

Supplementary Online Content

Blumenthal DM, Olenski AR, Tsugawa Y, Jena AB. Association between treatment by locum tenens internal medicine physicians and 30-day mortality among hospitalized Medicare beneficiaries. *JAMA*. Published December 5, 2017. doi:10.1001/jama.2017.17925

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This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Characteristics of Hospitalized Patients After Adjustment for Hospital Fixed Effects

	Hospitalized patients treated by non-locum tenens physicians ^a (No. of hospitalizations = 1,780,398)	Hospitalized patients treated by locum tenens physicians ^b (No. of hospitalizations = 38,475)	p-value
Mean age, year (sd)	74.8 (74.77, 74.78)	74.4 (74.10, 74.66)	.006
Female, %	59.2 (59.19, 59.21)	58.6 (58.10, 59.14)	.03
White, %	83.4 (83.40, 83.43)	83.6 (83.02, 84.19)	.54
Dual Eligibility ^c , %	26.9 (26.92, 26.96)	27.8 (26.87, 28.66)	.08
Mean Elixhauser Index ^d (sd)	5.7 (5.71, 5.72)	5.7 (5.67, 5.77)	.87
Elixhauser conditions^e, %			
<i>Congestive Heart Failure</i>	36.2 (36.19, 36.21)	36.1 (35.50, 36.72)	.78
<i>Cardiac Arrhythmias</i>	44.1 (44.10, 44.13)	44.1 (43.37, 44.80)	.95
<i>Valvular Disease</i>	16.0 (16.04, 16.06)	15.1 (14.65, 15.50)	<.001
<i>Pulmonary Circulation Disorders</i>	13.5 (13.49, 13.51)	13.5 (13.10, 13.92)	.97
<i>Peripheral Vascular Disorders</i>	16.3 (16.25, 16.27)	15.5 (15.06, 16.03)	.005
<i>Hypertension, Uncomplicated</i>	63.5 (63.44, 63.47)	63.3 (62.76, 63.91)	.70
<i>Other Neurological Disorders</i>	20.9 (20.85, 20.87)	21.8 (21.26, 22.28)	<.001
<i>Chronic Pulmonary Disease</i>	43.0 (42.96, 42.99)	42.4 (41.71, 43.03)	.08
<i>Diabetes, Uncomplicated</i>	34.7 (34.69, 34.71)	34.5 (33.91, 35.07)	.50
<i>Diabetes, Complicated</i>	13.0 (12.97, 12.99)	12.8 (12.39, 13.25)	.46
<i>Hypothyroidism</i>	23.8 (23.79, 23.82)	23.8 (23.19, 24.32)	.85
<i>Renal Failure</i>	31.4 (31.39, 31.42)	31.3 (30.69, 31.88)	.70
<i>Liver Disease</i>	6.1 (6.07, 6.09)	6.2 (5.93, 6.54)	.34
<i>Metastatic Cancer</i>	4.7 (4.67, 4.68)	4.7 (4.46, 4.99)	.74
<i>Solid Tumor Without Metastasis</i>	9.2 (9.16, 9.17)	9.2 (8.89, 9.57)	.72
<i>Rheumatoid Arthritis/Collagen Vascular</i>	6.3 (6.29, 6.30)	6.3 (6.05, 6.58)	.91
<i>Obesity</i>	16.7 (16.71, 16.73)	16.7 (16.16, 17.15)	.81
<i>Depression</i>	24.7 (24.72, 24.75)	24.5 (23.90, 25.06)	.40
<i>Hypertension, Complicated</i>	30.8 (30.78, 30.81)	30.2 (29.60, 30.89)	.10

Notes: This table presents differences in characteristics of hospitalized patients treated by locum and non-locum physicians, adjusted for hospital-level fixed effects. This analysis of the balance of patient characteristics mimics our empirical strategy of comparing hospitalized patients treated by locum vs non-locum physicians within the same hospital. P-values were computed using robust standard errors clustered at the hospital-level.

