

Online Supplementary Material for:

The effect of integration of hospitals and post-acute care providers on Medicare payment and patient outcomes

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Appendix Table 1. Twenty-five most common DRGs in each PAC setting and percent of patients in each DRG among all patients going to each PAC setting.

SNF	%
Major joint replacement or reattachment of lower extremity (544)	7.0
Heart failure & shock (127)	5.2
Septicemia w/o mechanical ventilation 96+ hours (576)	4.2
Intracranial hemorrhage or cerebral infarction (14)	3.1
Renal failure (316)	3.1
Simple pneumonia & pleurisy (89)	2.9
Chronic obstructive pulmonary disease (88)	2.3
Kidney & urinary tract infections (320)	2.3
Hip & femur procedures except major joint (210)	1.9
Kidney & urinary tract infections (321)	1.9
Hip & femur procedures except major joint (211)	1.9
Respiratory infections & inflammations (79)	1.8
Degenerative nervous system disorders (12)	1.6
Nutritional & misc metabolic disorders (296)	1.5
Medical back problems (243)	1.4
Simple pneumonia & pleurisy (90)	1.4
Acute myocardial infarction, discharged alive (121)	1.3
Nutritional & misc metabolic disorders (297)	1.2
G.I. hemorrhage (174)	1.1
Fractures of hip & pelvis (236)	1.1
Pulmonary edema & respiratory failure (87)	1.0
Syncope & collapse (141)	1.0
Esophagitis, gastroenteritis & misc digest disorders (182)	0.9
Cardiac arrhythmia & conduction disorders (138)	0.9
Septicemia age>17 (416)	0.9
HHA	%
Major joint replacement or reattachment of lower extremity (544)	10.0
Heart failure & shock (127)	6.4
Chronic obstructive pulmonary disease (88)	3.8
Simple pneumonia & pleurisy (89)	2.5
Septicemia w/o mechanical ventilation 96+ hours (576)	2.1
Renal failure (316)	2.1
Intracranial hemorrhage or cerebral infarction (14)	2.0
Simple pneumonia & pleurisy (90)	1.4
Syncope & collapse (141)	1.3
Kidney & urinary tract infections (321)	1.2
Cardiac arrhythmia & conduction disorders (139)	1.1

Cardiac arrhythmia & conduction disorders (138)	1.1
Acute myocardial infarction, discharged alive (121)	1.1
Kidney & urinary tract infections (320)	1.1
Cellulitis (278)	1.1
Cardiac valve & other major cardiothoracic proc w/o card catheterization (105)	1.0
Major joint & limb reattachment procedures of lower extremity (209)	1.0
Nutritional & misc metabolic disorders (297)	0.9
Pulmonary edema & respiratory failure (87)	0.9
Nutritional & misc metabolic disorders (296)	0.9
Esophagitis, gastroenteritis & misc digest disorders (183)	0.9
Medical back problems (243)	0.9
G.I. hemorrhage (174)	0.9
Transient ischemia (524)	0.8
Esophagitis, gastroenteritis & misc digest disorders (182)	0.8

Appendix Table 2. Person-level characteristics by differential distance between nearest integrated and nearest non-integrated hospital (for integration with each PAC type)

