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The association of comorbid dementia with length of stay, cost and mortality among older adults in US acute hospitals: An observational study

Luke E. Barry [a], Laura Carter [b], Roch Nianogo [a,1], Ciaran O'Neill [c,1], Eamon O'Shea [b,1], Stephen O'Neill [d,*]

[a] Department of Epidemiology, Fielding School of Public Health, University of California, Los Angeles, USA
[b] J.E. Cairnes School of Business & Economics, National University of Ireland, Galway, Ireland
[c] Centre for Public Health, School of Medicine, Dentistry and Biomedical Sciences, Queen's University Belfast, UK
[d] Department of Health Services Research and Policy, London School of Hygiene and Tropical Medicine, UK

HIGHLIGHTS

- The resource and cost implications of a comorbid diagnosis of dementia in acute US hospitals are largely unknown.
- Comorbid dementia is associated with longer lengths of stay and higher mortality but lower costs and fewer procedures per hospital admission compared to admissions for similar patients without comorbid dementia.
- Communication issues, less invasive/intensive care and administrative delays at the beginning and end of an admission may underlie these differences.

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ABSTRACT

Background: Although overall health and social care expenditures among persons with dementia are larger than for other diseases, the resource and cost implications of a comorbid diagnosis of dementia in acute hospitals in the U.S. are largely unknown. We estimate the difference in inpatient outcomes between similar hospital admissions for patients with and without comorbid dementia (CD).

Methods: Inpatient admissions, from the U.S. National Inpatient Sample (2016–2019), were stratified according to hospital characteristics and primary diagnosis (using ICD-10-CM codes), and entropy balanced within strata according to patient and hospital characteristics to create two comparable groups of admissions for patients (aged 65 years or older) with and without CD (a non-primary diagnosis of dementia). Generalized linear regression modeling was then used to estimate differences in length of stay (LOS), cost, absolute mortality risk and number of procedures between these two groups.

Results: The final sample consisted of 8,776,417 admissions, comprised of 1,013,879 admissions with and 7,762,538 without CD. CD was associated with on average 0.25 (95 % CI: 0.24–0.25) days longer LOS, 0.4 percentage points (CI: 0.37–0.42) higher absolute mortality risk, \$1187 (CI: −1202 to −1171) lower inpatient costs and 0.21 (CI: −0.214 to −0.210) fewer procedures compared to similar patients without CD.

Conclusion: Comorbid dementia is associated with longer LOS and higher mortality in acute hospitals but lower inpatient costs and fewer procedures. This highlights potential communication issues between dementia patients and hospital staff, with patients struggling to express their needs and staff lacking sufficient dementia training to address communication challenges.

1. Introduction

Among older people, dementia is the most common cause of functional and cognitive decline (Wübker et al., 2015). In the United States (US), the number of dementia cases is estimated to be over 5.2 million and is expected to rise to over 10.5 million by 2050 (Nichols

* Corresponding author at: Department of Health Services Research and Policy; London School of Hygiene and Tropical Medicine; UK.
E-mail address: Stephen.ONeill@lshtm.ac.uk (S. O'Neill).
[1] Equal Authorship.

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et al., 2022). Due to the progressive and debilitating nature of dementia, the care needs of people increase over time, therefore the costs attributable to dementia are substantial: health and long-term care costs are expected to rise from $345billion now to $1trillion by 2050 (Alzheimer's Association, 2022; Hurd et al., 2013). Hospital care constitutes the largest component of total health expenditure in the US (Centers for Medicare and Medicaid Services (CMS), 2022; Rama, 2016). Previous US research indicates that healthcare utilization and costs are higher among individuals with dementia compared to those without (Bynum et al., 2004; Phelan et al., 2012; Zhu et al., 2015). Hospitalization of people with dementia in the US is also associated with adverse outcomes including longer hospital stays, morbidity, mortality, delirium, functional decline, and institutionalization compared to those without dementia (Boltz & Mion, 2020; Goodwin et al., 2011; Zhu et al., 2015).

