Information on medications such as sedatives or analgesics were not collected in this cohort, and is a limitation of this analysis. In contrast to findings in the Sleep Heart Health Study that showed no association between mild COPD and OSA in a community cohort (2), there is a high prevalence of COPD–OSA overlap in the present COPD cohort that may limit generalizability.

Individuals with COPD and OSA have increased small airway WAF visualized by MDCT, which represents an airway phenotype not explained by poor lung function alone. This intriguing finding, though unlikely to change clinical practice, adds to existing literature on airway changes in COPD based on MDCT imaging and is worthy of further study. This evidence does not point to a new modality to screen for OSA; however, gaining an understanding of how airway measurements change with COPD and OSA is important for potential treatment with positive pressure. If OSA heightens WAF in COPD, understanding the underlying mechanisms is important, given the implications for treatment strategies and potential for improved outcomes in this high-risk population.

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Abigail L. Koch, M.D., M.H.S.*
Robert H. Brown, M.D., M.P.H.
Han Woo, Ph.D.
Alli C. Brooker, B.S., B.A.
Johns Hopkins University
Baltimore, Maryland

Laura M. Paulin, M.D., M.H.S.
Dartmouth-Hitchcock Medical Center/Geisel School of Medicine at Dartmouth
Lebanon, New Hampshire

Hartmut Schneider, M.D., Ph.D.
Alan R. Schwartz, M.D.
Gregory B. Diette, M.D.
Robert A. Wise, M.D.
Nadia N. Hansel, M.D., M.P.H.
Nirupama Putcha, M.D., M.H.S.
Johns Hopkins University
Baltimore, Maryland

ORCID IDs: 0000-0002-6871-2368 (A.L.K.); 0000-0002-8353-2349 (R.A.W.); 0000-0002-0688-1836 (N.P.).

*Corresponding author (e-mail: akoch11@jhmi.edu).

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Trends in Post-Acute Care Use after Admissions for Sepsis

To the Editor:

Sepsis, a life-threatening dysregulated host response to infection, is the most expensive condition treated in hospitals in the United States, responsible for upward of \$23 billion in hospital costs

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annually (1, 2). In-hospital sepsis mortality has been decreasing over time, leading to an increasing number of survivors, many with ongoing healthcare needs after hospital discharge (3–5). Postacute care (PAC) often meets those needs through home health services, skilled nursing facilities (SNFs), inpatient rehabilitation facilities (IRFs), and long-term care hospitals (6). PAC offers the opportunity for continued functional recovery after hospital discharge and may enable patients to ultimately return home safely. In addition, there is evidence demonstrating that rehabilitation after sepsis has the potential to improve long-term mortality (7). PAC use has proliferated in the last 30 years (8) under pressure to decrease hospital length of stay and to reduce readmissions, though more recent pressure to reduce spending with value-based purchasing has slowed or, in some cases, reversed its growth (9–11). The extent of PAC use after hospitalization for sepsis is unknown. Our objective

was to examine trends in use of different PAC settings after hospital admissions for sepsis in a large cohort of Medicare beneficiaries.

Methods

We performed a retrospective cohort study of discharges of Medicare beneficiaries who had been hospitalized for sepsis (diagnosis-related groups [DRGs] 870, 871, and 872) using 100% Medicare claims for hospitalization and PAC between 2011 and 2016, excluding those younger than 65 years of age, hospitalized fewer than 3 days, in a nursing home in 30 days before admission, enrolled in Medicare Advantage, or discharged to hospice or non-PAC institutional settings. DRGs were selected because they identify sepsis for payment purposes, including in bundled payment initiatives. We identified each discharge's first posthospitalization destination and examined trends in discharge disposition over time. We stratified our analyses by use of mechanical ventilation (based on *International Classification of Diseases, Ninth Revision* [ICD-9], and ICD-10 codes [12, 13]) and admission to the intensive care unit (ICU) (based on revenue center codes [14]). We used multivariable logistic regression, adjusting for age, sex, race, year, DRG, and 31 indicators of comorbidities measured in the year before hospitalization (using data from 2010 to 2016) based on the Hospital Readmissions Reduction Program, and then we estimated marginal predicted probabilities. The comorbidity indicators were based on diagnosis codes for the index hospitalization and any hospitalizations within the preceding 12 months, and they included diagnoses such as renal failure and malignancy. Trends were assessed using nonparametric tests with the *nptrend* package in the Stata statistical software (StataCorp) for unadjusted data and Wald tests for adjusted data. This study was approved by the institutional review board of the University of Pennsylvania.