	Based on differential distance to closest hospital <u>vertically</u> <u>integrated</u> with PAC				Based on differential distance to closest hospital <u>informally</u> <u>integrated</u> with PAC			
	<u>SNF</u>		<u>HHA</u>		<u>SNF</u>		<u>HHA</u>	
	< median	>= median	< median	>= median	< median	>= median	< median	>= median
Age	82.6	82.6	79.4	79.1	82.5	82.7	79.7	78.9
Female	66.7%	67.0%	62.4%	62.2%	65.2%	65.8%	62.2%	62.4%
Race								
-White	84.0%	89.3%	87.0%	86.5%	84.5%	87.8%	86.6%	86.8%
-Black	11.0%	8.0%	8.6%	8.8%	10.4%	9.5%	8.9%	8.6%
-Other	1.1%	0.6%	1.1%	1.0%	1.1%	0.6%	1.2%	1.0%
-Asian	1.9%	0.5%	1.3%	1.1%	1.7%	0.7%	1.3%	1.1%
-Hispanic	1.5%	1.1%	1.4%	2.0%	1.8%	0.9%	1.5%	2.0%
-North American Native	0.2%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.4%
-Unknown	0.3%	0.2%	0.3%	0.3%	0.2%	0.2%	0.3%	0.3%
Comorbidities, n(%)								
-Severe Infection	1.4%	1.3%	0.9%	1.0%	1.4%	1.3%	1.0%	1.0%
-Other Infectious Disease & Pneumonias	30.9%	31.3%	20.1%	20.5%	31.4%	30.8%	20.5%	20.1%
-Metastatic Cancer/Acute Leukemia	2.5%	2.3%	2.4%	2.4%	2.5%	2.4%	2.5%	2.3%
-Severe Cancer	4.1%	4.0%	4.3%	4.3%	4.2%	4.1%	4.4%	4.2%
-Other Cancers	5.6%	5.2%	4.9%	4.8%	5.5%	5.3%	5.1%	4.7%
-Diabetes Mellitus	30.9%	31.1%	30.0%	30.3%	31.4%	30.7%	30.2%	30.1%
-Protein-calorie Malnutrition	13.2%	12.8%	5.5%	6.1%	13.4%	12.7%	5.6%	6.1%
-End-stage Liver Disease	1.2%	1.1%	0.9%	0.9%	1.2%	1.1%	0.9%	0.9%
-Severe Hematological Disorders	1.5%	1.6%	1.4%	1.5%	1.5%	1.6%	1.4%	1.4%
-Alcohol Abuse	2.5%	2.5%	1.1%	1.0%	2.4%	2.6%	1.1%	1.0%
-Psychiatric Comorbidity	24.3%	26.0%	17.4%	18.5%	27.7%	25.6%	17.8%	18.0%
-Hemiplegia, paraplegia, paralysis	6.3%	5.9%	2.9%	2.9%	6.4%	5.9%	3.0%	2.8%
-Seizure Disorders	5.3%	5.0%	2.7%	2.7%	5.2%	5.1%	2.7%	2.6%
-Congestive heart failure	26.5%	26.2%	21.2%	20.4%	26.4%	26.2%	21.7%	20.0%
-Coronary atherosclerosis or angina	51.4%	52.3%	47.2%	47.4%	51.8%	51.2%	48.3%	46.4%
-Specified arrhythmias	24.6%	24.5%	19.6%	19.2%	24.5%	24.7%	20.4%	18.4%
-Chronic obstructive pulmonary disease	29.9%	30.2%	27.9%	27.7%	30.0%	30.1%	28.1%	27.6%
-Other chronic lung disorders	3.8%	3.8%	3.9%	4.0%	3.7%	3.8%	4.1%	3.8%

-Dialysis	1.5%	1.3%	8.8%	0.9%	1.5%	1.4%	0.9%	0.9%
-Decubitus Ulcer or Chronic Skin Ulcer	7.6%	6.9%	3.5%	3.5%	7.4%	7.1%	3.7%	3.2%
-Septicemia/Shock	7.2%	6.6%	3.0%	3.3%	7.2%	6.6%	3.2%	3.2%
-Disorders of fluid, electrolytes	29.6%	30.1%	19.1%	19.9%	30.0%	29.7%	19.7%	19.3%
-Iron Deficiency or other anemias	44.0%	45.3%	35.4%	37.4%	45.1%	44.2%	36.1%	36.7%
-Cardiorespiratory Failure or Shock	10.4%	10.8%	7.2%	7.9%	10.7%	10.6%	7.4%	7.7%
-Acute Renal Failure	21.0%	21.7%	14.4%	15.1%	21.3%	21.4%	15.1%	14.4%
-Pancreatic Disease	1.8%	1.7%	1.6%	1.6%	1.7%	1.7%	1.7%	1.5%
-Rheumatoid Arthritis	4.1%	4.4%	4.2%	4.4%	4.1%	4.3%	4.3%	4.3%
-Respirator Dependence/Tracheostomy	0.3%	0.3%	0.2%	0.1%	0.3%	0.3%	0.2%	0.1%
-Transplants	0.2%	0.2%	0.3%	0.3%	0.2%	0.2%	0.3%	0.3%
-Coagulation /Hematologic Disorders	4.4%	4.4%	3.1%	3.3%	4.5%	4.4%	3.3%	3.1%
-Hip Fracture/Dislocation	4.6%	4.8%	1.5%	1.5%	4.7%	4.6%	1.5%	1.6%
Six most common reasons for hospitalization, n(%)								
-Total knee or hip replacement	12.8%	13.8%	20.7%	23.1%	13.2%	13.4%	19.7%	24.1%
-Sepsis	8.0%	8.1%	4.2%	4.8%	8.3%	7.8%	4.3%	4.7%
-Congestive heart failure	9.8%	9.8%	14.0%	13.0%	9.7%	9.9%	14.3%	12.7%
-Urinary tract infection	7.8%	8.2%	4.6%	4.8%	8.0%	7.9%	4.6%	4.8%
-Hip Fracture	8.3%	8.7%	0%	0%	8.5%	8.5%	0%	0%
-Pneumonia	8.1%	8.2%	8.4%	7.9%	8.2%	8.1%	8.3%	8.0%