Most people with dementia are admitted to hospital for a primary diagnosis other than dementia (de Siún et al., 2014; Natalwala et al., 2008). International studies have reported that hospitalized patients with a comorbid diagnosis of dementia (CD) typically experience a longer length of stay (LOS) (Carter et al., 2022; Murata et al., 2015; Protty et al., 2017), have higher care costs(Carter et al., 2022), and an increased risk of mortality compared to patients without a diagnosis of dementia (Harvey et al., 2016; Protty et al., 2017). In the US, a recent study by Gupta and colleagues (2022) analyzed inpatients with COPD using data from the National Inpatient Sample (NIS), and found that LOS was longer for inpatients with CD compared to those without (4 days vs 3 days)(A. Gupta et al., 2022). Furthermore, patients with COPD were less likely to be discharged from hospital alive if they had CD. CD was also associated with longer LOS in a study of patients admitted to hospital for lower extremity fractures (Menendez et al., 2013). However, the study did not detect a relationship between CD and in-hospital mortality after adjusting for sex, age, and other comorbidities.

The objective of this paper is to estimate the difference in inpatient LOS, hospital service delivery costs, absolute mortality risk, and number of procedures (NPr) between similar admissions to US acute hospitals for patients with and without CD. Our estimates are therefore conditional on individuals surviving until admission. We found that LOS and mortality risk tended to be higher among patients with CD than for comparable admissions without CD, and show there is considerable heterogeneity in differences between the groups, noticeably with respect to mortality risk and cost.

2. Methods

2.1. Data

We used the National Inpatient Sample (NIS), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality discharge data from 2016 to 2019; beginning from the first full year that the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Clinical Modification (ICD-10-CM) coding system (National Center for Health Statistics, 2012) was used in NIS, and ending in the last year preceding the first wave of the Covid-19 pandemic. NIS is the largest publicly available all-payer inpatient care database in the US; full documentation is available from HCUP (Agency for Healthcare Research & Quality, 2022b).

NIS contains data on inpatient admissions (records). Patient (age, sex, household income quartile [by zip code], insurance status [Medicare, Medicaid, Private, None], race/ethnicity [Asian/Pacific Islander, Black, Hispanic, American Indian, White, Other], location [urban/rural classification], severity of illness (SOI), risk of mortality (ROM)), and hospital (bed size, region, location/teaching status) are available for each record along with year, admission source, elective status, weekend (Yes/No), hospital charge, LOS, in-hospital mortality, and number of procedures (NPr). Charges were converted to inpatient service delivery costs by applying the hospital-specific cost-to-charge ratios (Agency for Healthcare Research & Quality, 2022a) and inflated to 2020 USD using the Personal Consumption Expenditures – Hospital Care Index from the Bureau of Economic Analysis (Dunn et al., 2018). Each admission documents one primary diagnosis – using ICD-10-CM codes – and up to 39 comorbid diagnoses (29 only for 2016). Comorbid diagnoses were used to generate comorbidity variables, including CD, via the updated Elixhauser algorithm, which creates binary indicators for a range of diagnoses which are important predictors hospital LOS, costs and mortality (Moore et al., 2017).

The primary outcomes were (i) LOS (in days) for each inpatient episode of care, (ii) the cost of the admission (in USD 2020), (iii) the total number of ICD-10-PCS (Procedure Coding System) procedures documented on the discharge record, and (iv) whether the patient died during the hospitalization (absolute mortality risk [%]). In supporting analysis, we examined the discharge status of records and number of days to first procedure (for those with a procedure recorded). We examined two groups of admissions for individuals with and without CD (See supplement for ICD-10-CM code list). Admissions without CD were categorized as non-CD. Primary diagnoses were grouped into higher-level categories according the ICD-10-CM chapters (National Center for Health Statistics (NCHS), 2023) (eTable 1).

The data covers over 28 million inpatient records over 4 years. We excluded admissions for those: aged under 65 years to focus on older adults; with a primary diagnosis of dementia; with a primary or comorbid diagnosis of "other neurological disorders" to avoid misclassification bias; without any diagnoses coded; reported as subsequent or sequelae admissions to ensure a consistent comparison of admission type (initial encounters only). Subsequently admissions were excluded where the primary diagnosis category had very few cases, e.g. pregnancy-related categories (Supplement). Observations missing outcomes (LOS, cost, mortality, or NPr) accounted for 0.7 % of the sample and were excluded. Missing covariable data represented a further 5 % of admissions and were also excluded; this decision was examined in sensitivity analysis. See eFig. 1 for the flow diagram demonstrating sample selection.

