p=0.101
Tehrani 2013	America	631,734 Older patients with (n=15,335)/without dementia with AMI	Retrospective cohort.	Dementia was a significant predictor of in-hospital mortality for hospitalised individuals with AMI: OR 1.22 [1.15-1.29]. However, there was less likelihood of in-hospital mortality in participants with dementia who received diagnostic catheterization (OR 0.36 [0.16–0.78] p < .001), Percutaneous coronary infusion (PCI) (OR 0.57 [0.47–0.70] p < .001), or CABG (OR 0.22 [0.08–0.56] p < .001) than in those not receiving interventions.
Grosmaitre 2013	France	255 patients aged 75+ admitted to emergency departments with ST-segment elevation MI (STEMI), including 39 patients with dementia	Retrospective cohort	Of 39 patients with dementia, 34 (87.2%) had atypical symptoms at presentation, whilst 5 (4.8%) had chest pain. Atypical symptoms were significantly associated with treatment delays, reduced access to potentially lifesaving treatment, and consequently higher mortality rates at 1 month.
Saposnik 2012	Canada	Patients admitted to hospital with stroke: 877 with dementia and 877 without dementia.	Retrospective propensity-score matched cohort study	No significant difference in mortality at discharge between patients with/without dementia: risk ratio (RR) 0.88 [0.74-1.05].
Pisani 2005	U.S.A.	395 patients age 65+ with an ICU admission during hospitalisation (n=66 with dementia as per Modified Blessed Dementia Rating Scale - MBDRS)	Prospective cohort	No association between presence of moderate-severe dementia and mortality (21% for patients with dementia vs 25%, p=0.53), despite higher APACHE II scores for patients with dementia on admission to ICU (24.9 vs 22.7, p=0.02) and higher likelihood of having their code status changed to less aggressive (24% vs 14%, p=0.04).

Table 16 Resource utilisation and discharge destination

Authors, year	Country	Population	Study design	Main results
Length of stay				
Fogg 2017	UK	19,269 acute hospital admissions of 13,652 patients aged 75+	Retrospective cohort study	Length of stay (LOS) in days (median, IQR): patients with no CI: 6 (11); CI no diagnosis of dementia: 11 (16); diagnosis of dementia: 9 (17).
Reynish 2017	UK	10,014 emergency admissions of patients aged 65+, including 38.5% with a cognitive spectrum disorder (CSD) – delirium, dementia, or AMT<8	Prospective cohort study	Mean LOS longer in patients with CSD than those with no CI: 25.0 vs 11.8 days (difference 13.2 [11.2-15.3] p<0.001). Patients with DSD had significantly longer LOS than those with dementia alone (34.3 vs 20.1 days, p<0.001) or delirium alone (34.3 23.0 days, p<0.001).
Power 2017	Ireland	143 patients aged 65+ admitted to hospital, 39 dementia, 30 with mild cognitive impairment (MCI), 74 normal cognition	Prospective cohort study	The mean hospital stay was 32.2 days for patients with dementia, 18.2 days with MCI and 17.0 days with normal cognition. After adjustment, patients with dementia remained in hospital 15.3 days [1.9-18.8] longer than patients with normal cognition (p=0.047).
Bo 2016	Italy	1,568 patients age 65+ admitted to acute geriatric or medical wards	Prospective cohort study	For patients admitted from home (approx. 90% of the sample), delayed discharge occurred in 392 patients, and was independently associated with cognitive impairment: OR 1.12 [1.05-1.19] Among patients admitted from intermediate or long-term facilities, lower cognitive impairment was associated with prolonged stay: OR 0.59 [0.39-0.88].
Tropea 2016	Australia	93,300 hospital admissions of patients aged 50+, including 6,459 (6.9%) with CI.	Retrospective cohort	Patients with CI had a significantly longer adjusted median length of stay compared with the non-cognitively impaired group: 7.4 days (IQR 6.7–10.0) vs 6.6 days (IQR 5.7–8.3), p<0.001
Guijarro 2010	Spain	>3 million hospital discharge records of patients aged 65+, including n=40,482 with dementia	Retrospective cohort study	Patients with dementia had a longer average duration of hospital stay than those with no dementia: 13.4 vs. 10.7 days
Connolly 2015	Ireland	591,619 adult hospital admissions, with 6,702 discharges with a dementia record	Retrospective cohort study	The mean length of stay was higher for patients with dementia than those without across the age groups: 65-74: 24.4 vs 8.7 days; 75-84: 26.8 vs 11.0 days; 85+: 23.7 vs 12.8 days.
Wancata 2003	Austria	372 patients aged 60+ admitted to 4 general hospitals	Prospective cohort study	The mean length of stay of patients with dementia with non-cognitive symptoms (e.g. depression or delusions) was 30.4 days, vs 23.0 days in patients without such symptoms, vs 16.9 days in patients with no cognitive impairment.

