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Trends in Noninvasive and Invasive Mechanical Ventilation Among Medicare Beneficiaries at the End of Life

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IMPORTANCE End-of-life care is costly, and decedents often experience overtreatment or low-quality care. Noninvasive ventilation (NIV) may be a palliative approach to avoid invasive mechanical ventilation (IMV) among select patients who are hospitalized at the end of life.

OBJECTIVE To examine the trends in NIV and IMV use among decedents with a hospitalization in the last 30 days of life.

DESIGN, SETTING, AND PARTICIPANTS This population-based cohort study used a 20% random sample of Medicare fee-for-service beneficiaries who had an acute care hospitalization in the last 30 days of life and died between January 1, 2000, and December 31, 2017. Sociodemographic, diagnosis, and comorbidity data were obtained from Medicare claims data. Data analysis was performed from September 2019 to July 2020.

EXPOSURES Use of NIV or IMV.

MAIN OUTCOMES AND MEASURES Validated *International Classification of Diseases, Ninth Revision, Clinical Modification* or *International Statistical Classification of Diseases, Tenth Revision, Clinical Modification* procedure codes were reviewed to identify use of NIV, IMV, both NIV and IMV, or none. Four subcohorts of Medicare beneficiaries were identified using primary admitting diagnosis codes (chronic obstructive pulmonary disease [COPD], congested heart failure [CHF], cancer, and dementia). Measures of end-of-life care included in-hospital death (acute care setting), hospice enrollment at death, and hospice enrollment in the last 3 days of life. Random-effects logistic regression examined NIV and IMV use adjusted for sociodemographic characteristics, admitting diagnosis, and comorbidities.

RESULTS A total of 2 470 435 Medicare beneficiaries (1 353 798 women [54.8%]; mean [SD] age, 82.2 [8.2] years) were hospitalized within 30 days of death. Compared with 2000, the adjusted odds ratio (AOR) for the increase in NIV use was 2.63 (95% CI, 2.46-2.82; % receipt: 0.8% vs 2.0%) for 2005 and 11.84 (95% CI, 11.11-12.61; % receipt: 0.8% vs 7.1%) for 2017. Compared with 2000, the AOR for the increase in IMV use was 1.04 (95% CI, 1.02-1.06; % receipt: 15.0% vs 15.2%) for 2005 and 1.63 (95% CI, 1.59-1.66; % receipt: 15.0% vs 18.2%) for 2017. In subanalyses comparing 2017 with 2000, similar trends found increased NIV among patients with CHF (% receipt: 1.4% vs 14.2%; AOR, 14.14 [95% CI, 11.77-16.98]) and COPD (% receipt: 2.7% vs 14.5%; AOR, 8.22 [95% CI, 6.42-10.52]), with reciprocal stabilization in IMV use among patients with CHF (% receipt: 11.1% vs 7.8%; AOR, 1.07 [95% CI, 0.95-1.19]) and COPD (% receipt: 17.4% vs 13.2%; AOR, 1.03 [95% CI, 0.88-1.21]). The AOR for increased NIV use was 10.82 (95% CI, 8.16-14.34; % receipt: 0.4% vs 3.5%) among decedents with cancer and 9.62 (95% CI, 7.61-12.15; % receipt: 0.6% vs 5.2%) among decedents with dementia. The AOR for increased IMV use was 1.40 (95% CI, 1.26-1.55; % receipt: 6.2% vs 7.6%) among decedents with cancer and 1.28 (95% CI, 1.17-1.41; % receipt: 5.7% vs 6.2%) among decedents with dementia. Among decedents with NIV vs IMV use, lower rates of in-hospital death (50.3% [95% CI, 49.3%-51.3%] vs 76.7% [95% CI, 75.9%-77.5%]) and hospice enrollment in the last 3 days of life (57.7% [95% CI, 56.2%-59.3%] vs 63.0% [95% CI, 60.9%-65.1%]) were observed along with higher rates of hospice enrollment (41.3% [95% CI, 40.4%-42.3%] vs 20.0% [95% CI, 19.2%-20.7%]).

CONCLUSIONS AND RELEVANCE This study found that the use of NIV rapidly increased from 2000 through 2017 among Medicare beneficiaries at the end of life, especially among persons with cancer and dementia. The findings suggest that trials to evaluate the outcomes of NIV are warranted to inform discussions about the goals of this therapy between clinicians and patients and their health care proxies.

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The quality of medical care for patients who are seriously ill at the end of life is concerning because they often receive potentially burdensome care, including excessive health care transitions and intensive care unit (ICU) admissions.[1] This situation persists, even though most Medicare beneficiaries prefer treatment that is focused on palliation rather than life extension at the end of life.[2] High-intensity care is not associated with better outcomes given that geographical regions with greater overall spending on end-of-life care do not have improved survival, care quality, patient satisfaction, or perceptions of quality among bereaved families.[3,4] High-intensity care at the end of life may also be associated with adverse consequences, including reduced quality of life (QOL), increased financial hardship, and discordant care that is not aligned with the wishes of patients or their families.[2,5-7]

A common diagnosis associated with ICU admission is acute respiratory failure, and many patients with this condition require ventilatory support. At any time, approximately 40% of patients admitted to an ICU receive invasive mechanical ventilation (IMV),[8] which is costly, labor intensive, and accounts for a disproportionate amount of health care resources.[9] In addition, IMV often necessitates sedating medications (and urinary catheters) that are associated with delirium, particularly among older patients.[10,11] Use of noninvasive ventilation (NIV), such as continuous or bilevel positive airway pressure, has increased in select populations of patients with respiratory failure (eg, those with acute exacerbations of chronic obstructive pulmonary disease [COPD] or congestive heart failure [CHF])[12,13] because of improved outcomes (ie, increased survival, shorter length of stay, and lower costs) compared with IMV.[14-16] As a result of the expanded use of NIV, use of IMV among these populations has substantially decreased over time.[13,17]