2.2. Statistical analysis

To compare outcomes between those with and without CD, while controlling for observed confounders, we used entropy balancing (EB) (Hainmueller, 2012). EB is an approach similar to inverse probability weighting that tends to be less prone to giving extreme weights to some units (Li & Thomas, 2019). Admissions were first stratified according to primary diagnosis categories as well as hospital location/teaching status and region to ensure exact balance within these groups. Within strata, admissions with and without CD were balanced according to age, sex, race, income, insurance status, location, admission source, elective/non-elective, weekend (Yes/No), year, hospital bed size, SOI, ROM, and comorbidity status (eTable 2).

We performed descriptive comparisons between the two groups. We compared demographic characteristics and outcomes from admissions with and without CD before and after EB using the absolute value of the standardized mean difference (Tables 1 & 2). Next, we estimated the difference in each primary outcome associated with CD using logistic (for mortality) and generalized linear (with log-link and Gaussian-family distribution for cost, LOS and NPr) regression models combined with EB weights. We estimated these differences for the entire sample, and to examine heterogeneity, separately by primary diagnosis category (Fig. 1). To account for residual imbalance, we adjusted for the same variables used in balancing/stratification as well as age-squared and four primary diagnosis categories which, due to small numbers, could not be used for stratification.

In sensitivity analysis, we examined whether results were sensitive to: stratification (Yes/No); alternative balancing approaches; covariable adjustment (Yes/No); including/excluding ROM and SOI scores; and including a category for missing covariables [$n = 9{,}235{,}966$] (eFig. 2). We examined differences in outcomes separately according to insurance

Table 1
Summary of inpatient-record characteristics* for those with and without comorbid dementia before and after balancing on confounders.

	Before entropy balancing			After entropy balancing		
	No comorbid dementia	Comorbid dementia	|SMD|	No comorbid dementia	Comorbid dementia	|SMD|
Age (years), mean (95 % CI)	76 (76.01–76.03)	82.5 (82.52–82.54)	0.901	82.5 (82.52–82.54)	82.5 (82.53–82.54)	<0.001
Sex, *n* (95 % CI)						
Male	46.7 (46.7–46.8)	39.3 (39.2–39.4)	0.153	39.3 (39.2–39.3)	39.3 (39.2–39.3)	<0.001
Female	53.3 (53.2–53.3)	60.7 (60.6–60.8)	0.153	60.7 (60.7–60.8)	60.7 (60.7–60.8)	<0.001
Insurance Status, *n* (95 % CI)						
No Insurance	2.2 (2.16–2.18)	1.7 (1.66–1.71)	0.038	1.7 (1.68–1.7)	1.7 (1.68–1.7)	<0.001
Medicare	88.5 (88.46–88.5)	92.5 (92.41–92.51)	0.138	92.5 (92.44–92.49)	92.5 (92.44–92.49)	<0.001
Medicaid	1.5 (1.49–1.51)	1.4 (1.4–1.45)	0.006	1.4 (1.41–1.44)	1.4 (1.41–1.44)	<0.001
Private	7.9 (7.83–7.87)	4.4 (4.38–4.46)	0.144	4.4 (4.41–4.45)	4.4 (4.4–4.44)	<0.001
Race, *n* (95 % CI)						
White	78 (77.98–78.04)	73.7 (73.62–73.79)	0.088	73.7 (73.67–73.75)	73.7 (73.67–73.75)	<0.001
Black	9.9 (9.85–9.9)	12.5 (12.45–12.58)	0.084	12.5 (12.49–12.55)	12.5 (12.49–12.55)	<0.001
Hispanic	7.1 (7.07–7.1)	8.4 (8.3–8.41)	0.048	8.4 (8.33–8.38)	8.4 (8.33–8.38)	<0.001
Asian or Pacific Islander	2.4 (2.34–2.36)	2.7 (2.65–2.72)	0.021	2.7 (2.67–2.7)	2.7 (2.67–2.7)	<0.001
Native American	0.4 (0.4–0.4)	0.3 (0.31–0.33)	0.014	0.3 (0.31–0.32)	0.3 (0.31–0.32)	<0.001
Other	2.3 (2.27–2.29)	2.4 (2.39–2.45)	0.009	2.4 (2.4–2.43)	2.4 (2.4–2.43)	<0.001
Transfer Status, *n* (95 % CI)						
Not transferred in	90.4 (90.38–90.42)	84.3 (84.21–84.35)	0.180	84.3 (84.25–84.32)	84.3 (84.25–84.32)	<0.001
Transferred in from a different acute care hospital	6.1 (6.04–6.07)	5.2 (5.12–5.2)	0.039	5.2 (5.14–5.18)	5.2 (5.14–5.18)	<0.001
Transferred in from another type of health facility	3.5 (3.53–3.56)	10.6 (10.49–10.61)	0.274	10.6 (10.52–10.58)	10.6 (10.53–10.58)	<0.001
Admission Type, *n* (95 % CI)						
Non-elective admission	78.2 (78.21–78.27)	93.2 (93.15–93.25)	0.433	93.2 (93.17–93.22)	93.2 (93.18–93.22)	<0.001
Elective admission	21.8 (21.73–21.79)	6.8 (6.75–6.85)	0.435	6.8 (6.78–6.83)	6.8 (6.78–6.82)	<0.001
***n* = 8776,417**	7,762,538	1,013,879		4,388,209	4,388,209	

