The Burden of Pneumonia in Patients Receiving Dialysis: Incidence, Case Fatality, and Costs to Medicare

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Introduction

- End-stage renal disease (ESRD) patients receiving dialysis are immnocompromised and have a high frequency of healthcare contact. Consequently, they are at elevated risk for contracting infections.[1]
- Approximately 20% of infections in ESRD patients are due to pulmonary causes, including pneumonia, and evidence suggests that episodes of pneumonia are associated with particularly high morbidity and mortality in ESRD patients.[2-4]
- Episodes of pneumonia frequently result in the need for hospitalization and increased health care utilization.
  - Costs for these services are largely borne by Medicare, the payor for the vast majority of the ESRD population, and may represent a significant economic burden in an already costly patient population.

Objective

The objective of this study was to assess the clinical and economic burden of pneumonia in a contemporary population of Medicare beneficiaries with ESRD.

Methods

Data Sources and Study Patients

- The study was a retrospective observational analysis. Study data were derived from the electronic health records of a large dialysis organization (LDO) and Medicare Part A and Part B claims available in the United States Renal Data System (USRDS) data set.
- Eligible patients were those who, between 01 January 2009 and 31 December 2011, were ≥18 years old, received dialysis at LDO facilities, and were concurrently enrolled in Medicare Parts A and B.
  - Patients were considered at-risk from the first date on which they met enrollment criteria until study end or censoring (for transplant, withdrawal from dialysis, recovery of renal function, loss of Medicare benefits, or death).

Identification of Pneumonia Episodes

- Pneumonia episodes were identified from Medicare claims considering ICD-9 diagnosis codes 480.x-486.x or 487.0 in any position on the claim. Outpatient episodes were required to be accompanied by a claim (within ±14 days) for chest x-ray.
  - Consecutive pneumonia claims were considered to represent a single pneumonia episode until a 90-day period had elapsed during which there were no additional pneumonia claims.

Outcomes

- Pneumonia incidence rates were calculated among all eligible patients.
- Case fatality rates were calculated for the subset of patients who:
  - Had at least 1 qualifying pneumonia event during the study period
  - Received dialysis at the LDO within the 90-day period prior to the pneumonia event (to ensure visibility of death date abstracted from LDO's records)
- Hospitalization rates (all cause and cardiovascular event) and Medicare costs (inpatient, outpatient, ancillary service, dialysis) were assessed in the subset of patients who:
  - Had pneumonia index date prior to 31 December 2010 (to ensure 12-month follow-up window)
  - Had a 90-day pneumonia-free period preceeding episode start date for baseline comparison

Statistical Analysis

- Hospitalization rates and costs before and after pneumonia episodes were compared using linear mixed-effects models including an indicator for sequential month and a random-effects term for the unique patient identifier.
  - Models of hospital admission rates were specified with a log link and a Poisson/negative binomial distribution. Cost models were specified with an identity link and a Gaussian distribution.
  - For all models, analyses assessed monthly estimates referent to values in month 3 prior to the index event (month -3), thus allowing for effects of pneumonia that may have manifested prior to diagnosis.