^aLocum tenens provided temporary coverage for 4,123 non-locum tenens physicians during the study period.

^bIncludes patients treated by 44,520 non-locum tenens physicians. ^cDual Eligibility refers to patients who are eligible for Medicare and Medicaid. ^dThe Elixhauser Comorbidity Index is a set of 31 distinct clinical comorbidities that can be reliably and accurately identified using large administrative inpatient datasets. The Elixhauser Index ranges from 0-31 and each comorbidity equals one Index point. Higher Elixhauser Indices indicate the presence of greater numbers of comorbidities and are associated with longer length of stay, higher hospital charges for care, and higher patient mortality.¹⁷ ^eElixhauser comorbidities displayed in this Table were chosen based on their prevalence and their likelihood

of being associated with common indications for inpatient treatment by general internal medicine physicians. The following Elixhauser conditions were excluded from the Table for simplicity: Paralysis, Peptic Ulcer Disease, AIDS/HIV, Lymphoma, Coagulopathy, Weight Loss, Fluid and Electrolyte Disorders, Blood Loss Anemia, Deficiency Anemia, Alcohol Abuse, Drug Abuse, and Psychoses.

eTable 2. Yearly Unadjusted and Adjusted 30-Day Mortality Among Hospitalized Patients Treated by Locum and Non-Locum Tenens Physicians, Overall and by Tercile of Locum Tenens Intensity

	2009	2010	2011	2012	2013	2014
Overall 30-Day Mortality, %						
<i>Unadjusted</i>						
Non-Locum Tenens	8.63	8.42	8.53	8.74	8.90	8.68
Locum Tenens	9.10	9.56	8.35	9.21	8.90	9.46
P-value for Difference	.15	.15	.80	.57	.94	.32
<i>Adjusted^a</i>						
Non-Locum Tenens	8.00	7.96	8.65	8.78	8.94	8.90
Locum Tenens	8.36	8.71	8.34	9.11	8.80	9.36
P-value for Difference	.33	.12	.22	.12	.67	.74
30-Day Mortality in Lower Tercile of Locum Intensity, %^b						
<i>Unadjusted</i>						
Non-Locum Tenens	8.57	8.23	8.30	8.56	8.71	8.63
Locum Tenens	10.55	12.61	13.48	15.08	6.69	11.48
P-value for Difference	.10	.03	.01	<.001	.30	.17
<i>Adjusted^a</i>						
Non-Locum Tenens	7.93	7.75	8.42	8.62	8.74	8.81
Locum Tenens	11.56	10.40	13.47	15.59	7.34	10.58
P-value for Difference	.06	.21	.01	<.001	.54	.48
30-Day Mortality in Middle Tercile of Locum Intensity, %^b						
<i>Unadjusted</i>						
Non-Locum Tenens	8.68	8.58	8.78	9.01	8.96	8.63
Locum Tenens	8.92	8.75	8.83	9.11	8.76	8.56
P-value for Difference	.75	.61	.68	.79	.60	.52
<i>Adjusted^a</i>						
Non-Locum Tenens	7.97	8.09	8.88	9.03	9.05	8.93
Locum Tenens	8.11	7.70	9.03	9.03	8.72	8.71
P-value for Difference	.82	.64	.73	.81	.56	.47
30-Day Mortality in Upper Tercile of Locum Intensity, %^b						
<i>Unadjusted</i>						
Non-Locum Tenens	8.69	8.62	8.72	8.80	9.30	8.86
Locum Tenens	9.00	9.60	8.06	9.03	9.02	9.61
P-value for Difference	.27	.10	.08	.39	.40	.16
<i>Adjusted^a</i>						
Non-Locum Tenens	8.20	8.24	8.87	8.81	9.27	9.06
Locum Tenens	8.34	9.12	8.20	9.12	9.10	9.71
P-value for Difference	.55	.12	.09	.36	.44	.18

Notes: This table presents yearly unadjusted and adjusted estimates of 30-day mortality among hospitalized Medicare patients treated by locum tenens and non-locum tenens physicians overall, and among patients admitted to hospitals in the lower, middle, and upper terciles in terms of their locum tenens intensity, respectively. ^aAll estimates were adjusted for patient age, sex, race, month of year of admission, day of week of admission, Medicaid eligibility, indicators for 31 Elixhauser conditions, and the admitting Major Diagnostic Category (MDC), and hospital fixed effects, with robust standard errors clustered at the hospital-level.

