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Dementia and Outcomes of Mechanical Ventilation

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Abstract

Objectives—To describe the impact of dementia on hospital outcomes among patients requiring invasive mechanical ventilation (IMV)

Design—We conducted a retrospective cohort study of hospitalized patients using the 2011 Nationwide Inpatient Sample. We calculated the adjusted predicted probability of receiving IMV for patients with and without dementia. Next, we examined outcomes for patients receiving IMV using multivariable logistic regression; dementia was the primary predictor and mortality was the outcome.

Measurements and Main Results—Of the 13,816,586 (standard deviation [SD]=262,182) hospitalizations among older patients in the United States in 2011, we identified 2,204,506 (16%, SD= 45,651) with a dementia diagnosis code. Patients with dementia had statistically significant lower predicted probability of receiving IMV than patients without dementia (5.7%; 95% CI:

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Author Contributions

Drs. Lagu and Lindenauer had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Drs. Lagu, Lindenauer, Zilberberg, Stefan and Tjia conceived of the study. Dr. Lagu acquired the data. Drs. Lagu, Lindenauer, Shieh, Stefan, Zilberberg, Tjia, and Pekow analyzed and interpreted the data. Dr. Lagu drafted the manuscript. Drs. Lagu, Lindenauer, Shieh, Stefan, Zilberberg, Tjia, and Pekow critically reviewed the manuscript for important intellectual content.

Sponsor's Role

The content of the presented manuscript is solely the responsibility of the authors. The Tufts University School of Medicine and the National Institutes of Health had no role in the design, conduct, analysis, interpretation of data, or the preparation, review or approval of the manuscript.

Conflicts of Interest

The authors have no conflicts of interest. The study was conducted with funding from the Tufts University School of Medicine Charlton Grant Research Program and from the Center for Quality of Care Research at Baystate Medical Center. Dr. Lagu is supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under Award Number K01HL114745. Dr. Stefan is supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under Award Number K01HL114631.

5.63–5.85% vs. 6.5%; 95% CI: 6.45–6.64%). When we limited the dataset to patients receiving IMV, those with dementia were older (mean age 80 vs. 76, $p<0.0001$) and had a higher combined Gagne comorbidity score (4.4 vs. 4.1, $p<0.001$) than patients without dementia. In a multivariable model, dementia (vs. no dementia) was associated with improved survival to hospital discharge (OR=0.79, $p<0.001$). Patients with dementia also had shorter length of stay (12.5, SD=0.2 vs. 13.1, SD=0.2, $p=0.01$) and lower cost per hospitalization for survivors (\$37,213 vs. \$44,557, $p<0.001$).

Conclusion—Older, critically ill patients with dementia receiving IMV had better in-hospital outcomes than those without dementia. Because a lower adjusted percentage of patients with dementia received IMV, patient selection likely drove outcome differences. These findings suggest that patients, families, and clinicians are carefully considering prognosis, patient quality of life, and appropriate use of intensive care unit (ICU) resources when deciding whether to use IMV in patients with dementia.

Keywords

dementia; mechanical ventilation; critical care resources

INTRODUCTION

The number of hospitalizations among patients over 65 years of age that involved invasive mechanical ventilation (IMV) rose by 30% between years 2001 and 2011. Within the same time period, the growth in IMV hospitalizations among patients with dementia outpaced, by 4-fold, the increase in use among persons without dementia.¹

Despite these ballooning numbers, the impact of this aggressive therapy on elderly patients with dementia remains unclear. Although the evidence on the short-term benefits of critical care for the elderly with dementia continues to be debated,^{2–5} there is clear evidence that use of IMV puts these patients at high risk for delirium, in turn tripling their risk of subsequent death.^{2–5} Of course, the choice (by patients, families, or physicians) not to use IMV for severely ill elders could also result in the patient's death. To further clarify the impact of dementia on hospital outcomes among patients requiring IMV, we conducted a multicenter retrospective cohort study.