Use of NIV to improve survival has been established; however, its use has also been suggested to achieve palliation in persons with terminal illness.[18,19] Although evidence is limited, under palliative circumstances, NIV may be introduced on a trial basis to reduce dyspnea and respiratory distress while allowing patients and families more time to address goals and finalize affairs. Compared with high-flow or supplemental oxygen therapy, NIV has been associated with reduced dyspnea and morphine needs among patients with cancer.[20,21] In a mixed group of patients in the ICU with acute respiratory failure and a do-not-intubate order who received NIV, no statistically significant difference in QOL was observed between 90 days and baseline measurements among those who survived.[22] As a result, the joint European Respiratory Society and American Thoracic Society guidelines on NIV for acute respiratory failure suggest offering NIV for palliation in the setting of terminal conditions.[23] Therapy is considered successful if it improves breathlessness and respiratory distress without introducing adverse consequences, such as mask discomfort or prolonged agitation.

This population-based cohort study aimed to address several important questions regarding ventilatory support for patients at the end of life using Medicare beneficiary data from 2000 to 2017. These questions were as follows: (1) what were the trends in NIV and IMV use among patients hospitalized at the end of life? (2) were there differences in NIV and IMV use among patients with select admitting diagnoses? and (3) were there differences in in-hospital death, hospice enrollment, and late hospice enrollment among these select patient populations?

Key Points

Question What are the trends in the use of noninvasive ventilation at the end of life?

Findings In this cohort study of 2 470 435 Medicare beneficiaries who were hospitalized in the last 30 days of life, the use of noninvasive ventilation rapidly expanded from 2000 to 2017, with a slight increase in the use of invasive mechanical ventilation at the end of life. Use of noninvasive ventilation increased among patients with cancer and dementia, with concomitant increases in invasive mechanical ventilation use.

Meaning The findings from this study suggest that further research is needed to examine the outcomes of noninvasive ventilation at the end of life, especially for patients with cancer and dementia.

Methods

This cohort study was approved by the institutional review boards of Oregon Health and Science University and Brown University. These institutional review boards waived patient consent requirements as the study involved deceased individuals.

Data and Study Population

We selected a 20% random sample of Medicare fee-for-service beneficiaries aged 66 years or older who had a hospital admission in the last 30 days of life and died between January 1, 2000, and December 31, 2017. In addition, within this cohort, we identified 4 subcohorts of Medicare beneficiaries. A diagnosis of dementia was ascertained using the primary or the first 9 secondary admission diagnosis codes for hospitalization from the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) or *International Statistical Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*). The other subcohort diagnoses (CHF, COPD, and cancer) were identified using the primary admitting diagnosis codes from *ICD-9-CM* or *ICD-10-CM* (eMethods and eTable 1 in the Supplement). We truncated the number of secondary diagnosis coding slots after 2011 to reduce bias[24,25] attributed to the Centers for Medicare & Medicaid Services expansion of the number of secondary diagnoses, which occurred in January 2011.[26] Patients with a primary admitting diagnosis of cardiac arrest or with preexisting tracheostomy were excluded because of ventilatory requirements. The cohort included decedents in hospitals that provided 5 or more beneficiary hospitalizations per year in the last 30 days of life and 1 hospitalization per unique beneficiary. Because of the transition from *ICD-9-CM* to *ICD-10-CM* codes, deaths from October 1, 2015, to December 31, 2015, were excluded.

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Table 1. Characteristics of Decedents With 1 or More Hospitalizations in Their Last Month of Life, by Year

Characteristic	Year of hospitalization, % (95% CI)			
	2000-2003 (n = 605 350)	2004-2007 (n = 591 608)	2008-2012 (n = 670 492)	2013-2017 (n = 602 985)[a]
Age, mean (SD) [IQR], y	81.9 (7.9) [75.9- 87.7]	82.2 (8.0) [76.2- 88.0]	82.4 (8.2) [76.1- 88.6]	82.5 (8.6) [75.6- 89.1]
Female sex	55.4 (55.3-55.6)	54.9 (54.8-55.0)	54.5 (54.4-54.6)	54.4 (54.3-54.5)
Race/ethnicity				
White	87.1 (87.0-87.2)	86.7 (86.6-86.8)	86.4 (86.3-86.5)	85.7 (85.6-85.8)
Black	9.6 (9.5-9.6)	9.5 (9.4-9.6)	9.2 (9.1-9.3)	9.3 (9.2-9.3)
Hispanic	1.4 (1.3-1.4)	1.5 (1.5-1.6)	1.7 (1.7-1.72)	1.6 (1.5-1.6)
Hospital primary diagnosis[b]				
Pneumonia/sepsis	18.1 (18.0-18.2)	20.2 (20.1-20.3)	22.9 (22.8-23.0)	23.7 (23.6-23.9)
Cancer	11.0 (10.9-11.1)	10.7 (10.6-10.8)	9.1 (9.1-9.2)	7.7 (7.6-7.8)
Dementia[c]	9.4 (9.3-9.4)	8.4 (8.3-8.5)	10.0 (10.0-10.1)	18.8 (18.7-18.9)
CHF	7.1 (7.0-7.2)	6.7 (6.6-6.8)	5.8 (5.8-5.9)	5.6 (5.5-5.6)
COPD	2.4 (2.4-2.5)	2.1 (2.0-2.1)	2.1 (2.0-2.1)	1.6 (1.6-1.64)
CCI score, mean (SD) [IQR]	2.4 (2.3) [1-3]	2.5 (2.4) [1-3]	2.8 (2.5) [1-4]	3.7 (2.8) [2-5]

Abbreviations: CCI, Charlson Comorbidity Index (score range: 0-40, with the highest score indicating the highest predicted risk of death); CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; IQR, interquartile range.