Li 2013	China	34,888 patients aged 60+ admitted to a tertiary hospital, including 918 with dementia	Retrospective case-control study	Patients with dementia had a mean LOS of 13 days (Standard deviation (SD) 8-20) vs 15 days (SD 11-23) for those without, p<0.001.
Annear 2013	Australia	4,332 hospital admissions of patients aged 55+	Retrospective cohort	Patients with dementia had a median hospital stay of 5 days in both 2013 and 2014, whereas people without had a stay of 2 days in 2013 and 3 days in 2014.
Draper 2011	Australia	409,000 hospitalisations in 253,000 patients aged 50+.	Retrospective cohort	The mean length of stay for admissions for people with dementia was 16.5 days vs 8.9 days for those without dementia (p<0.0001)
Briggs 2016	Ireland	69,718 hospital admissions in patients 65+, including 1433 (2%) admissions with a diagnosis of dementia (929 patients)	Retrospective cohort	The mean LOS was 31 days in patients with dementia, as compared to 14.1 days in patients without a diagnosis.
Lang 2006	France	908 patients aged 75+ with an acute admission to hospital	Propsective cohort	Patients with CI were more likely to stay more than 30 days in hospital: OR 2.2 [1.2–4.0], including after adjustment by French Diagnosis Related Groups (f-DRGs): OR 7.1 [2.3-49.9]
Caspe Healthcare Knowledge Systems (CHKS) 2013	UK	UK-wide hospital episode statistics of people aged 45+	Retrospective analysis	In 2011, standardised excess length of stay in patients with dementia estimated at 22.1%.
Holmes 2000	UK	731 patients aged 65+ with a hip fracture admitted to orthopaedic wards	Prospective cohort	Concurrent dementia or delirium significantly decreased the likelihood of timely discharge as compared to patients with no psychiatric diagnosis: dementia – OR 0.47 [0.38-0.58]; delirium – OR 0.53 [0.41-0.68]
Murata 2015	Japan	14,569 patients aged 80+ treated by endoscopic hemostasis for haemorrhagic peptic ulcer disease, including 695 patients with dementia	Retrospective cohort	Patients with dementia stayed an additional 3.12 [1.58-4.67] days in hospital as compared to those without (p<0.001).
Zuliani 2011	Italy	51,838 patients aged 60+ admitted to hospital, 4,466 with a diagnosis of dementia	Retrospective cohort study	Median length of stay 7 days (IQR 4-12) in patients with no dementia, versus 8 days (IQR 5-12) in patients with dementia, p=0.12.
Zekry 2009	Switzerland	435 hospital patients aged 80+	Prospective cohort	The median length of stay varied from 41.5 days in patients with dementia: 31 days in patients with MCI, and 29 days in patients with normal cognition, p<0.001. In multivariate analysis, length of stay was not independently related to cognition : Clinical dementia rating (CDR) 0.5-1: OR 2.12 [0.79-5.69] p=0.134, CDR 2-3: OR 2.15 [0.75-6.22], p=0.156
Timmons 2016	Ireland	660 inpatients with a diagnosis of dementia and LOS >5 days	National audit – retrospective chart review, interviews with	72% of people of dementia did not have discharge planning initiated within 24 hours of admission, and less than 40% had a plan for discharge recorded