Appendix Table 3. Robustness checks on Medicare payment outcomes

		SNF			HHA		
		Total payment	Hospital payment	PAC payment	Total payment	Hospital payment	PAC payment
<u>Cohort</u>							
Primary specification	Vertical integration	2423.5***	149.6	2273.9***	-303.2**	-261.5**	-41.7
		(4.52)	(0.57)	(5.16)	(-2.35)	(-2.03)	(-0.94)
	N of discharges	2,651,748	2,651,748	2,651,748	1,318,577	1,318,577	1,318,577
	N of provider pairs	87,440	87,440	87,440	56,093	56,093	56,093
Vertically integrated but not informally integrated	Vertically integrated	3824.3***	320.7	3503.6***	-361.6**	-257.5	-104.0
		(5.31)	(0.90)	(5.86)	(-2.02)	(-1.37)	(-1.44)
	N of discharges	2,472,970	2,472,970	2,472,970	10,057,761	10,057,762	10,057,763
	N of provider pairs	86,999	86,999	86,999	55,590	55,590	55,590
Most competitive markets	Vertically integrated	2616.3***	186.8	2429.5***	-305.5**	-266.2*	-39.3
		(4.56)	(0.67)	(5.14)	(-2.25)	(-1.95)	(-0.85)
	N of discharges	2,502,313	2,502,313	2,502,313	1,244,192	1,244,192	1,244,192
	N of provider pairs	84,736	84,736	84,736	54,405	54,405	54,405
Balanced panel of hospital-PAC pairs	Vertically integrated	2938.3***	309.1	2629.2***	-261.2**	-214.1	-47.1
		(4.27)	(0.94)	(4.63)	(-2.01)	(-1.63)	(-1.06)
	N of discharges	2,212,188	2,212,188	2,212,188	1,052,936	1,052,936	1,052,936
	N of provider pairs	28,715	28,715	28,715	11,828	11,828	11,828
All Medicare payments within 60 days as dependent variable	Vertically integrated	2494.6***			-372.9**		
		(4.32)			(-2.06)		
	N of discharges	2,651,748			1,318,577		

N of provider pairs 87,440 56,093

Informal integration

		SNF			HHA		
<u>Cohort</u>		Total payment	Hospital payment	PAC payment	Total payment	Hospital payment	PAC payment
Primary specification	Informally integrated	-204.4	-326.3***	121.8	32.4	47.1	-14.71
		(-1.23)	(-3.53)	(0.86)	(0.54)	(0.92)	(-0.63)
	N of discharges	2,651,748	2,651,748	2,651,748	1,318,577	1,318,577	1,318,577
	N of provider pairs	87,440	87,440	87,440	56,093	56,093	56,093
Vertically integrated but not informally integrated	Informally integrated	-268.2	-411.2***	142.9	4.1	60.9	-56.9
		(-1.22)	(-3.71)	(0.75)	(0.04)	(0.71)	(-1.46)
	N of discharges	2,387,101	2,387,101	2,387,101	1051948	1051948	1051948
	N of provider pairs	86,895	86,895	86,895	55504	55504	55504
Most competitive markets	Informally integrated	-315.9*	-359.2***	43.31	58.5	76.0	-17.5
		(-1.78)	(-3.62)	(0.29)	(0.92)	(1.39)	(-0.70)
	N of discharges	2,502,313	2,502,313	2,502,313	1,244,192	1,244,192	1,244,192
	N of provider pairs	84,736	84,736	84,736	54,405	54,405	54,405
Balanced panel of hospital-PAC pairs	Informally integrated	-363.0*	-399.8***	36.80	33.9	61.8	-28.0
		(-1.92)	(-3.78)	(0.23)	(0.56)	(1.19)	(-1.17)
	N of discharges	2,212,188	2,212,188	2,212,188	1,052,936	1,052,936	1,052,936
	N of provider pairs	28,715	28,715	28,715	11,828	11,828	11,828
Excluding small hospitals	Informally integrated	-126.5	-309.1***	182.6	-123.4*	-71.6	-51.8**