[a] 2015 data were partial owing to the transition from *International Classification of Diseases, Ninth Revision, Clinical Modification* to *International Statistical Classification of Diseases, Tenth Revision, Clinical Modification*, on October 1, 2015.

[b] Primary admitting diagnosis was rank ordered by most common in 2000 to 2003.

[c] A diagnosis of dementia was identified by the primary or the first 9 secondary diagnosis codes. All of the other diagnoses were identified by the primary admitting diagnosis.

Measures

We reviewed validated procedure codes to identify the use of NIV (*ICD-9-CM* or *ICD-10-CM* codes 93.90, 93.91, 93.99/5A09357, 5A09457, 5A09557, 5A09358, 5A09458, 5A09558, 5A0935Z, 5A0945Z, and 5A0955Z), IMV (*ICD-9-CM* or *ICD-10-CM* codes 96.7x/5A1935Z, 5A1945Z, and 5A1955Z), both NIV and IMV, or none.[27-30] The sociodemographic characteristics of the Medicare beneficiaries were based on the information contained in the Master Beneficiary Summary File, including age, sex, and race/ethnicity. Race/ethnicity data were based on information collected by the Social Security Administration. Comorbidities were based on *ICD-9-CM* or *ICD-10-CM* codes that were submitted as part of the Medicare claim for that hospitalization within 30 days of death. Measures of end-of-life care by ventilatory support and admitting diagnosis group included in-hospital death (acute care setting), hospice enrollment at death, and hospice enrollment in the last 3 days of life.

Statistical Analysis

Descriptive statistics were used to characterize patient variables by year of hospitalization and ventilatory support, and 95% CIs were calculated with the Clopper-Pearson method. Rates of NIV and IMV use were tabulated by year. We examined descriptions to ascertain whether the IMV trend for representative years varied by admission type (medical or surgical). Multivariable random-effects logistic regressions were performed to examine NIV and IMV use among decedents clustered by hospital, adjusting for age, sex, race/ethnicity, admitting diagnosis, and Charlson Comorbidity Index score (range, 0-40, with the highest score indicating the highest predicted risk of death).[31] Dichotomous variables for the years were included to capture time trends, with the year 2000 used as a reference. For the NIV model, NIV and no ventilatory support groups were included; for the IMV model, IMV and no ventilatory support groups were included. Subgroup analyses (CHF, COPD, cancer, and dementia diagnoses) were conducted to investigate the secular trends among diagnostic groups. End-of-life care measures were tabulated by diagnostic group for descriptive comparisons using the most recent quartile (2013-2017), excluding Medicaid-eligible beneficiaries.

Data analysis was performed with Stata, version 15.0 (StataCorp LLC) from September 2019 to July 2020. Comparisons between years were interpreted as different if their 95% CIs did not overlap.

Results

From 2000 to 2017, a total of 2 470 435 Medicare fee-for-service beneficiaries (1 353 798 women [54.8%] and 1 116 637 men [45.2%] with a mean [SD] age of 82.2 [8.2] years) were hospitalized within the last 30 days of life. Among these decedents, the top 3 admitting diagnoses were pneumonia or sepsis (n = 525 523 [21.3%]), cancer (n = 237 335 [9.6%]), and CHF (n = 155 273 [6.3%]). The sociodemographic characteristics for the cohort are shown in **Table 1**. Overall, IMV was used in 401 419 of 2 470 435 decedents (16.3%), NIV in 90 700 decedents (3.7%), and both IMV and NIV in 25 689 decedents (1.0%) (**Table 2**). Among decedents who received NIV, 51 038 (56.3%) had an ICU stay.

From 2000 to 2017, an almost 9-fold absolute increase in NIV use from 0.8% to 7.1% occurred, whereas IMV use increased slightly from 15.0% to 18.5% and was twice as common as NIV use (**Figure 1**). Compared with 2000 (the

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Table 2. Characteristics of Decedents With 1 or More Hospitalizations in Their Last Month of Life, by Ventilatory Support

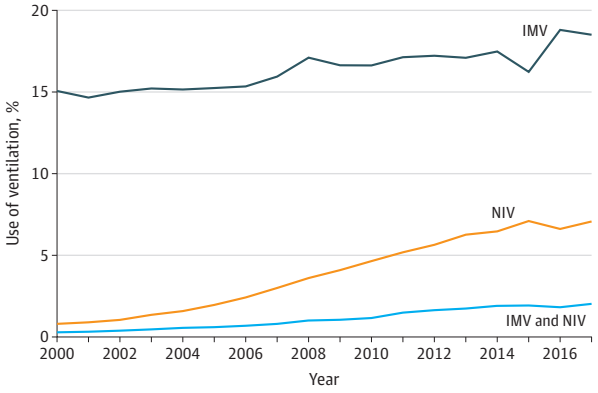
Characteristic	Ventilatory support, % (95% CI)			
	No ventilatory support (n = 1 952 627)	IMV (n = 401 419)	NIV (n = 90 700)	NIV and IMV (n = 25 689)
Age, mean (SD) [IQR], y	82.9 (8.2) [76.7-89.0]	79.4 (7.5) [73.3-84.9]	82.2 (8.0) [76.0-88.3]	79.0 (7.5) [72.8-84.6]
Female sex	55.6 (55.5-55.7)	50.9 (50.8-51.1)	55.5 (55.2-55.8)	50.6 (50.1-51.2)
Race/ethnicity				
White	87.4 (87.3-87.4)	81.8 (81.6-81.9)	88.6 (88.4-88.9)	84.1 (83.6-84.5)
Black	8.8 (8.8-8.9)	12.6 (12.5-12.7)	6.6 (6.4-6.8)	10.2 (9.8-10.6)
Hispanic	1.4 (1.4-1.5)	2.0 (2.0-2.1)	1.7 (1.6-1.8)	1.8 (1.6-1.9)
Hospital admitting diagnosis[a]				
Pneumonia/sepsis	19.5 (19.5-19.6)	26.5 (26.4-26.7)	31.7 (31.4-32.0)	35.0 (34.5-35.6)
Dementia[b]	13.4 (13.3-13.4)	4.2 (4.1-4.2)	9.4 (9.2-9.6)	3.4 (3.2-3.6)
Cancer	11.1 (11.1-11.2)	3.9 (3.9-4.0)	4.2 (4.0-4.3)	3.1 (2.9-3.3)
CHF	6.7 (6.6-6.7)	3.4 (3.4-3.5)	11.1 (10.9-11.3)	4.8 (4.5-5.1)
COPD	1.9 (1.9-2.0)	1.8 (1.8-1.84)	4.6 (4.5-4.8)	4.4 (4.1-4.6)
CCI score, mean (SD) [IQR]	2.9 (2.6) [1-4]	2.5 (2.2) [1-3]	3.1 (2.4) [1-4]	3.1 (2.3) [1-4]