*For brevity this table presents a selection of key patient characteristics for each admission. These, along with other hospital, patient and admission variables, were used as part of entropy balancing and full tables, including missingness, of all summary characteristics are in the supplement eTable 2. Race and ethnicity are categorized according to Healthcare Cost and Utilization Project. |SMD| - Absolute value of the Standardized Mean Difference.

status (eFig. 3). Detailed methods, including validation of the regression models, are in the Supplement. The study conforms with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cross-sectional studies (von Elm et al., 2008). Institutional Review Board approval was not required because de-identified data were used. All analyses were conducted using Stata, version 16 (StataCorp, 2019).

2.3. Data availability

The data used in this study may be accessed upon request to the Agency for Healthcare Research and Quality.

3. Results

Our final sample consisted of 8,776,417 admissions, comprised of 1,013,879 admissions with and 7,762,538 without CD. Table 1 presents the main sample characteristics before and after EB for complete cases only (eTable 2 presents the full sample characteristics including missingness). Prior to EB, admissions for patients with CD involved: older patients (83 years vs 76 years); more females (60.7 % vs 53.3 %); more Black (12.5 % vs 9.9 %), Hispanic (8.4 % vs 7.1 %), Asian or Pacific Islander (2.7 % vs 2.4 %) and "Other" (2.4 % vs 2.3 %) race/ethnicity patients; fewer White (73.7 % vs 78 %), and Native American (0.3 % vs 0.4 %) race/ethnicity patients; more Medicare (92.5 % vs 88.5 %) and fewer private insurance patients (4.4 % vs 7.9 %). CD admissions were more likely to involve non-elective patients (93.2 % vs 78.2 %) and those transferred in from another health facility (10.6 % vs 3.5 %). After EB, admission characteristics were very similar with the absolute value of the standardized mean difference (|SMD|) between those with and without CD being <0.001 for every variable used in balancing.

Although differences in outcomes were smaller after EB, admissions involving CD were still associated with lower costs, longer LOS, higher mortality, and fewer procedures. Furthermore, CD admissions were more likely to involve a transfer to another facility, less likely to involve a routine discharge, and had a longer time to first procedure (Table 2). On average, CD admissions were $1187 lower (95 %CI −1202 to −1171), 0.25 days longer (0.24 to 0.25), had a mortality risk 0.4 percentage points higher (0.37–0.42), and involved 0.21 fewer procedures (−0.214 to −0.210) than for admissions involving similar patients without CD (eTable 3).

Fig. 1 shows the difference in each outcome, overall and across primary diagnosis categories, associated with CD following EB and regression adjustment using the method of recycled predictions (Basu &

Table 2

Summary of inpatient-record length of stay, cost, absolute mortality risk and number of procedures as well as auxiliary outcomes for those with and without comorbid dementia before and after balancing on confounders.