		(-0.77)	(-2.71)	(1.39)	(-1.91)	(-1.21)	(-2.06)
	N of discharges	2,453,016	2,453,016	2,453,016	952,926	952,926	952,926
	N of provider pairs	83,457	83,457	83,457	48,724	48,724	48,724
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Alternative definition of informal integration	Informally integrated	-240.6	-198.1**	-42.5	-128.3*	24.0	-152.4***
		(-1.58)	(-2.31)	(-0.33)	(-1.82)	(0.36)	(-5.62)
	N of discharges	2,650,900	2,650,900	2,650,900	1,207,015	1,207,015	1,207,015
	N of provider pairs	87,432	87,432	87,432	55,140	55,140	55,140
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All Medicare payments within 60 days as dependent variable	Informally integrated	-182.9			19.8		
		(-0.91)			(0.20)		
	N of discharges	2,651,748			1,318,577		
	N of provider pairs	87,440			56,093		

Note: Regression includes all the covariates reported in Table 3, a full set of DRG controls, hospital-PAC-pair fixed effects, and year fixed effects.

Robust t-statistics in parentheses

* p<0.10 ** p<0.05 ***p<0.01

Appendix Table 4. Robustness checks on length of stay outcomes

Vertical integration

		SNF			HHA		
<u>Cohort</u>		Total LOS	Hospital LOS	PAC LOS	Total LOS	Hospital LOS	PAC LOS
Primary specification	Vertical integration	3.9*** (3.42)	-0.7*** (-2.70)	4.6*** (4.13)	-1.1* (-1.95)	-0.1 (-1.28)	-1.0* (-1.78)
	N of discharges	2,651,748	2,651,748	2,651,748	1,318,577	1,318,577	1,318,577
	N of provider pairs	87,440	87,440	87,440	56,093	56,093	56,093
Vertically integrated but not informally integrated	Vertically integrated	5.2*** (3.38)	-1.0*** (-2.72)	6.2*** (4.11)	-1.3 (-1.57)	-0.03 (-0.22)	-1.3 (-1.57)
	N of discharges	2,472,970	2,472,970	2,472,970	1,033,033	1,033,033	1,033,033
	N of provider pairs	86,999	86,999	86,999	55,590	55,590	55,590
Most competitive markets	Vertically integrated	4.5*** (3.73)	-0.8*** (-2.76)	5.4*** (4.45)	-1.1* (-1.88)	-0.1 (-1.56)	-0.9* (-1.67)
	N of discharges	2,502,313	2,502,313	2,502,313	1,244,192	1,244,192	1,244,192
	N of provider pairs	84,736	84,736	84,736	54,405	54,405	54,405
Balanced panel of hospital-PAC pairs	Vertically integrated	4.6*** (3.10)	-0.7** (-2.05)	5.3*** (3.64)	-1.3** (-2.32)	-0.1* (-1.77)	-1.1** (-2.08)
	N of discharges	2,212,188	2,212,188	2,212,188	1,052,936	1,052,936	1,052,936
	N of provider pairs	28,715	28,715	28,715	11,828	11,828	11,828
Using negative binomial model	Vertically integrated	0.4*** (16.46)	-0.3*** (-8.98)	0.4*** (14.55)	-0.04*** (-4.79)	-0.02* (-1.87)	-0.04*** (-4.26)
	N of discharges	2,626,214	2,626,214	2,626,214	1,299,442	1,299,442	1,299,442

Informal integration

		SNF			HHA		
<u>Cohort</u>		Total LOS	Hospital LOS	PAC LOS	Total LOS	Hospital LOS	PAC LOS
Primary specification	Informally integrated	-0.8** (-2.09)	-0.1 (-1.48)	-0.6* (-1.78)	-0.4 (-1.43)	-0.02 (-0.48)	-0.4 (-1.35)
	N of discharges	2,651,748	2,651,748	2,651,748	1,318,577	1,318,577	1,318,577
	N of provider pairs	87,440	87,440	87,440	56,093	56,093	56,093
Vertically integrated but not informally integrated	Informally integrated	-0.9* (-1.72)	-0.2 (-1.49)	-0.7 (-1.37)	-1.4*** (-3.01)	-0.03 (-0.31)	-1.3*** (-2.96)
	N of discharges	2,387,101	2,387,101	2,387,101	1,051,948	1,051,948	1,051,948
	N of provider pairs	86,895	86,895	86,895	55,504	55,504	55,504
Most competitive markets	Informally integrated	-0.6 (-1.59)	-0.1 (-1.41)	-0.5 (-1.27)	-0.03 (-0.08)	-0.02 (-0.42)	-0.4 (-1.44)
	N of discharges	2502313	2502313	2502313	1,244,192	1,244,192	1,244,192
	N of provider pairs	84736	84736	84736	54,405	54,405	54,405
Balanced panel of hospital-PAC pairs	Informally integrated	-0.9** (-2.16)	-0.1 (-1.14)	-0.8* (-1.95)	-0.3 (-1.11)	-0.02 (-0.42)	-0.3 (-1.04)
	N of discharges	2212188	2212188	2212188	1,052,936	1,052,936	1,052,936
	N of provider pairs	28715	28715	28715	11,828	11,828	11,828
Excluding small hospitals	Informally integrated	-0.7** (-2.00)	-0.01 (-0.15)	-0.7** (-2.04)	-0.7** (-2.32)	0.02 (0.30)	-0.7** (-2.36)
	N of discharges	2453016	2453016	2453016	952,926	952,926	952,926