Abbreviations: CCI, Charlson Comorbidity Index (score range: 0-40, with the highest score indicating the highest predicted risk of death); CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; IMV, invasive mechanical ventilation; IQR, interquartile range; NIV, noninvasive ventilation.

[a] Primary or secondary admitting diagnosis was rank ordered by most common in the no ventilatory support group.

[b] A diagnosis of dementia was identified by the primary or the first 9 secondary diagnosis codes. All of the other diagnoses were identified by the primary admitting diagnosis.

Figure 1. Trends in Ventilatory Support at the End of Life, 2000-2017



Overall, 401 419 (16.3%) Medicare beneficiaries received invasive mechanical ventilation (IMV), 90 700 (3.7%) received noninvasive ventilation (NIV), and 25 689 (1.0%) received both IMV and NIV. The use of NIV increased almost 9-fold from 0.8% in 2000 to 7.1% in 2017, whereas the use of IMV was stable and then increased slightly from 15.0% in 2000 to 18.5% in 2017 in the last 30 days of life.

reference group), the adjusted odds ratio (AOR) for the increase in NIV use was 2.63 (95% CI, 2.46-2.82; % receipt: 0.8% vs 2.0%) for 2005, 7.87 (95% CI, 7.38-8.39; % receipt: 0.8% vs 5.2%) for 2011, and 11.84 (95% CI, 11.11-12.61; % receipt: 0.8% vs 7.1%) for 2017 (eTable 2 in the Supplement). Compared with 2000, the AOR for the increase in IMV use was 1.04 (95% CI, 1.02-1.06; % receipt: 15.0% vs 15.2%) for 2005, 1.39 (95% CI, 1.36-1.42; % receipt: 15.0% vs 17.1%) for 2011, and 1.63 (95% CI, 1.59-1.66; % receipt: 15.0% vs 18.2%) for 2017. The IMV trend stratified by admission type was similar.

NIV and IMV Use Among Select Populations

All comparisons used 2000 as a reference group. In 2017, the AOR for the increase in NIV use was 14.14 (95% CI, 11.77-16.98; % receipt: 1.4% vs 14.2%) among decedents with CHF and 8.22 (95% CI, 6.42-10.52; % receipt: 2.7% vs 14.5%) among decedents with COPD (eTable 2 in the Supplement). The reciprocal AOR stabilization in IMV use for 2017 was 1.07 (95% CI, 0.95-1.19; % receipt: 11.1% vs 7.8%) among decedents with CHF and 1.03 (95% CI, 0.88-1.21; % receipt: 17.4% vs 13.2%) among decedents with COPD. In 2017, among decedents with cancer, the AOR for the increases was 10.82 (95% CI, 8.16-14.34; % receipt: 0.4% vs 3.5%) for NIV use and 1.40 (95% CI, 1.26-1.55; % receipt: 6.2% vs 7.6%) for IMV use. Among decedents with dementia, the AOR for the increases was 9.62 (95% CI, 7.61-12.15; % receipt: 0.6% vs 5.2%) for NIV use and 1.28 (95% CI, 1.17-1.41; % receipt: 5.7% vs 6.2%) for IMV use.

Ventilatory support trends from 2000 to 2017 were plotted for select populations at the end of life (**Figure 2**). Among decedents with CHF and COPD, increases in NIV use in 2017 (AOR: 14.14 vs 8.22) were balanced by reciprocal decreases in 2010 (AOR: 0.72 vs 0.84) and then stabilization in 2017 (AOR: 1.07 vs 1.03) in IMV use. Among decedents with cancer and dementia, increases in NIV use in 2017 (AOR: 10.82 vs 9.62) were observed with concomitant increases in IMV use in 2017 (AOR: 1.40 vs 1.28).