	Before entropy balancing		After entropy balancing	
	No comorbid dementia	Comorbid dementia	No comorbid dementia	Comorbid dementia
Main Outcomes				
Cost ($), 2020 USD	15,112 (15,099–15,125)	12,319 (12,294–12,345)	13,088 (13,074–13,103)	12,319 (12,307–12,332)
Length of Stay (LOS), days	4.7 (4.693–4.7)	5.37 (5.362–5.385)	5.09 (5.086–5.096)	5.37 (5.368–5.379)
No. of Procedures (NPr), count	1.63 (1.631–1.634)	1.01 (1.01–1.017)	1.21 (1.207–1.211)	1.01 (1.012–1.016)
Mortality Risk, %	2.67 (2.66–2.68)	4.4 (4.36–4.44)	4.03 (4.01–4.05)	4.4 (4.38–4.42)
Auxiliary Outcomes				
No. of days from admission to first procedure, (for those who had at least one procedure; $n = 4,896,026$)	1.349 (1.346–1.351)	1.799 (1.789–1.809)	1.749 (1.745–1.753)	1.799 (1.794–1.804)
Disposition of Patient,% (95 % CI)				
Routine	49.87 (49.84–49.91)	20.93 (20.85–21)	35.02 (34.97–35.06)	20.93 (20.89–20.96)
Transfer to Short-term Hospital	2.36 (2.35–2.37)	1.76 (1.74–1.79)	2.38 (2.36–2.39)	1.76 (1.75–1.77)
Transfer Other: Includes Skilled Nursing Facility (SNF), Intermediate Care Facility (ICF), Another Type of Facility	22.6 (22.57–22.63)	51.54 (51.45–51.64)	36.36 (36.31–36.4)	51.54 (51.5–51.59)
Home Health Care (HHC)	21.85 (21.83–21.88)	20.95 (20.87–21.03)	21.67 (21.64–21.71)	20.95 (20.91–20.98)
Against Medical Advice (AMA)	0.61 (0.61–0.62)	0.38 (0.37–0.4)	0.51 (0.5–0.52)	0.38 (0.38–0.39)
Died	2.67 (2.66–2.68)	4.4 (4.36–4.44)	4.03 (4.01–4.05)	4.4 (4.38–4.42)
Discharge alive, destination unknown	0.03 (0.03–0.03)	0.04 (0.03–0.04)	0.04 (0.03–0.04)	0.04 (0.03–0.04)
$n = 8776,417$	7,762,538	1,013,879	4,388,209	4,388,209

Rathouz, 2005). Within primary diagnoses, the direction of association was generally consistent (or was not significantly different from zero; alpha = 0.05), except for diseases of the digestive system (K00–K93) and infectious and parasitic diseases (A00–B99) for LOS, and mental and behavioral disorders (F00–F99) for costs.

Across models, the direction of association was consistent and the magnitude was robust to the inclusion of missing data and alternative balancing approaches (eFig. 4); the direction of association was also consistent across insurance status categories or was not significantly different from zero (eFig. 5). The shift in results following regression adjustment highlights the importance of accounting for non-linearities in relation to age (from the inclusion of age-squared). Sensitivity analyses examining covariate balance and prediction accuracy following EB, and the distribution of outcomes including and excluding in-hospital deaths are presented in eFig. 3–6. Results differed when excluding SOI and ROM scores (available on request). Since CD explains a small proportion of the variation in SOI and ROM (eTable 4), these indicators are likely to capture important determinants of outcomes and their inclusion is warranted. In order to examine procedure count, we did not adjust for the types of procedures undergone by patients with and without CD. However eTable 5 shows the general overlap in procedures between similar patient admissions with and without CD.