Results

Of 1,640,433 hospital discharges after sepsis, 52.6% were discharged to home, 29.3% to SNFs, 13.1% to home with home health services, 2.5% to long-term care hospitals, and 2.5% to IRFs. Compared

with patients discharged to home, patients discharged to PAC had longer hospital lengths of stay and more frequent mechanical ventilation and ICU stays (Table 1). Among facilities, PAC length of stay was shortest at IRFs (13.4 d) and longest at SNFs (39.8 d).

In general, there was an increase in the proportion of patients discharged to home without services, from 50.8% in 2011 to 54.1% in 2016, and a decrease in the proportion using PAC ($P < 0.05$ for tests of temporal trend in each setting). The reduction in PAC use was driven by fewer discharges to SNFs, from 30.8% in 2011 to 28.3% in 2016. However, the observed decline in the use of PAC was confined to patients who did not receive care in an ICU (Figures 1 and 2). Specifically, among patients who received mechanical ventilation, discharges to PAC facilities increased from 59.0% in 2011 to 61.2% in 2016. The rates were stable among patients who received care in the ICU, with more patients discharged to home than to PAC.

Discussion

We found that patients are commonly discharged to PAC after admissions for sepsis, and although evidence suggests that rehabilitation after sepsis may confer a long-term survival benefit (7), an increasing majority of patients were discharged directly to home, with fewer patients going to SNFs. This trend did not extend, however, to patients with mechanical ventilation or ICU stays during their hospitalization, potentially indicating that care for critically ill patients may be less responsive to payment reforms or institutional sepsis initiatives. Differences in illness severity likely explain the increased use of PAC among patients who received mechanical ventilation, but not among all patients with ICU stays.

Recent research has found that patients discharged to SNFs have lower readmission rates, albeit at higher costs, than those discharged to home with home health (15). Declining SNF use has been associated with recent payment reforms, including bundled payment initiatives and accountable care organizations, and likely reflects pressure to constrain costs under these reforms (16–18). This trend is expected to continue as more health systems work to optimize care delivery while constraining costs (19). Our

Table 1. Characteristics of patients discharged from the hospital in the study cohort

	Home (n = 862,594)	Home with Home Health (n = 214,465)	SNF (n = 480,716)	IRF (n = 41,060)	LTCH (n = 41,598)
Beneficiary age, yr	77.4 (7.9)	79.7 (8.1)	81.8 (8.2)	78.6 (7.6)	78.2 (8.0)
Female sex, %	51.1	54.9	59.0	49.7	51.3
Race/ethnicity, %					
White	85.3	85.3	85.4	88.0	73.7
Black	7.7	7.8	9.3	7.1	16.4
Hispanic	2.2	2.3	1.7	1.9	4.6
Dually enrolled in Medicare and Medicaid, %	16.9	17.9	34.1	10.6	30.5
Hospital length of stay, d	4.8 (3.6)	6.4 (4.4)	7.9 (5.6)	8.9 (5.9)	10.1 (6.8)
Mechanical ventilation during hospitalization, %	3.4	4.2	7.8	15.6	26.9
ICU admission during hospitalization, %	21.1	24.4	29.9	42.0	53.7
PAC length of stay, d	—	47.5 (84.5)	39.8 (34.3)	13.4 (5.8)	25.7 (19.5)

Definition of abbreviations: ICU = intensive care unit; IRF = inpatient rehabilitation facility; LTCH = long-term care hospital; PAC = postacute care; SNF = skilled nursing facility.

Data are mean (standard deviation [SD]) unless specified otherwise.

Figure 1. Discharge to home or to home health compared with post-acute care facility over time, stratified by mechanical ventilation (MV). Home includes discharge to home with or without home health.

findings of fewer patients being discharged to SNFs is consistent with broader national trends in PAC use and raises concerns that declining SNF use could result in higher readmission rates for patients with sepsis.

Limitations of this study include those inherent in administrative data, particularly because prior studies have shown that claims-based identification of patients with sepsis increased over time, whereas the trends are stable using electronic health records (20–22). We addressed this concern with adjustments for both administrative code (DRG) and patient comorbidities, but it remains a limitation. Given the substantial differences in the characteristics of patients discharged to different settings, we cannot directly comment on how these trends might affect patient outcomes.

In conclusion, discharge patterns have changed over time for patients after admissions for sepsis, with a trend toward decreased use of PAC, particularly SNFs, but only for patients without ICU admission or mechanical ventilation. This may reflect broader trends of constraining costs, with less elasticity for sicker patients. Discharge destination is a likely target for constraining costs after

Figure 2. Discharge to home or to home health compared with post-acute care facility over time, stratified by intensive care unit (ICU) admission. Home includes discharge to home with or without home health.

hospital discharge, driving a need to understand trade-offs in discharges to different PAC settings.