			senior management and ward managers	in the notes. The LOS was significantly greater for new discharges to residential care than to usual residence: median 35 vs 10 days, p<0.001.
Saravay 2004	U.S.	93 patients age 65+ admitted to hospital	Prospective cohort	Emergence of mental signs and symptoms in patients with CI, dementia or delirium prior to behavioural disturbance increase LOS
Chen 2011	Australia	408 patients aged 70+ admitted to hospital	Retrospective case control.	Cognitive impairment is related to an increased risk of recurrent falls, and patients with recurrent falls are more likely to have a LOS >5 weeks (50.7% of patients with recurrent falls vs 27.2% with a single fall, and 23.2% with no falls, p<0.001)
Bail 2015	Australia	426,276 overnight hospital episodes in patients aged 50+, matched 1 patient with dementia:4 patients without dementia	Retrospective cohort study	People with dementia had increased LOS (10.9 vs 7.1 days).
Chang 2015	Taiwan	203 patients aged 65+ with Alzheimer's, vascular dementia or Parkinsonism-related dementia admitted to hospital at least once over 4 year period (472 admissions)	Prospective cohort	Of the dementia subtypes, patients with Alzheimer's had the shortest hospital stays (mean 10.2 days), followed by vascular dementia (16.8 days), and then Parkinsonism related dementia (17.4 days), p=0.010. The following were independently associated with prolonged hospital stay (>14 days), specifically: diabetes mellitus: OR 2.7 [1.17-6.66], p=0.02; pneumonia: OR 11.21 [3.40-37.01], p<0.001; fall-related hip fracture: OR 4.76 [1.18-19.29], p=0.029.
Costs				
Caspe Healthcare Knowledge Systems (CHKS) 2013	UK	UK-wide hospital episode statistics of people aged 45+	Retrospective analysis	In 2011, additional costs attributed to excess length of stay in patients with dementia estimated at £83.8 million.
Briggs 2016	Ireland	69,718 hospital admissions in patients 65+, including 1433 (2%) admissions with a diagnosis of dementia (929 patients)	Retrospective cohort	The average cost for a patient with dementia was almost three times that of a patient with no dementia: £13,832 vs £5,404
Tropea 2016	Australia	93,300 hospital admissions of patients aged 50+, including 6,459 (6.9%) with CI.	Retrospective cohort	CI (defined as dementia or delirium coded during admission) increased costs of hospitalisation by 51%.
Annear 2016	Australia	4,332 hospital admissions of patients aged 55+	Retrospective cohort	Costs of a hospital stay for people with the dementia in the winter months of 2013 and 2014 exceeded the costs of patients without dementia by at least 39%

Connolly 2015	Ireland	591,619 adult hospital admissions, with 6,702 discharges with a dementia record	Retrospective cohort study	Estimated that the extra length of stay in patients with dementia results in an additional 246,908 hospital days per annum, at a cost of 199 million Euros
Murata 2015	Japan	14,569 patients aged 80+ treated by endoscopic hemostasis for haemorrhagic peptic ulcer disease, including 695 patients with dementia	Retrospective cohort	Average additional costs for patients with dementia were 1171 USD on average (95% CI 533.8-1,809.5) p<0.001.
Bail 2015	Australia	426,276 overnight hospital episodes in patients aged 50+, matched 1 patient with dementia:4 patients without dementia	Retrospective cohort study	Patients with dementia who had complications during hospitalisation accounted for 10.4% of hospital episodes, but comprised 22% of the extra costs.
Lane 1998	U.S.	3,109 patients with Alzheimer's disease at end-of-life	Retrospective cohort	51% died in hospital, where the costs for end-of-life care are estimated to be six times higher than hospice or home care.
Araw 2003	U.S.	60 hospitalised patients with end-stage dementia	Retrospective cohort	Patients with dementia who had received a palliative care consultation reduced the average daily pharmacy cost from 31.16 USD to 20.83 USD (p<0.003), even though there was an increase in the prescribing (and therefore costs) of analgesics and anti-emetics.
Discharge to a nursing or residential care home				
Fogg 2017	UK	19,269 acute hospital admissions of 13,652 patients aged 75+	Retrospective cohort study	Patients with cognitive impairment (no dementia diagnosis) and those with a dementia diagnosis have higher rates of being discharged to a nursing or residential home than patients with no CI: 11.3% and 16.3% versus 3.5%, p<0.001.
Harrison 2017	Scotland	100 adult patients (18+) with an emergency hospital admission from home and discharged to a care home	Retrospective cohort	75% of new discharges to care homes were in people with with cognitive impairment – 55% with dementia, and 20% with CI (no dementia diagnosis). Interdisciplinary standards should be set to support assessment and appropriate care for these patients.
Power 2017	Ireland	143 patients aged 65+ admitted to hospital, 39 dementia, 30 with mild cognitive impairment (MCI), 74 normal cognition	Prospective cohort study	Patients with dementia were less likely to be discharged home (70.5%), as compared to those with normal cognition (88.8%) or mild cognitive impairment (MCI) (90%)
Zekry 2009	Switzerland	435 hospital patients aged 80+	Prospective cohort	Dementia is an independent predictor of institutionalisation, i.e. a new admission to a nursing home or other long-term care facility, with patients with severe dementia being four times more likely to be institutionalised. Rates of institutionalisation were: patients with dementia: 20.1%, patients with MCI: 8.3%, normal cognition: 8.2%, p=0.001 Clinical dementia rating