METHODS

We used data from the 2011 Nationwide Inpatient Sample (NIS). NIS contains a 20% stratified sample of all short-term, non-federal, non-rehabilitation hospitals in the United States. We included patients who were 65 years or older who were discharged during the study period with an ICD-9-CM procedure code for mechanical ventilation (96.70; 96.71; 96.72). We used the ICD-9-CM procedure code 96.72 for prolonged acute mechanical ventilation (PAMV) to indicate use of IMV for >96 hrs. We identified dementia using discharge diagnoses (ICD-9-CM codes 290.0–290.9, 291.1, 291.2, 291.82, 292.83, 294.0, 294.1, 294.8, 294.9, 331.0, 331.1, 331.7, 331.9, 797, 799.3). To understand the frequency of use of IMV (which would indicate whether patient selection was occurring), we first used generalized estimating equations logistic regression models to calculate the predicted

probability of receiving IMV (creating separate models for patients with and without dementia). These models were adjusted for age, comorbidity,^{6,7} sex, race, principal diagnosis, and hospital characteristics. We next examined outcomes for patients with and without dementia who received IMV. The primary outcome was in-hospital mortality. Secondary outcomes included discharge disposition, length of stay, and costs. We examined summary statistics and calculated unadjusted outcomes using a Rao-Scott chi-square test for categorical variables and Wald F tests for continuous variables. We then created a multivariable logistic regression model with dementia as the primary predictor and mortality as the outcome. We adjusted for demographics, comorbid conditions, and principal diagnosis. We also tested for an interaction with principal diagnosis. All analyses accounted for sampling weights and were carried out using SAS statistical software (Version 9.3, Cary, NC).

RESULTS

We identified a total of 13,816,586 (SD=262,182) hospitalizations among older patients in the United States in 2011. Of these patients, 2,204,506 (standard deviation [SD]=45,651, 16% of overall hospitalizations) had a diagnosis code indicative of dementia (Table 1). Among patients with dementia, 68,495 (SD=2,326, 3.1%) received IMV, compared to 429,031 (SD=10,964, 3.7%) of patients without dementia. The adjusted predicted probability of receiving IMV for patients without dementia group was 6.5% (95% CI: 6.45–6.64%). For patients with dementia, predicted probability was lower: 5.7% (95% CI: 5.63–5.85%), indicating that IMV was used less often in this group.

Compared to patients without dementia who received IMV, those with dementia who received IMV were older (mean age 80 vs. 76, $p<0.0001$), more likely to be female (55% vs. 49%, $p<0.001$), and were more likely to be discharged to a skilled nursing facility (51% vs. 38%, $p<0.001$). While patients with dementia had a higher combined Gagne comorbidity score (4.4 vs. 4.1, $p<0.001$)⁷ and were more likely to have a principal diagnosis of sepsis or respiratory failure, they were less likely to have conditions that were predictors of mortality, including cancer, liver disease, diabetes with complications, chronic renal failure, or coagulation disorders. Those with dementia were also less likely to die in the hospital (32.5% vs. 36.8%, $p<0.001$), had lower cost per hospitalization for both survivors and all patients (all patients: with dementia, \$33,527 vs. without dementia \$40,453, $p<0.001$; survivors only: \$37,213 vs. \$44,557, $p<0.001$), shorter length of stay (12.5, SD=0.2 vs. 13.1, SD=0.2, $p=0.01$), and had similar rates of PAMV (37.9% vs. 38.2%, $p=0.228$). This lower mortality rate for patients with dementia was consistent across the top five principal diagnoses (Figure). In a multivariable model, dementia (vs. no dementia) was associated with improved survival to hospital discharge (OR=0.79, $p<0.001$), irrespective of the principal diagnosis.

DISCUSSION

Despite being older with greater comorbidity burden, patients with dementia who received IMV had lower costs of hospitalization, shorter length of stay, and lower mortality compared

to patients without dementia who received IMV. These results were consistent across the top five principal diagnoses we studied.

What can explain this paradoxical finding? The most likely explanation is that clinicians, patients, and families were selective in their choice to use IMV for patients with dementia (either through use of advanced directives or selection in patients appropriate for ICU admission), limiting use to patients with the best prognosis. This hypothesis is supported by the lower predicted probability of IMV use among patients with dementia compared to those without (5.7% vs. 6.5%) and the fact that patients with dementia were less likely to have comorbid conditions that were associated with mortality (e.g., metastatic cancer, liver disease) than their peers without dementia. It is less supported by the fact that the combined comorbidity score was higher for patients with dementia. Additionally, patients with dementia were more likely to have a principal diagnosis of sepsis or respiratory failure, which may indicate worse disease severity.