End-of-Life Care From 2013 to 2017

In all subgroups of CHF, COPD, cancer, and dementia diagnoses, decedents who received NIV vs IMV had lower rates (expressed as % of hospitalizations or hospice enrollees) of in-hospital death (50.3% [95% CI, 49.3%-51.3%] vs 76.7% [95% CI, 75.9%-77.5%]) and hospice enrollment in the last 3 days of life (57.7% [95% CI, 56.2%-59.3%] vs 63.0% [95% CI, 60.9%-65.1%]) as well as a higher rate of hospice enrollment (41.3% [95% CI, 40.4%-42.3%] vs 20.0% [95% CI, 19.2%-20.7%]) (**Figure 3**). Decedents from CHF and COPD subgroups with NIV use had similar end-of-life care (in-hospital death, hospice enrollment in the last 3 days of life, and hospice enrollment) (CHF vs COPD, in-hospital death: 49.0% [95% CI, 47.3%-50.6%] vs 43.6% [95% CI, 40.7%-46.5%]; hospice enrollment in the last 3 days: 40.2% [95% CI, 38.6%-41.8%] vs 42.5% [95% CI, 39.6%-

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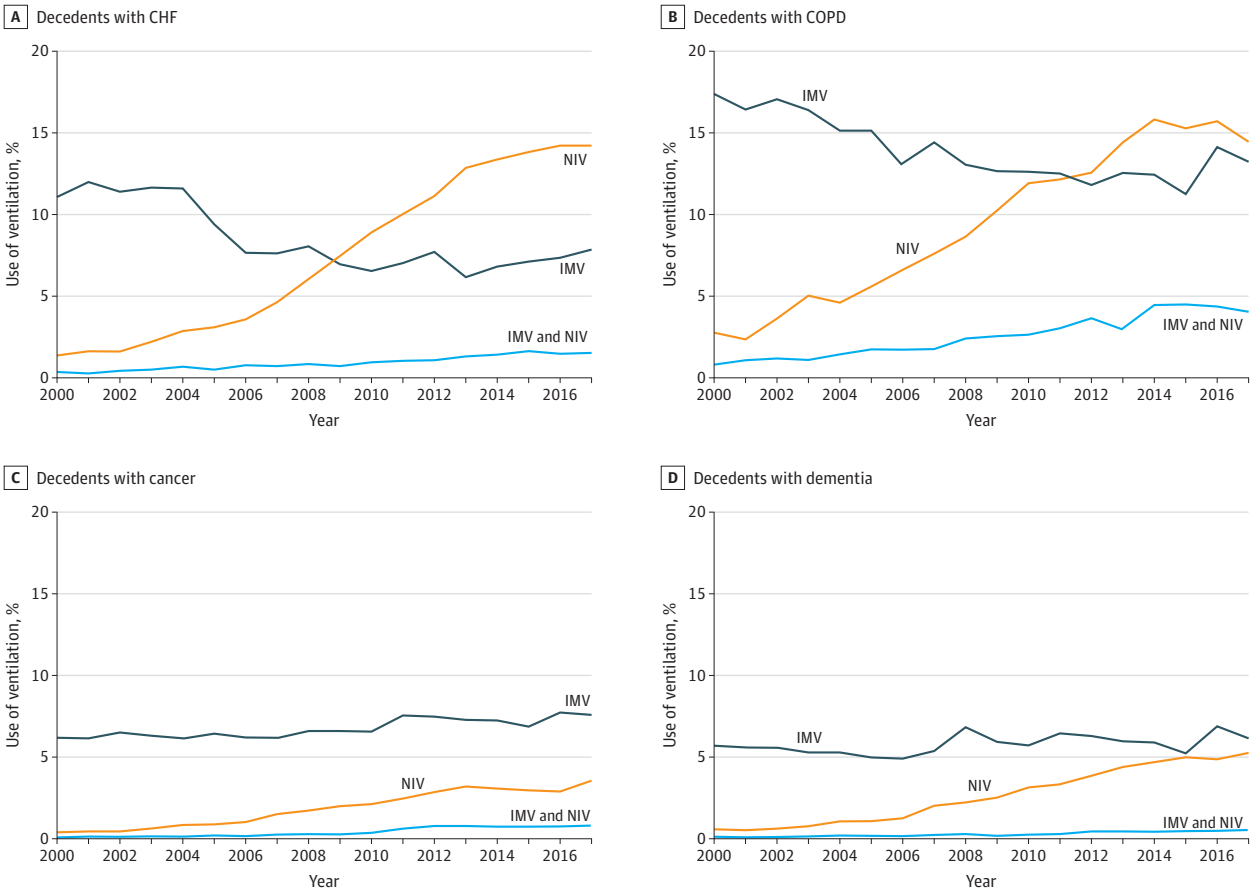
Figure 2. Trends in Use of Noninvasive Ventilation (NIV), Invasive Mechanical Ventilation (IMV), or Both at the End of Life by Admitting Diagnosis, 2000-2017



Among decedents with congestive heart failure (CHF) and chronic obstructive pulmonary disease (COPD), increases in NIV use are balanced by reciprocal decreases and then stabilization in IMV use. Among decedents with cancer and dementia, statistically significant increases in NIV use occurred with concomitant increases in IMV use.

45.4%]; and hospice enrollment: 24.2% [95% CI, 22.9%-25.6%] vs 23.4% [95% CI, 21.0%-26.0%]). Meanwhile, decedents from cancer and dementia subgroups with NIV use had the following end-of-life care (in-hospital death: 60.8% [95% CI, 58.0%-63.5%] vs 50.1% [95% CI, 48.5%-51.8%]; hospice enrollment in the last 3 days: 38.9% [95% CI, 36.2%-41.7%] vs 43.0% [95% CI, 41.4%-44.6%]; and hospice enrollment: 24.3% [95% CI, 21.9%-26.8%] vs 24.0% [95% CI, 22.6%-25.4%]) (Figure 3).

Discussion

Critical decisions are made regarding the use of life-sustaining treatments associated with QOL, especially among those hospitalized within 30 days of death. For patients with CHF and COPD, use of NIV may improve outcomes and avoid the use of IMV. In this study, the finding of the rapid growth of NIV use among persons with cancer and dementia without reciprocal decreases in IMV use raises more questions than answers. Use of NIV may be associated with agitation and distress for patients with cancer and dementia at the end of life, prolonging their death. Given the rapid growth in NIV use, further research is needed to examine the goals of this therapy and whether it achieves those goals.