^bAmong hospitals with any locum tenens use, we computed the percentage of a hospital's patients treated by a locum tenens physician, and divided hospitals into terciles along that metric. The lower tercile hospitals involved locum tenens physicians in 0.01% to < 0.45% of their admissions, the middle tercile in 0.45% to < 2.5% of admissions, and the upper tercile in at least 2.5% of all admissions.

eTable 3. Characteristics of Hospitalized Patients After Adjustment for Physician Fixed Effects

	Hospitalized patients treated by non-locum tenens physicians ^a (No. of hospitalizations = 1,780,398)	Hospitalized patients treated by locum tenens physicians ^b (No. of hospitalizations= 38,475)	p-value
Mean age, year (sd)	74.8 (74.75, 74.79)	74.7 (74.56, 74.92)	.77
Female, %	59.2 (59.15, 59.23)	59.0 (58.45, 59.59)	.58
White, %	83.4 (83.33, 83.51)	83.6 (83.09, 84.02)	.56
Dual Eligibility ^c , %	26.9 (26.86, 27.02)	27.9 (27.25, 28.52)	.004
Mean Elixhauser Index ^d (sd)	5.7 (5.71, 5.72)	5.8 (5.77, 5.86)	<.001
Elixhauser conditions^e, %			
<i>Congestive Heart Failure</i>	36.2 (36.12, 36.24)	37.2 (36.48, 37.82)	.005
<i>Cardiac Arrhythmias</i>	44.1 (44.03, 44.14)	45.4 (44.66, 46.11)	<.001
<i>Valvular Disease</i>	16.0 (15.99, 16.08)	15.8 (15.40, 16.30)	.44
<i>Pulmonary Circulation Disorders</i>	13.5 (13.45, 13.52)	14.2 (13.73, 14.62)	.003
<i>Peripheral Vascular Disorders</i>	16.2 (16.21, 16.29)	15.9 (15.37, 16.33)	.11
<i>Hypertension, Uncomplicated</i>	63.5 (63.40, 63.50)	63.3 (62.68, 63.99)	.73
<i>Other Neurological Disorders</i>	20.9 (20.82, 20.91)	21.7 (21.18, 22.24)	.002
<i>Chronic Pulmonary Disease</i>	43.0 (42.90, 43.00)	43.4 (42.75, 44.12)	.17
<i>Diabetes, Uncomplicated</i>	34.7 (34.64, 34.73)	35.1 (34.48, 35.65)	.21
<i>Diabetes, Complicated</i>	13.0 (12.94, 13.02)	13.0 (12.59, 13.43)	.90
<i>Hypothyroidism</i>	23.8 (23.76, 23.83)	24.2 (23.67, 24.76)	.14
<i>Renal Failure</i>	31.4 (31.34, 31.45)	31.8 (31.18, 32.49)	.19
<i>Liver Disease</i>	6.1 (6.05, 6.10)	6.3 (6.03, 6.65)	.10
<i>Metastatic Cancer</i>	4.7 (4.66, 4.70)	4.7 (4.39, 4.92)	.87
<i>Solid Tumor Without Metastasis</i>	9.2 (9.14, 9.19)	9.3 (8.93, 9.66)	.51
<i>Rheumatoid Arthritis/Collagen Vascular</i>	6.3 (6.28, 6.32)	6.3 (5.99, 6.58)	.94
<i>Obesity</i>	16.7 (16.67, 16.76)	16.9 (16.37, 17.35)	.57
<i>Depression</i>	24.7 (24.67, 24.76)	25.3 (24.76, 25.79)	.04
<i>Hypertension, Complicated</i>	30.8 (30.72, 30.83)	31.1 (30.47, 31.77)	.31