The hypothesis that patient selection is occurring is also, however, supported by the prior literature. A small, single-center study by Pisani et al. examined 395 patients admitted to the ICU at a single academic center, 66 (17%) of whom had a diagnosis of dementia. Although these authors had the benefit of data unavailable in the current analysis, including code status at presentation and severity of dementia, the authors found no difference in short-term outcomes such as in-hospital mortality, readmission to ICU, or discharge location.³ Notably, only 27 patients with dementia in their study received IMV, indicating that the study lacked sufficient power to detect a difference between those with and without dementia who received IMV. A Taiwanese study of patients with severe sepsis found that dementia increased the likelihood of organ dysfunction and mortality, although the mortality differences did not remain significant after adjustment for early use of ICU therapies, including mechanical ventilation.⁸ Because patients with dementia tend to be older, have higher levels of comorbidity, and have risk factors that are not adjusted for in these retrospective analyses, it seems counterintuitive that they are equally or less likely to die than their peers without dementia when admitted to the ICU. Therefore, similar to the current analysis, these studies both suggest that patient selection may play a role in the outcomes observed.

This study has several important limitations. We used diagnosis codes to identify patients with dementia, so we may have misclassified some patients because dementia may not always be reliably coded. We were also not able to determine whether patients with dementia had early disease or more advanced disease with significantly impaired functional status. It has been suggested that more advanced cases of the disease are more likely to be coded.⁹ If true, then our finding of better outcomes among persons with dementia (vs. those without dementia) is even more counterintuitive and requires a reexamination in a study where clinical data are available. We were not able to determine resuscitation status, although all included patients in the primary analysis were receiving mechanical ventilation, indicating a preference for at least some life-sustaining therapy. Additionally, we could not determine the code status of patients who did not receive IMV. Therefore, we could not determine the extent to which selection was determined by patient and family decision (through selection of do-not-resuscitate status) or by clinician decisions around ICU

admission. Because of limitations in determining delirium via ICD-9-CM coding, we could not quantify the incidence of delirium, which could be a risk factor for worse longer-term outcomes. Furthermore, the NIS lacks data on acute illness severity on presentation. As a result, we were not able to determine whether patients with dementia were less ill on presentation, which would support our theory of patient selection. Finally, we only examined a short-term outcome (in hospital mortality). Cognitive impairment, including dementia, is a risk factor for delirium,¹⁰ and delirium during hospitalization is most strongly associated with worse long-term outcomes (e.g., 6-month mortality and further cognitive decline), which we were not able to examine given the limitations of the data.^{4,11} Thus, the fact that we observed similar short term outcomes in this study may be somewhat misleading, because we may have missed the impact of ICU delirium on outcomes that occurred 6 months or longer after hospital discharge.

In a large national cohort, we observed that among critically ill patients who received IMV, patients diagnosed with dementia had better in-hospital outcomes than those who did not. These findings suggest that patients with dementia who received IMV had a better starting prognosis than their peers without dementia, which may indicate that patients, families, and clinicians are carefully considering prognosis, patient quality of life, and appropriate use of ICU resources when making the decision whether to use IMV in patients with dementia. Further confirmation of these findings should be attempted using a clinical data source.

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References

1. Lagu T, Zilberberg MD, Tjia J, et al. Use of mechanical ventilation by patients with and without dementia, 2001 through 2011. *JAMA Intern Med.* 2014; 174:999–1001. [PubMed: 24781856]
2. Richardson SS, Sullivan G, Hill A, et al. Use of aggressive medical treatments near the end of life: Differences between patients with and without dementia. *Health Serv Res.* 2007; 42:183–200. [PubMed: 17355588]
3. Pisani MA, Redlich CA, McNicoll L, et al. Short-term outcomes in older intensive care unit patients with dementia. *Crit Care Med.* 2005; 33:1371–1376. [PubMed: 15942358]
4. Ely EW, Shintani A, Truman B, et al. Delirium as a predictor of mortality in mechanically ventilated patients in the intensive care unit. *JAMA.* 2004; 291:1753–1762. [PubMed: 15082703]
5. Salluh JIF, Wang H, Schneider EB, et al. Outcome of delirium in critically ill patients: systematic review and meta-analysis. *BMJ.* 2015; 350:h2538. [PubMed: 26041151]
6. Elixhauser A, Steiner C, Harris DR, et al. Comorbidity measures for use with administrative data. *Med Care.* 1998; 36:8–27. [PubMed: 9431328]