Results

Table 1. Baseline Patient Characteristics by Study Cohort

		All Eligible Patients[a] N = 231,202	Patients with Pneumonia Episodes while Dialyzing at LDO[b] N = 39,998
Age, years	mean ± SD	61.0 ± 15.3	64.6 ± 14.9
	median (p25, p75)	62 (51, 72)	66 (55, 76)
Sex	n (%)		
Male		130,255 (56.4)	21,602 (54.0)
Female		100,738 (43.6)	18,383 (46.0)
Race/Ethnicity	n (%)		
White		105,733 (45.8)	18,426 (46.1)
Black		79,503 (34.4)	13,314 (33.3)
Hispanic		29,028 (12.6)	5408 (13.5)
Asian		6634 (2.9)	1065 (2.7)
Other/unknown		10,095 (4.4)	1772 (4.4)
Dialysis vintage, months	mean ± SD	30.1 ± 39.6	44.1 ± 41.2
	median (p25, p75)	18 (1, 44)	34 (14, 62)
Body mass index, kg/m^2	mean ± SD	28.1 ± 7.3	26.9 ± 7.0
	median (p25, p75)	26.7 (22.9, 31.8)	25.6 (22.1, 30.3)
Body weight, kg	mean ± SD	81.3 ± 22.9	77.0 ± 21.4
	median (p25, p75)	77.6 (65.1, 93.5)	73.5 (62.1, 88.0)
Access type	n (%)		
Arteriovenous fistula		53,819 (23.3)	18,953 (47.4)
Arteriovenous graft		21,322 (9.2)	8302 (20.8)
Central venous catheter		37,334 (16.2)	10,588 (26.5)
Peritoneal dialysis catheter		8953 (3.9)	2122 (5.3)
Unknown		109,565 (47.4)	20 (0.1)
Etiology of end-stage renal disease	n (%)		
Diabetes		97,779 (42.3)	18,769 (46.9)
Hypertension		66,305 (28.7)	11,341 (28.4)
Other/unknown		66,909 (29.0)	9875 (24.7)
CCI score	mean ± SD	5.2 ± 1.8	5.9 ± 1.9
	median (p25, p75)	5 (4, 6)	6 (5, 7)
Hemoglobin, g/dL	mean ± SD	11.6 ±1.4	11.0 ± 1.4
	median (p25, p75)	11.6 (10.8, 12.5)	11.1 (10.1, 11.9)
Serum albumin, g/dL	mean ± SD	3.8 ± 0.5	3.6 ± 0.5
	median (p25, p75)	3.8 (3.5, 4.1)	3.7 (3.3, 4.0)
Serum phosphate, mg/dL	mean ± SD	5.2 ± 1.6	5.0 ± 1.7
	median (p25, p75)	5.0 (4.1, 5.9)	4.7 (3.9, 5.8)
Serum calcium, mg/dL	mean ± SD	8.8 ± 0.7	8.7 ± 0.8
	median (p25, p75)	8.8 (8.4, 9.2)	8.7 (8.2, 9.1)
Parathyroid hormone, ng/mL	mean ± SD	380 ± 394	361 ± 389
	median (p25, p75)	271 (176, 446)	261 (166, 419)

[a] At time of study entry.
[b] At time of first qualifying pneumonia episode.
Abbreviations: CCI, Charlson comorbidity index; LDO, large dialysis organization; p25, 25th percentile; p75, 75th percentile; SD, standard deviation.

Figure 1. Incidence and Case Fatality Rates of Pneumonia (2009-2011)

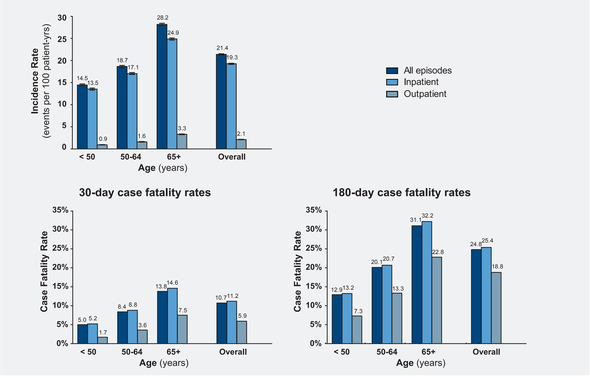
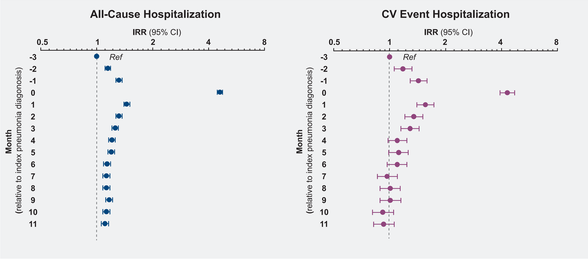


Table 2. Hospitalization Rates (All-Cause and Cardiovascular Event) and Healthcare Costs Before and After Pneumonia Episodes