Use of IMV among Medicare beneficiaries at the end of life was relatively stable from 2008 to 2015, a finding that was consistent with the reported stabilization of other measures of aggressive health care at the end of life (eg, ICU stay in the last 30 days of life).[1] End-of-life care has been identified as an area for quality improvement[32,33]; however, it is difficult to attribute changes in this care to any single guideline or policy. We observed a slight increase in the use of IMV after 2015, which was a meaningful finding given that critical care accounted for a substantial proportion of US health care costs[34] and that IMV was associated with considerably higher daily ICU costs per patient.[35] In addition, IMV was associated with high rates of mortality and morbidity, which were partially attributable to the complications (eg, pneumonia, ventilator-associated lung injury) and adverse effects (eg, prolonged sedation, tracheal injury) of treatment.[36,37] The introduction and expanded use of NIV,

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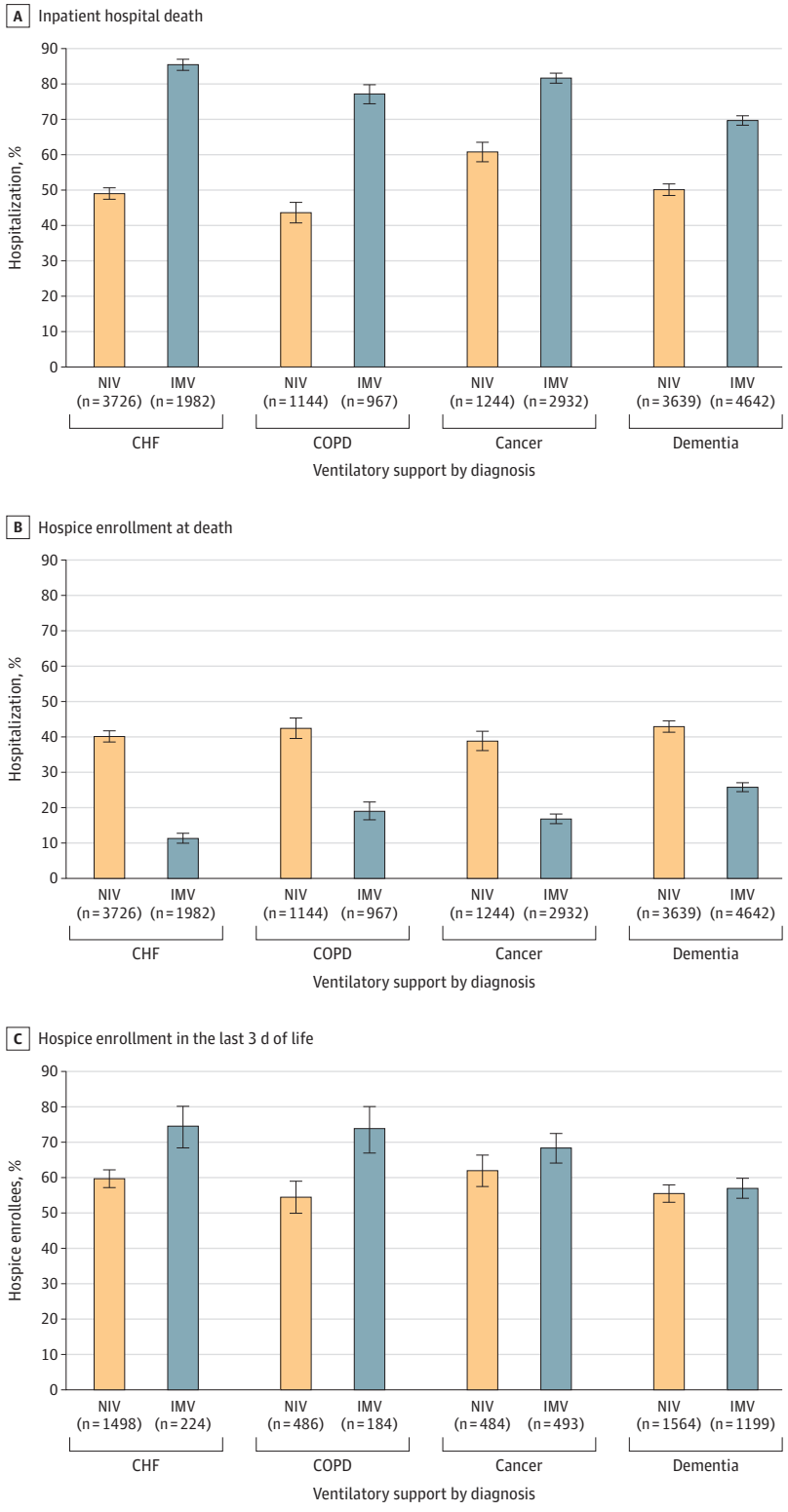
Figure 3. Rates of In-Hospital Death, Hospice Enrollment at Death, and Late Hospice Enrollment in the Last 3 Days of Life by Ventilatory Support and Admitting Diagnosis, 2013-2017



Among all diagnosis subgroups (congestive heart failure [CHF], chronic obstructive pulmonary disease [COPD], cancer, and dementia), noninvasive ventilation (NIV) use compared with invasive mechanical ventilation (IMV) was associated with lower rates of in-hospital death in acute inpatient sites (50.3% [95% CI, 49.3%-51.3%] vs 76.7% [95% CI, 75.9%-77.5%]) and hospice enrollment in the last 3 days of life (57.7% [95% CI, 56.2%-59.3%] vs 63.0% [95% CI, 60.9%-65.1%]) and with a higher rate of hospice enrollment at death (41.3% [95% CI, 40.4%-42.3%] vs 20.0% [95% CI, 19.2%-20.7%]). Decedents with CHF and COPD who received NIV had similar rates of in-hospital death, hospice enrollment at death, and hospice enrollment in the last 3 days of life compared with decedents with cancer and dementia. In-hospital death and hospice enrollment outcomes are expressed as % of hospitalizations, whereas hospice enrollment in the last 3 days of life outcome is expressed as % of hospice enrollees. Error bars represent 95% CIs.