7. Gagne JJ, Glynn RJ, Avorn J, Levin R, Schneeweiss S. A combined comorbidity score predicted mortality in elderly patients better than existing scores. *J Clin Epidemiol.* 2011; 64:749–759. [PubMed: 21208778]
8. Shen H-N, Lu C-L, Li C-Y. Dementia increases the risks of acute organ dysfunction, severe sepsis and mortality in hospitalized older patients: A National Population-Based Study. *PLoS ONE.* 2012; 7:e42751. [PubMed: 22905169]
9. Quan H, Li B, Saunders LD, et al. Assessing validity of ICD-9-CM and ICD-10 administrative data in recording clinical conditions in a unique dually coded database. *Health Serv Res.* 2008; 43:1424–1441. [PubMed: 18756617]
10. Schor JD, Levkoff SE, Lipsitz LA, et al. Risk factors for delirium in hospitalized elderly. *JAMA.* 1992; 267:827–831. [PubMed: 1732655]
11. Pandharipande PP, Girard TD, Jackson JC, et al. Long-term cognitive impairment after critical illness. *N Engl J Med.* 2013; 369:1306–1316. [PubMed: 24088092]

Figure.
Mortality for Patients with and without Dementia, by Principal Diagnosis

Table 1

Characteristics of Patients with and without Dementia Who Received Mechanical Ventilation

	Without Dementia N (%)	With Dementia N (%)	p-value
TOTAL	429,031	68,495	
Mean age (in years) [SD]	76 [0.06]	80.3 [0.11]	<.0001
Female	210,792 (49.1)	37,790 (55.2)	<.0001
Race			
White	284,617 (69.6)	41,967 (61.3)	<.0001
Black	52,703 (12.9)	11,988 (17.5)	
Hispanic	30,595 (7.5)	6,156 (9.0)	
Other	61,116 (14.9)	8,384 (12.2)	
Hospital region			
Northeast	93,464 (21.8)	13,451 (19.6)	0.1926
Midwest	89,998 (21.0)	14,110 (20.6)	
South	162,847 (38.0)	26,922 (39.3)	
West	82,722 (19.3)	14,012 (20.5)	
Hospital type			
Non-teaching	207,875 (49.0)	36,518 (53.7)	0.0007
Teaching	216,543 (51.0)	31,517 (46.3)	
Principal Diagnosis			
Arrhythmia	20323 (4.7)	1873 (2.7)	<.0001
Pneumonia	28926 (6.7)	4264 (6.2)	
Stroke	26963 (6.3)	3518 (5.1)	
Sepsis	81593 (19)	18371 (26.8)	
Respiratory Failure	82113 (19.1)	14858 (21.7)	
Other	189112 (44.1)	25611 (37.4)	
Selected Elixhauser Comorbidities			
Congestive heart failure	136,781 (31.9)	22700 (33.1)	0.0205
Chronic pulmonary disease	156,131 (36.4)	23513 (34.3)	0.0005
Hypertension	276,773 (64.5)	47407 (69.2)	<.0001
Anemia (chronic and acute)	127,953 (29.8)	26185 (38.2)	<.0001
Diabetes (without complications)	121,344 (28.3)	20462 (29.9)	0.0012
Weight loss	94,158 (22.0)	17778 (26.0)	<.0001
Renal failure	115,906 (27.0)	18116 (26.5)	0.2597
Solid tumor (without metastasis)	17,586 (4.1)	2024 (3.0)	<.0001
Coagulation disorders	68,823 (16.0)	9086 (13.3)	<.0001
Peripheral vascular disease	55,998 (13.1)	7914 (11.6)	<.0001
Valvular disease	37,092 (8.7)	5642 (8.2)	0.1324
Diabetes with complications	29,552 (6.9)	3932 (5.7)	<.0001
Pulmonary circulation disease	36,558 (8.5)	5041 (7.4)	<.0001
Metastatic cancer	19,412 (4.5)	1487 (2.2)	<.0001
Liver disease	13,356 (3.1)	1472 (2.2)	<.0001

	Without Dementia N (%)	With Dementia N (%)	p-value
Combined Comorbidity Score Median (IQR [*])	3.3 (1.5–5.4)	3.8 (1.9–5.8)	<.0001
Disposition			
Routine	43,709 (10.2)	3,092 (4.5)	<.0001
Transfer to short-term hospital	22,223 (5.2)	2,351(3.4)	
Skilled Nursing Facility	162,365 (37.9)	34,752 (50.8)	
Home health care	41,293 (9.6)	5,844 (8.4)	
Against medical advice	762 (0.2)	51 (0.1)	
Died in hospital	157,597 (36.8)	22,243 (32.5)	
Discharged elsewhere	421 (0.1)	114 (0.2)	

^{*}
IQR=Interquartile range