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Jessica T. Lee, M.D., M.H.S.*

Mark E. Mikkelsen, M.D., M.S.C.E.

Mingyu Qi, M.S.

Perelman School of Medicine at the University of Pennsylvania
Philadelphia, Pennsylvania

Rachel M. Werner, M.D., Ph.D.

Perelman School of Medicine at the University of Pennsylvania
Philadelphia, Pennsylvania

and

Corporal Michael J. Crescenz VA Medical Center
Philadelphia, Pennsylvania

*Corresponding author (e-mail: jessica.lee4@pennmedicine.upenn.edu).

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¹²⁹Xe Gas Exchange Magnetic Resonance Imaging as a Potential Prognostic Marker for Progression of Idiopathic Pulmonary Fibrosis

To the Editor:

Idiopathic pulmonary fibrosis (IPF) is a chronic and progressive pulmonary scarring disorder in which individuals exhibit distinct clinical trajectories (1, 2). Currently, these trajectories are defined retrospectively, with disease progression being assessed by clinical symptoms and pulmonary function testing (PFT) (3–5). It is desirable to identify robust, specific, and sensitive methods to assess IPF prognosis. This has led to development of clinical, physiological, genetic, and molecular predictors (3, 4). However, these fail to capture regional disease variation, a task better suited to three-dimensional (3D) imaging. To this end, a computed tomography (CT)-based structural analysis of several radiological factors, including pulmonary vessel volume, has been associated with IPF prognosis (6).

Alternatively, 3D measurement of pulmonary function is now possible using hyperpolarized xenon-129 gas (¹²⁹Xe) magnetic resonance imaging (MRI) (7). This enables regional quantitative mapping of gas distribution in the alveolar space, its uptake in interstitial barrier tissues (“barrier uptake”), and its transfer to red blood cells (“RBC transfer”) (8). Application of ¹²⁹Xe MRI to subjects with IPF identified regional enhancement of barrier uptake and focal defects in RBC transfer (9). To further these observations, in the present hypothesis-generating pilot study, we used the heterogeneity of ¹²⁹Xe imaging features from this previously described cohort to investigate how they relate to patient-specific clinical outcomes.

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The 12 subjects with IPF, previously described (9) and diagnosed by multidisciplinary consensus criteria (2), together with 13 healthy control subjects, underwent ¹²⁹Xe MRI (Table 1). All subjects with IPF underwent baseline PFT and high-resolution CT scanning scored by a chest radiologist (10). After ¹²⁹Xe MRI, subjects received clinical care as directed by their pulmonary provider. Prospective clinical data were collected for up to 36 months, including outcomes such as lung transplant or death.

Anatomical ¹H images of the thoracic cavity and functional ¹²⁹Xe images of ventilation, barrier uptake, and RBC transfer were acquired using a 1.5-T scanner with multinuclear capabilities (GE EXCITE 15M4; GE Healthcare). Functional image voxels were binned according to thresholds derived from a healthy reference cohort (8). Our investigational biomarkers, Barrier_{High} and RBC_{Low}, were defined as the percentages of lung volume in which barrier uptake and RBC transfer were in the highest and lowest two bins, respectively. The heterogeneity of Barrier_{High} and RBC_{Low} across the IPF cohort enabled the classification of subjects into distinct groups. If Barrier_{High} or RBC_{Low} values exceeded the mean values of the healthy reference cohort by more than 2 standard deviations, they were categorized as abnormal. Using this definition, we identified three groups: group 1 with normal Barrier_{High} but abnormal RBC_{Low}, group 2 with abnormal Barrier_{High} and normal RBC_{Low}, and group 3 with combined abnormal Barrier_{High} and RBC_{Low} (Figure 1).

Differences in baseline clinical metrics among groups were tested for significance using analysis of variance (ANOVA), followed by Tukey-Kramer honestly significant difference *post hoc* tests (applied when $P < 0.1$) to evaluate differences between groups. Transplant-free survival analysis was performed between subject groups by using the Kaplan-Meier method and Wilcoxon test. Reported statistical confidence intervals (CIs) are at 95%.

Interestingly, cumulative prospective data revealed different patterns of disease progression between ¹²⁹Xe MRI-defined groups. Subjects with both abnormal barrier uptake and abnormal RBC transfer (group 3) were the only group to progress to death ($n = 2$) or require lung transplant ($n = 2$). Median transplant-free survival in group 3 (21.2 mo) was less than in group 2 (no deaths/transplants) (Wilcoxon; $P = 0.05$).