				(CDR) 0.5-1: OR 1.69 [0.45-6.42] p=0.438, CDR 2-3: OR 4.17 [1.07-16.26], p=0.040
Caspe Healthcare Knowledge Systems (CHKS) 2013	UK	UK-wide hospital episode statistics of people aged 45+	Retrospective analysis	In 2011, deficit in the number of people with dementia with non-elective admissions returning to their usual place of residence estimated at 7.1%.
Draper 2011	Australia	253,000 patients aged 50+ admitted to hospital, including 20,793 with dementia.	Retrospective cohort.	Patients with dementia were more likely to be discharged to a nursing home across the age groups, increasing from 8.2% in 50-64 years to 22.4% in 85+ years.
Harrison 2017	Various	Observational studies of patients admitted directly to long-term institutional care following acute hospitalisation, where factors associated with institutionalisation were reported. 23 studies (354,985 participants)	Systematic review and meta-analysis	For the 11 studies included in the quantitative synthesis, patients with dementia had an increased odds of institutionalisation: pooled OR 2.14 [1.24-3.70].
Kasteridis 2016	England	31,120 patients with a primary diagnosis of dementia admitted to hospital and 139,267 patients with dementia admitted for ambulatory care sensitive conditions	Retrospective cohort study	19% of patients with dementia were discharged to a care home, falling to 14% in patients with an ambulatory care sensitive condition
Saposnik 2012	Canada	Patients admitted to hospital with stroke: 877 with dementia and 877 without dementia.	Retrospective propensity-score matched cohort study	There was no difference in the proportion of patients going home at discharge: 19.6% with dementia, 19.4% without dementia, RR 1.01 [0.84-1.22]
Leung 2010	UK	N/A	Review	Poor, uncoordinated hospital care may contribute to increased rates of nursing home admissions in people with dementia
Wancata 2003	Austria	372 patients aged 60+ admitted to 4 general hospitals	Prospective cohort study	Both cognitive and non-cognitive symptoms of dementia, including depression, agitation and delusions, were significant independent predictors of nursing home placement. Dementia without non-cognitive symptoms: aOR 2.28 [1.37-3.79], p=0.001; dementia with non-cognitive symptoms: aOR 3.61 [1.76-7.38], p<0.001. In patients with dementia, more severe CI and an increased number of non-cognitive symptoms increased likelihood of institutionalisation: aOR 2.82[1.10-7.19], p=0.030 and aOR 1.38 [1.01-1.88] respectively.
Tochimoto 2015	Japan	391 patients with dementia hospitalised for treatment of BPSD	Prospective cohort study (chart review)	Aggressiveness in BPSD at admission was independently associated with not being discharged home: aOR 0.56 [0.36-0.87], p=0.010

Brindle 2005	UK	n/a	Discussion paper	Whether the wishes of the individual concerned have been met should be considered in discharge planning, as they may differ markedly from those of health care professionals, carers or relatives, thus promoting choice and person-centred care.
Royal College of Psychiatrists, 2017	United Kingdom	Patients with dementia in the acute setting.	National audit	Over one third of patients did not have their consent to a change in residence after discharge, or evidence that a best interests decision making process had taken place, in the case that they lacked capacity. 54% of carer's comments regarding discharge/care transfer said that discharge was unsafe and poorly planned, which may lead to readmissions to hospital due to lack of readiness of support in the discharge location.