4. Discussion

This study examined differences in inpatient LOS, cost, mortality and number of procedures between a comparable group of admission for patients with and without a comorbid diagnosis of dementia. We found that LOS was longer among patients with CD. This estimate is consistent with previous findings that people with CD experience longer LOS while in the hospital setting (Carter et al., 2022; Gupta et al., 2022; Menendez et al., 2013; Möllers et al., 2019; Murata et al., 2015; Protty et al., 2017). In our study, LOS was generally longer, though heterogeneous, across primary diagnosis categories (Fig. 1) except for digestive and infectious/parasitic diseases. Patients with CD had higher mortality and fewer procedures during this initial hospital admission, which was generally consistent within primary diagnoses. Contrary to expectation and previous literature (Briggs et al., 2016; Carter et al., 2022), costs were lower among those with CD except for mental or behavioral disorders (F00–F99).

The reasons for extended LOS of hospitalized patients with CD may be related to the increased risk of delirium among patients with dementia (Harvey et al., 2016), difficulties communicating symptoms due to cognitive impairment (Phelan et al., 2012), or a limited ability to self-manage one's own primary condition (Phelan et al., 2012). Insufficient training in dementia-specific care and education among hospital staff may also extend LOS for patients with dementia (George et al., 2013; Jensen et al., 2019). Ultimately, the care needs of such patients are more complex so caring for this group may require increased attention to the detail of the disease and its self-limiting implications for patients (Gkioka et al., 2020). However, healthcare workers are often limited by organizational and environmental factors, including time constraints, that impact on the provision of person-centered care (Gupta et al., 2022). From a healthcare planning viewpoint, it is essential that staff are equipped with knowledge of dementia and the necessary training to address the various challenges associated with the condition. The development and use of evidence-based recommendations for care can help to manage the complex and often stressful transition for patients with dementia in and out of the inpatient setting (Hirschman & Hodgson, 2018). Adopting characteristics of a dementia-friendly hospital such as awareness of the environment, valuing relatives, continuity of care, and person-centeredness can help to better support people with dementia while in hospital (Manietta et al., 2022).

That patients with CD had a higher risk of mortality, lower cost, fewer procedures and longer LOS warrants careful interpretation. One interpretation is that providers deliberately pursue less intensive and less invasive technological care pathways for people with dementia (Gupta & Lamont, 2004) that accounts for the impact of the cognitive