especially among patients with evidence-based indications, such as CHF or COPD, can decrease IMV use and its complications, shorten ICU length of stay, and improve survival; however, marked heterogeneity in outcomes has suggested that the result of this therapy varies among select populations.[38]

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The strongest evidence of the benefit of NIV exists among patients with acute exacerbations of CHF or COPD.[39,40] The potential for improved outcomes in these patients likely explains the increases in NIV use and the reciprocal decreases in IMV use that we observed. However, outside of these indications (CHF and COPD), favorable outcome of NIV use in patients with hypoxemia was not established in randomized clinical trials[41] unless trials of patients with CHF or COPD were included[42]; therefore, the rapid growth in NIV use that we observed among persons with cancer and dementia is concerning. In addition, NIV necessitates a higher level of care than provided in a hospital ward because of the closer monitoring required; therefore, the recommendation is to implement NIV in an ICU or a high-dependency unit (eg, ICU step-down unit) in hospitals that have these units.[43] Other obstacles for NIV include the contraindications in patients who are agitated, are uncooperative, have substantial airway secretions, or are unable to protect their airway. Approximately 22% of the present cohort may have had NIV failure, a rate that was comparable to the one-quarter to one-third of patients who reportedly had NIV failure and required endotracheal intubation and IMV,[13,44] which has been associated with increased risk of death.[12,44]

The rapid increase in NIV use that was observed in this study was consistent with findings in previous studies of hospitalized patients,[45] with an important distinction that the present population was analyzed at the end of life. Among patients with cancer and dementia, the expansion in NIV use was lower than among patients with CHF but higher than among patients with COPD. The most troubling aspect of this finding was that this rapid expansion occurred without a reciprocal reduction in IMV use. Instead, increases in IMV use were seen among patients with cancer and dementia at the end of life. This situation occurred despite evidence that IMV use was a factor in mortality in patients with cancer and was not associated with substantial improvements in survival in patients with dementia.[46-49] However, improvements in outcomes among patients with cancer who received IMV may partly explain the expanded IMV use in this group.[50,51] The trend that we observed in increased IMV use among patients with dementia was consistent with trends in similar populations (any dementia diagnosis) as reported in previous studies from the US,[52] Canada,[53] and parts of Europe.[54] The rapid growth in NIV use among patients with cancer and dementia may represent another example of overtreatment or low-quality care (ie, care in which the risks outweigh the benefits) at the end of life.[32] Given the potential for substantial patient and family burden, costs, and health care resources associated with NIV without demonstrable benefit, and even the potential to introduce harm,[55] NIV use among patients with cancer and dementia at the end of life warrants a thorough discussion about the goals of therapy between clinicians and patients and their health care proxies.

As an alternative explanation to overtreatment, NIV use at the end of life has been suggested based on limited evidence for palliation on a trial basis to help alleviate respiratory distress and provide patients and families time to address goals.[19] Small studies among patients with advanced cancer have suggested some symptom advantages[20,21] without reductions in 90-day QOL[22]; however, findings from randomized clinical trials are nonexistent. In this study, evidence that supported the palliative intent of NIV, based on measures of end-of-life care, was lacking given that in-hospital death, hospice enrollment, and late hospice enrollment were similar for patients with cancer and dementia who received NIV compared with patients with CHF or COPD who received NIV. Furthermore, we observed worse rates of hospice enrollment among patients with cancer and dementia who received NIV than were previously reported among Medicare fee-for-service beneficiaries at the end of life,[1] which was not consistent with palliative intent. Although palliative use of NIV at the end of life may offer some value to patients with advanced cancer, based on limited evidence, inherent differences among patients with dementia deserve consideration.[56-59]

The finding that NIV use rapidly increased among patients with dementia in the last 30 days of life was striking because advanced dementia is characterized by profound memory deficits, reduced verbal abilities, and severely diminished cognition.[56] Agitation and lack of cooperation are relative contraindications to NIV initiation, and up to 22% of all patients started on NIV were expected to discontinue use for these reasons.[57] Patient-machine asynchrony or NIV asynchrony, which is characterized by air leaks, play a substantial role in NIV failure,[58] which may be exacerbated by the absence of psychomotor skills and reflexes, and the generalized rigidity that can be seen in patients with dementia. Pneumonia is common in dementia; therefore, the use of NIV can present difficulties with clearing secretions. Agitation and copious secretions are both contraindications to NIV initiation and are expected to be associated with increased NIV failure and its associated mortality. Treatment decisions for patients with advanced dementia are often dependent on their health care proxies, who overwhelmingly prefer comfort-based care[59]; therefore, patient assent and participation with therapy could be another barrier to success. Use of NIV among patients with dementia at the end of life should be considered carefully given the potential harm and low likelihood of favorable outcome associated with this therapy.