	N of provider pairs	83457	83457	83457	48,724	48,724	48,724
Alternative definition of informal integration	Informally integrated	-1.6*** (-4.66)	-0.2* (-1.86)	-1.5*** (-4.33)	-1.2*** (-3.51)	-0.01 (-0.25)	-1.2*** (-3.51)
	N of discharges	2,650,900	2,650,900	2,650,900	1,207,015	1,207,015	1,207,015
	N of provider pairs	87,432	87,432	87,432	55,140	55,140	55,140
Using negative binomial model	Informally integrated	-0.02** (-2.10)	-0.01 (-0.87)	-0.02* (-1.77)	-0.08*** (-13.37)	-0.01 (-1.60)	-0.1*** (-15.63)
	N of discharges	2,626,214	2,626,214	2,626,214	1,299,442	1,299,442	1,299,442
	N of provider pairs						

Note: Regression includes all the covariates reported in Table 3, a full set of DRG controls, hospital-PAC-pair fixed effects, and year fixed effects.

Robust t-statistics in parentheses

* p<0.10 ** p<0.05 ***p<0.01

Appendix Table 5. Robustness checks on rehospitalization or death outcomes

<u>Vertical integration</u>			
<u>Cohort</u>		SNF	HHA
Primary specification	Vertical integration	-0.054** (-1.96)	-0.004 (-0.49)
	N of discharges	2,651,748	1,318,577
	N of provider pairs	87,440	56,093
Vertically integrated but not informally integrated	Vertical integration	-0.063* (-1.65)	-0.012 (-0.94)
	N of discharges	24,729,70	1,033,033
	N of provider pairs	86999	55590
Most competitive markets	Vertical integration	-0.070** (-2.37)	-0.006 (-0.76)
	N of discharges	2,502,313	1,244,192
	N of provider pairs	84,736	54,405
Balanced panel of hospital-PAC pairs	Vertical integration	-0.062* (-1.75)	-0.005 (-0.59)
	N of discharges	2,212,188	1,052,936
	N of provider pairs	28,715	11,828
<u>Informal integration</u>			
<u>Cohort</u>		SNF	HHA
Primary specification	Informal integration	0.005 (0.54)	-0.002 (-0.47)
	N of discharges	2,651,748	1,318,577
	N of provider pairs	87,440	56,093
Vertically integrated but not informally integrated	Informal integration	0.0001 (0.01)	-0.007 (-0.84)
	N of discharges	2,387,101	1,051,948
	N of provider pairs	86,895	55,504
Six most common DRGs	Informal integration	0.006 (0.47)	-0.001 (-0.20)
	N of discharges	1,282,965	757,073

	N of provider pairs	67,936	44,349
Most competitive markets	Informal integration	0.004 (0.45)	-0.001 (-0.26)
	N of discharges	2,502,313	1,244,192
	N of provider pairs	84,736	54,405
Balanced panel of hospital-PAC pairs	Informal integration	0.004 (0.38)	-0.001 (-0.11)
	N of discharges	2,212,188	1,052,936
	N of provider pairs	28,715	11,828
Alternative definition of informal integration	Informal integration	0.008 (0.93)	0.002 (0.29)
	N of discharges	2,650,900	1,207,015
	N of provider pairs	87,432	55,140
Excluding small hospitals	Informal integration	-0.001 (-0.11)	-0.000 (-0.09)
	N of discharges	2,453,016	1,201,838
	N of provider pairs	83,457	49,325

Note: Regression includes all the covariates reported in Table 3, a full set of DRG controls, hospital-PAC-pair fixed effects, and year fixed effects.

Robust t-statistics in parentheses

* p<0.10 ** p<0.05 ***p<0.01