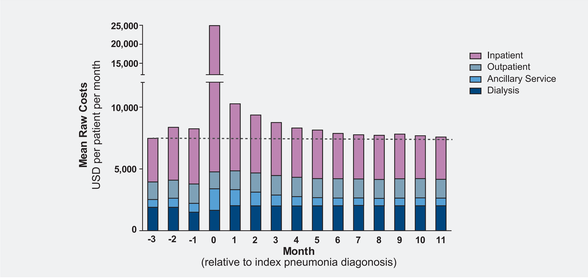
		Month (relative to index pneumonia diagnosis)														
		-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+ 10	+11
Patient-time, 100 patient-years		15.33	15.52	15.78	16.76	14.75	13.98	13.37	12.86	12.46	12.03	11.69	11.37	11.07	10.82	10.51
All-Cause Hospitalization																
Number of events		4728	5509	6457	23,936	6579	5634	5088	4627	4437	3993	3830	3725	3693	3449	3262
Raw incidence rate, events/100 patient-years		308.51	355.01	409.06	1428.54	445.96	403.05	380.64	359.87	356.23	331.89	327.58	327.56	333.49	318.79	310.38
Incidence rate ratio (95% CI)		1 (ref)	1.15 (1.11, 1.19)	1.32 (1.27, 1.37)	4.61 (4.46, 4.76)	1.45 (1.40, 1.51)	1.32 (1.27, 1.37)	1.26 (1.21, 1.31)	1.21 (1.16, 1.26)	1.20 (1.15, 1.25)	1.14 (1.09, 1.19)	1.13 (1.08, 1.18)	1.13 (1.08, 1.18)	1.17 (1.12, 1.22)	1.13 (1.08, 1.18)	1.11 (1.06, 1.16)
Cardiovascular Event Hospitalization																
Number of events		607	730	894	2856	913	747	679	556	541	509	440	439	425	377	366
Raw incidence rate, events/100 patient-years		39.61	47.04	56.64	170.45	61.89	53.44	50.80	43.24	43.44	42.31	37.63	38.60	38.38	34.85	34.82
Incidence rate ratio (95% CI)		1 (ref)	1.18 (1.06, 1.32)	1.43 (1.29, 1.59)	4.30 (3.93, 4.71)	1.56 (1.40, 1.73)	1.35 (1.21, 1.51)	1.29 (1.15, 1.44)	1.10 (0.98, 1.24)	1.12 (0.99, 1.26)	1.10 (0.97, 1.24)	0.97 (0.86, 1.10)	1.01 (0.89, 1.14)	1.01 (0.89, 1.15)	0.92 (0.81, 1.05)	0.93 (0.82, 1.06)
Total Medicare Costs																
Total Medicare costs, USD	mean ± SD	7470 ± 12,519	8367 ± 13,186	8245 ± 11,536	24,893 ± 29,875	10,269 ± 14,497	9367 ± 13,811	8757 ± 12,466	8313 ± 12,184	8145 ± 11,651	7871 ± 11,918	7761 ± 11,297	7725 ± 11,408	7817 ± 11,562	7690 ± 10,920	7583 ± 10,982
	median	3510	3732	3703	16,979	4972	4563	4171	3951	3894	3823	3694	3675	3677	3641	3588
	p25, p75	2278, 8040	2354, 9437	2105, 10,481	10,765, 30,082	2701, 13,106	2598, 11,805	2521, 10,827	2484, 10,115	2510, 9618	2472, 8996	2474, 8901	2461, 8842	2490, 8818	2469, 8774	2459, 8510
Modelled cost difference, USD (95% CI)		0 (ref)	+330 (+251, +409)	+381 (+302, +460)	+10,976 (+10,717, +11,235)	+1292 (+1198, +1386)	+1087 (+995, +1180)	+871 (+780, +962)	+742 (+652, +832)	+752 (+661, +843)	+634 (+544, +724)	+664 (+572, +756)	+643 (+550, +735)	+712 (+618, +806)	+714 (+619, +809)	+694 (+598, +790)

Figure 2. All-Cause and Cardiovascular Event Hospitalization in the Peripneumonia Period



Abbreviations: CI, confidence interval; CV, cardiovascular; IRR, incidence rate ratio

Figure 3. Component Medicare Costs in the Peripneunomia Period



Summary and Conclusions

- The overall incidence rate of pneumonia for the study period was 21.4 events per 100 patient-years; the majority of pneumonia episodes (~90%) required inpatient treatment.
- The 30-day and 180-day case fatality rates for pneumonia episodes overall were 10.7% and 24.8%, respectively. Case fatality rates increased with patient age and were higher for episodes that required inpatient care than for those treated in the outpatient setting.
- Rates of all-cause hospitalization were 4.6-fold higher in the month of index pneumonia episode compared to baseline month -3 and remained persistently elevated through 1-year follow up. Rates of hospitalization for acute cardiovascular events also increased over 4-fold in the month of pneumonia diagnosis and remained persistently elevated for the first 6 months of follow up.
- The total incremental cost to Medicare accumulated to approximately $20,000 over the year following a pneumonia episode.
  - Incremental costs were largely driven by high inpatient costs incurred within the 3 months following diagnosis. However, total costs remained elevated over baseline month -3 throughout the 1-year follow-up period.

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