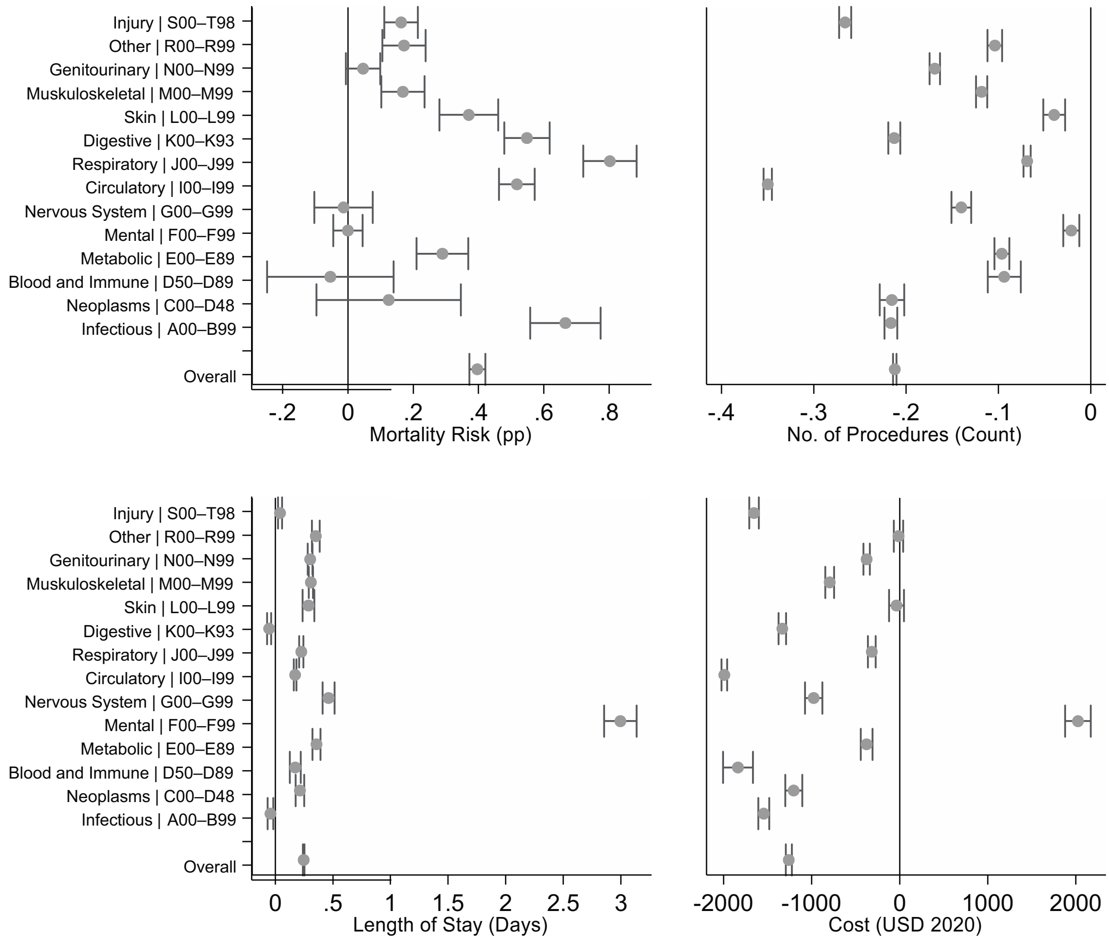

Fig. 1. Association (with 95 % CIs) of comorbid dementia with each outcome across primary diagnoses. Legend: Associations are estimated from the baseline model (using stratification, entropy balancing, regression adjustment and including missing covariables categories). Abbreviated primary diagnosis titles are used here, please see eTable 1 for full ICD-10-CM title descriptions.

impairment on the person and on the process of care which may be done in consultation with the patient and/or caregiver. The 2016 white paper by the Dementia Action Alliance pointed out that health professionals can have a limited perspective about the lived experience of people with dementia and are not always able to develop effective care relationships and optimal care pathways (Pinkowitz et al., 2016). Instead of a simple patient-professional relationship, the care experience of older people with cognitive difficulties in hospital should be a 'triad', involving family carers or third party advocates (Jurgens et al., 2012). This should be accompanied by the provision of practical and accessible information systems on wards to help staff identify patients with dementia, facilitating higher levels of person-centered care and the development of appropriate care pathways (Brooke & Semlyen, 2019). The frequency with which a patient is hospitalized may also be a factor in decisions regarding the intensity and invasiveness of their care. Patients with dementia are more likely than those without dementia to be admitted to the ED and to be hospitalized (LaMantia et al., 2015; Shepherd et al., 2019). In NIS, It is not possible to observe whether a patient had multiple visits in one year. We therefore cannot assess whether the lower cost and fewer procedures observed among patients with comorbid dementia is related to the frequency of hospitalization.

Delays at both the beginning and end of a hospital encounter may also underlie differences in LOS and cost. Difficulties frequently arise when securing appropriate placement (i.e. administrative delays) (Protty et al., 2017), and may affect LOS without affecting the choice of treatment in hospital and relatedly the number of procedures. Hospitals may therefore function as de facto nursing homes for, at least, some period of the treatment. We found that patients with CD were more likely to be discharged to another facility, including care facilities. They also waited longer until their first procedure, arising perhaps from uncertainty created by communication difficulties among patients with dementia and inadequate training among hospital staff on eliciting information from such patients. Additional research is required into the factors that improve health among people with CD in hospitals, including end-of-life care, as well as on alternative pathways to care outside of hospitals.

The study results also indicate that in-hospital mortality was higher among patients with CD compared to similar patients without CD. This is consistent with several studies which indicated an increased risk of mortality for patients with dementia in hospitals and in the general population (Gupta et al., 2022; Sampson et al., 2009; Tehrani et al., 2013). Dementia can cause complications for patients such as dehydration, malnutrition, and an increased risk of falls while in the hospital setting (Alzheimer's Association, 2022; Ching LIM, 2017; Fogg et al., 2018). Dementia can also reduce a person's ability to recognize and communicate pain possibly leading to delays in diagnosis of infections that can cause death (Kelley et al., 2008). For example pneumonia is one of the most common causes of immediate death for older people with dementia in the US (Alzheimer's Association, 2022). That mortality was highest among infectious/parasitic and respiratory primary diagnoses supports this (Fig. 1) though further research on the patterns of mortality is warranted. Fogg et al. (2018) highlights the importance of staff awareness around increased susceptibility to adverse events while in hospital to help prevent mortality among patients with dementia (Fogg et al., 2018). Mortality may play a more important role in cost differences between CD and non-CD patients for different LOS (eFig. 6) however further research, for example mediation analysis, is needed.