Limitations

This study has limitations. We used Medicare claims data and did not have access to clinical data, such as disease severity or patient preferences for end-of-life care; IMV or NIV may represent goal-concordant care for some decedents. Medicare claims files were only included for fee-for service beneficiaries; thus, these results may not be generalizable to other populations or patients with Medicare managed plans (ie, Medicare Advantage beneficiaries) who are less likely to be hospitalized at the end of life.[1] We relied on *ICD-9-CM* or *ICD-10-CM* diagnosis codes in Medicare claims to identify decedents with a diagnosis of CHF, COPD, cancer, or dementia; these methods are known to underdiagnose dementia in decedents.[60] We applied methods to reduce bias[25,27] from the Centers for Medicare & Medicaid Services expansion of secondary diagnoses in January 2011,[24,26] but residual confounding may exist. Among nonsurgical patients, codes for mechanical ventilation using Medicare data have high specificity and

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positive and negative predictive value, but they may have low sensitivity.[30] An increasing component of clinical practice since 2015, use of high-flow nasal cannula was unavailable; however, use of high-flow nasal cannula did not reduce intubation rates compared with NIV among older adults.[61]

Conclusions

From 2000 to 2017, the use of NIV in older adults who were hospitalized in the last 30 days of life rapidly increased. Although expanded use of NIV for CHF and COPD can be justified based on favorable outcomes, the increased use of NIV among patients with cancer and dementia, without a concomitant decrease in IMV use, suggests possible overtreatment or palliation. Given the rapid growth, the potential for patient harm and distress, and the substantial health care resources associated with NIV use, further research is warranted to evaluate its outcomes and to inform discussions about the goals of this therapy between clinicians and patients and their health care proxies so that they can make patient-centered choices.

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Invited Commentary

Noninvasive Ventilation in Seriously Ill Older Adults at the End of Life—The Evidence Remains Elusive

Anand S. Iyer, MD, MSPH

Acute respiratory failure is a frequent cause of hospitalizations among seriously ill older adults at or near the end of life. These terminal hospitalizations are often complicated by distressful respiratory symptoms and chaotic transitions that result in high-intensity, high-risk interventions such as invasive mechanical ventilation (IMV) and noninvasive ventilation (NIV), which delivers positive pressure ventilation through a mask. In this issue of *JAMA Internal Medicine*, Sullivan and colleagues[1] studied trends in IMV and NIV use among older decedents hospitalized at the end of life. The authors found a substantial increase in NIV use and a slight increase in IMV use in the past 2 decades, potentially signifying a major shift in the way that clinicians provide ventilatory support at the end of life. Although use of NIV in older adults with terminal respiratory failure may seem appealing, high-quality evidence supporting its use across serious illnesses remains elusive.

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In the current study, Sullivan and colleagues[1] analyzed patterns in NIV and IMV use over 17 years in almost 2.5 million older Medicare beneficiaries who were hospitalized in the last 30 days of life. Overall, the mean age of the cohort was 82 years, and 21.3% of Medicare beneficiaries were admitted for pneumonia or sepsis. Use of NIV during terminal hospitalizations increased 9-fold between 2000 (0.8%) and 2017 (7.1%), whereas IMV use remained relatively stable in the same period (15.0% in 2000 to 18.2% in 2017). The increase in NIV use was pronounced in older patients, with a 10-fold increase in those with congestive heart failure (CHF) and a 5-fold increase in those with chronic obstructive pulmonary disease (COPD). In addition, NIV use increased by 9-fold in patients with cancer and dementia at the end of life. Although the increase in NIV use in CHF and COPD was reciprocated by a decrease in IMV use, this reciprocal reduction was not observed in patients with cancer and dementia, who experienced a slight increase in IMV use during the study period. Furthermore, two-thirds of older adults who received NIV required an intensive care unit, suggesting that resource use remained high for older decedents at the end of life. However, as a signal for potential palliative advantage in an exploratory aim of the study, Sullivan and colleagues[1] found that older decedents who received NIV had higher frequency of hospice enrollment and lower rates of in-hospital death overall; the advantage did not appear to be as pronounced in those with cancer and dementia as in those with CHF and COPD.

Routine NIV use to deliver positive pressure ventilation grew in the 1990s owing in part to the proliferation of more comfortable masks and a push to avoid the potential complications of IMV.[2] The evidence quickly expanded to support NIV to deliver bilevel positive airway pressure in patients with acute hypercapnic respiratory failure with COPD, acute cardiogenic pulmonary edema, acute hypoxemia in those who were immunocompromised, and in select patients after surgical procedures to facilitate liberation from IMV.[3] Guidelines delineated when NIV should be avoided, including when a patient is medically unstable, is acutely agitated, is unable to cooperate with the NIV mask, cannot protect their airway, cannot clear their secretions, or has facial trauma or anatomical abnormalities that preclude proper mask fit.[4] The data from the current analysis by Sullivan and colleagues[1] seem to illustrate that clinicians were practicing beyond these guidelines and potentially broadly using NIV to provide palliative ventilatory support at the end of life across populations of seriously ill older adults.

Where the evidence for NIV use remains elusive is in older patients with de novo acute hypoxemic respiratory failure without a previous diagnosis of chronic respiratory disease (ie, pneumonia or acute respiratory distress syndrome), as in many decedents in the current analysis.[1] Evidence does not clearly support NIV use in these situations, resulting in the European Respiratory Society and the American Thoracic Society not making a recommendation for its use in these instances in a 2017 joint statement.[3] Although NIV use in younger patients with de novo acute hypoxemic respiratory failure under close monitoring and with experienced clinicians could be supported,[5] its use for this indication in older adults may confer greater risks.[6]

As a means of providing palliative ventilatory support, NIV reduces the work of breathing and dyspnea and is often initiated to avoid the need for IMV or to offer more time for families. However, the European Respiratory Society and the American Thoracic Society provided only a conditional recommendation for palliative use of NIV based on a moderate certainty of evidence in studies with small samples. For instance, in a study of older patients with a do-not-intubate status, NIV use compared with standard medical therapy in acute hypercapnic respiratory failure reduced respiratory distress,

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