Notes: This table presents differences in characteristics of hospitalized patients between hospitalizations in which care was provided by a locum versus non-locum physician *among those physicians who ever used locum care*, adjusted for physician-level fixed effects. The purpose of this analysis is to demonstrate that among those physicians who ever used locums care as a substitute for their own care, those hospitalized patients treated by a locum physician had similar characteristics to hospitalized patients treated by the original physician who was replaced by a locum tenens. This analysis addresses the concern that, among those physicians who use locum care as a substitute for their own care, patients who are hospitalized while the physician is away (and therefore cared for by a locum tenens) may be unobservably sicker or healthier than patients who are hospitalized when the physician is not being covered by a locum tenens. P-values were computed using robust standard errors clustered at the hospital-level. ^aLocum tenens provided temporary coverage for 4,123 non-locum tenens physicians during the study period. ^bIncludes patients treated by 44,520 non-locum tenens physicians. ^cDual Eligibility refers to patients who are eligible for Medicare and Medicaid. ^dThe Elixhauser Comorbidity Index is a set of 31 distinct clinical comorbidities that can be reliably and accurately identified using large administrative inpatient datasets. The Elixhauser Index ranges from 0-31 and each comorbidity equals one Index point. Higher

Elixhauser Indices indicate the presence of greater numbers of comorbidities and are associated with longer length of stay, higher hospital charges for care, and higher patient mortality.¹⁷ Elixhauser comorbidities displayed in this Table were chosen based on their prevalence and their likelihood of being associated with common indications for inpatient treatment by general internal medicine physicians. The following Elixhauser conditions were excluded from the Table for simplicity: Paralysis, Peptic Ulcer Disease, AIDS/HIV, Lymphoma, Coagulopathy, Weight Loss, Fluid and Electrolyte Disorders, Blood Loss Anemia, Deficiency Anemia, Alcohol Abuse, Drug Abuse, and Psychoses.

eTable 4. Sensitivity Analyses Evaluating Adjustment for Physician Fixed Effects and Use of a Linear Probability Model^a

Analysis Type	Number of Hospitalized Patients Treated by Locum and Non-Locum Tenens		Adjusted Mean 30-day Mortality Rates Among Hospitalized Patients Treated by Locum and Non-Locum Tenens		
	No. of Non-Locum Tenens Hospitalizations ^b	No. of Locum Tenens Hospitalizations ^c	Non-Locum Tenens Mortality, % (95% CI)	Locum Tenens Mortality, % (95% CI)	Difference (95% CI)
Inclusion of physician fixed effects in statistical model ^d	1,780,398	38,475	9.15 (9.14, 9.16)	9.41 (9.05, 9.77)	0.26 (-0.11, 0.63)
Analysis with linear probability model	1,780,398	38,475	8.70 (8.69, 8.70)	8.85 (8.53, 9.16)	0.15 (-0.17, 0.48)

Notes: ^a30-day mortality rates were adjusted for patient age, sex, race, month of year of admission, day of week of admission, Medicaid eligibility, indicators for 31 Elixhauser conditions, the admitting Major Diagnostic Category (MDC), and hospital fixed effects, with robust standard errors clustered at the hospital-level. ^b Locum tenens provided temporary coverage for 4,123 non-locum tenens physicians during the study period. ^c Includes patients treated by 44,520 non-locum tenens physicians. ^d This sensitivity analysis evaluated how adding a physician-level fixed effects variable to the baseline multivariable adjustment model impacted adjusted 30-day mortality rates for patients treated by locum tenens physicians versus non-locum tenens physicians.