In the US, healthcare costs for patients with dementia are substantially larger than those for other diseases (Kelley et al., 2015) however the resource and cost implications for patients with CD in acute hospitals is largely unknown. Though these results are correlational a key strength of this study was the large sample size, making it possible to balance on a larger selection of covariables to account for observed confounding between CD and non-CD groups (Hainmueller, 2012). Examining outcomes across disease categories highlights potentially vulnerable subgroups - mortality risk was highest for CD patients admitted with a primary diagnosis for respiratory (J00–99) or infectious (A00–B99) diseases - or sources of bias – admissions with a primary diagnoses for a mental or behavioral disorders (F00–F99) may reflect a misclassified primary encounter for dementia.

As NIS contains data on inpatient admissions not individual patients, we cannot see whether a patient had multiple visits in one year. Our auxiliary analysis suggests that delays at the beginning and end of an admission may in part underlie the longer LOS, fewer procedures, and lower costs observed in our analysis. However, the frequency of hospitalization may be another source of variation that we are unable to assess and would be an important area for future research. Unidentified dementia continues to be a problem in US hospitals (Alzheimer's Association, 2022; Amjad et al., 2018; Lenze et al., 2004). Consequently, it is possible that undetected patients with CD have been placed into the comparison group thereby underestimating the real effect of CD on inpatient outcomes. It is also possible that the study results may be subject to unobserved confounding. Despite efforts to include an extensive range of covariables, predictors which may influence inpatient outcomes such as cognitive functioning, dementia severity, physical dependency, the presence of advanced directives, caregiver burden and attitudes to medical care, and a more detailed socio-economic characterization of the patient and caregiver were not included in the analysis. Such information is not routinely collected in administrative data nor is more granular admission and discharge data (for example whether a patient was discharged to a hospice) available in NIS. Furthermore our results examine differences according to comorbid dementia conditional on an individual surviving until hospital admission thus we can only make inferences about this population.

Since we use EB weights, we did not use HCUP survey weights and therefore our estimates are not nationally representative though it's unlikely the inclusion of HCUP survey weights would have impacted results (Supplement). Finally we use SOI and ROM scores to account for differences in underlying health which are a function of diagnosis-related groups, and potentially dementia status; our analysis may therefore underestimate the true effect of CD. Further research is required to more fully understand differences in in-hospital outcomes among patients with and without CD, and the mechanism through which such differences arise.

5. Conclusion

Our findings suggest that a comorbid diagnosis of dementia is associated with longer LOS, lower costs, fewer procedures and higher mortality in US acute hospitals. These findings have implications for care processes within the acute hospital setting. For instance, improvements in detecting and addressing dementia during the hospital stay, in addition to equipping staff with the necessary training and resources to address the various challenges associated with the condition, could help to reduce LOS and mortality in the acute care setting. That CD admissions have higher costs and fewer procedures may suggest that providers deliberately pursue less intensive and less invasive technological care pathways for people with dementia that takes account of the impact of the cognitive impairment on the person and on the process of care. Ultimately, the care needs of dementia patients are different and this must be recognised by healthcare providers and policymakers, but that difference should not lead to inferior or less effective care in hospitals. Evaluating the impact of CD on inpatient outcomes will undoubtedly be useful for improving the quality of care for dementia patients in the future. The paper is also a contribution to the debate on developing appropriate models of care to meet the heterogeneous psychosocial needs of older people with dementia in acute hospitals settings.

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CRediT authorship contribution statement

Luke E. Barry: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Laura Carter:** Writing – review & editing, Writing – original draft, Software, Methodology, Conceptualization. **Roch Nianogo:** Writing – review & editing, Methodology, Formal analysis. **Ciaran O'Neill:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Eamon O'Shea:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Stephen O'Neill:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.archger.2024.105487.

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