Appendix B Variables generated from dataset

Table 17 Variables generated from the dataset

Original variable(s)	New variable	New variable description	Papers used
Age at admission	Age category	Five year age bands from 75-79 etc, with the top category set as 95 and above.	Papers 1, 2, 3
Length of stay	Length of stay category	Categories included less than 7 days, 7 to 13 days, 14 to 27 days, and 28 days and above.	Paper 1
- existing diagnosis of dementia - exhibiting disturbed behaviour - current delirium - increased forgetfulness over the last 12 months - AMTS value	Cognitive impairment category	In Papers 1 and 2, this was considered in three categories: 1. a known diagnosis of dementia (DD), recorded during a dementia screening assessment at any point during admission; 2. cognitive impairment with no known diagnosis of dementia (CI), defined as a positive response to one/both dementia screening questions (i. exhibiting disturbed behaviour, ii. increased forgetfulness over the last 12 months) and an AMTS of 8 or below; 3. no cognitive impairment, defined as a negative response to both dementia screening questions, or a positive response to one/both screening questions and an AMTS of 9 or 10 or no AMTS data available. In Paper 3, categories 1 and 2 were combined, thus cognitive impairment was defined as either a known diagnosis of dementia, or a positive answer to at least one dementia screening question (disturbed behaviour/ forgetfulness) with an AMTS of 8 or below.	Papers 1, 2, 3
Primary diagnosis code based on based on Clinical Coding System bundles (Clinical Indicators Team NHS Digital, 2017)	Primary diagnosis group	Diagnoses were grouped into system-organ classes, with the exception of codes relating to 'infection' which were grouped as a separate category, regardless of organ system, and cancers.	Papers 1, 2, 3

Appendix B Variables generated from dataset

Original variable(s)	New variable	New variable description	Papers used
Charlson co-morbidity index (CCI) (Charlson et al., 1994)	CCI group	CCI 0=1; CCI 1-5=2; CCI≥6=3	Papers 1, 2, 3
National Early Warning Score (NEWS) value at admission (Smith et al., 2013)	NEWS severity category	NEWS value 0-4=low; NEWS value 5-6=medium; NEWS value ≥7=high	Papers 1, 2, 3
First Malnutrition Universal Screening Tool (MUST) score during admission (British Association for Parenteral and Enteral Nutrition (BAPEN), 2011)	MUST category	0=low risk, 1=medium risk, ≥2=high risk. Due to a high level of missing values (approximately 30%), a dummy category of 'missing' was included in Paper 2 and Paper 3 to maintain cohort size and reduce selection bias.	Papers 1, 2, 3
Body mass index (BMI)	BMI category	<18.5=underweight, 18.5-<25=normal weight, 25.0-<30=overweight, 30.0-<40=obese, 40 and above=morbidly obese	Paper 1
Admission ward	Admission ward category	Grouped into: surgical, medicine – medicine for older people, rehabilitation and stroke (MOPRS), and medicine – other.	Papers 1, 2, 3
Ward transfers	Ward transfer category	Two or more ward transfers during admission (yes/no) (does not include transfer from Medical Assessment Unit to initial 'home' ward)	Paper 3
Discharge specialty	Discharge specialty category	Medicine (includes medical specialties and medicine for older people), non-medicine (includes surgery, trauma and orthopaedics)	Papers 1, 2, 3
Admission dates, patient and admission episode identifiers	Re-admission within 30 days	Flag variable (0/1) indicating whether or not the patient was re-admitted to hospital during the 30 days following discharge.	Papers 2, 3
Registered Nurse (RN)/Nursing Assistant (NA)/total	Mean RN/NA/total care hours/skill	The total of the RN hours/NA hours/total care hours/skill mix for each ward divided by the number of days that each ward has data over	Paper 3

Original variable(s)	New variable	New variable description	Papers used
care hours per day per ward and skill mix per day per ward	mix for each ward across the study period	the study period. Reflects the staffing 'establishment' (i.e. necessary/planned level of staffing) for the ward.	
- RN/NA/total care hours per day per ward and skill mix per day per ward) - Mean RN/NA/total care hours/skill mix for each ward across the study period	Average RN hours/NA hours/total care hours/skill mix variation from the mean for the patient admission	A dataset was generated to include a row for each day of each patient admission. This was then linked to the ward transfer dataset to insert the ward each patient was housed in at midnight at the beginning of each day. Each day of each patient admission was then linked with (i) the total of the RN hours/NA hours/total care hours/skill mix for that day for the relevant ward, (ii) the mean RN hours/NA hours/total care hours/skill mix for the relevant ward over the study period. Four separate variables were then generated which calculated the differences from the mean value for each day for each of RN hours/NA hours/total care hours/skill mix by subtracting the mean value for the ward from the actual value the patient experienced on that day. Four further variables were then generated which calculated the average variation from the mean (which incorporated the different wards the patient had been transferred to) for each patient for each admission.	Paper 3
Average RN hours/NA hours/total care hours/skill mix variation from the mean for the patient admission	Polynomial terms for average RN hours/NA hours/total care hours/skill mix variation from the mean for the patient admission	Quadratic term (average variable*average variable) and cubic term (average variable*average variable*average variable)	Paper 3

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