

Supplemental materials for

Chong C, Campbell D, Elliott M, Aghajafari F, Ronksley P. Determining the association between continuity of primary care and acute care use in chronic kidney disease: a retrospective cohort study. *Ann Fam Med.* 2022;20(3):237-245.

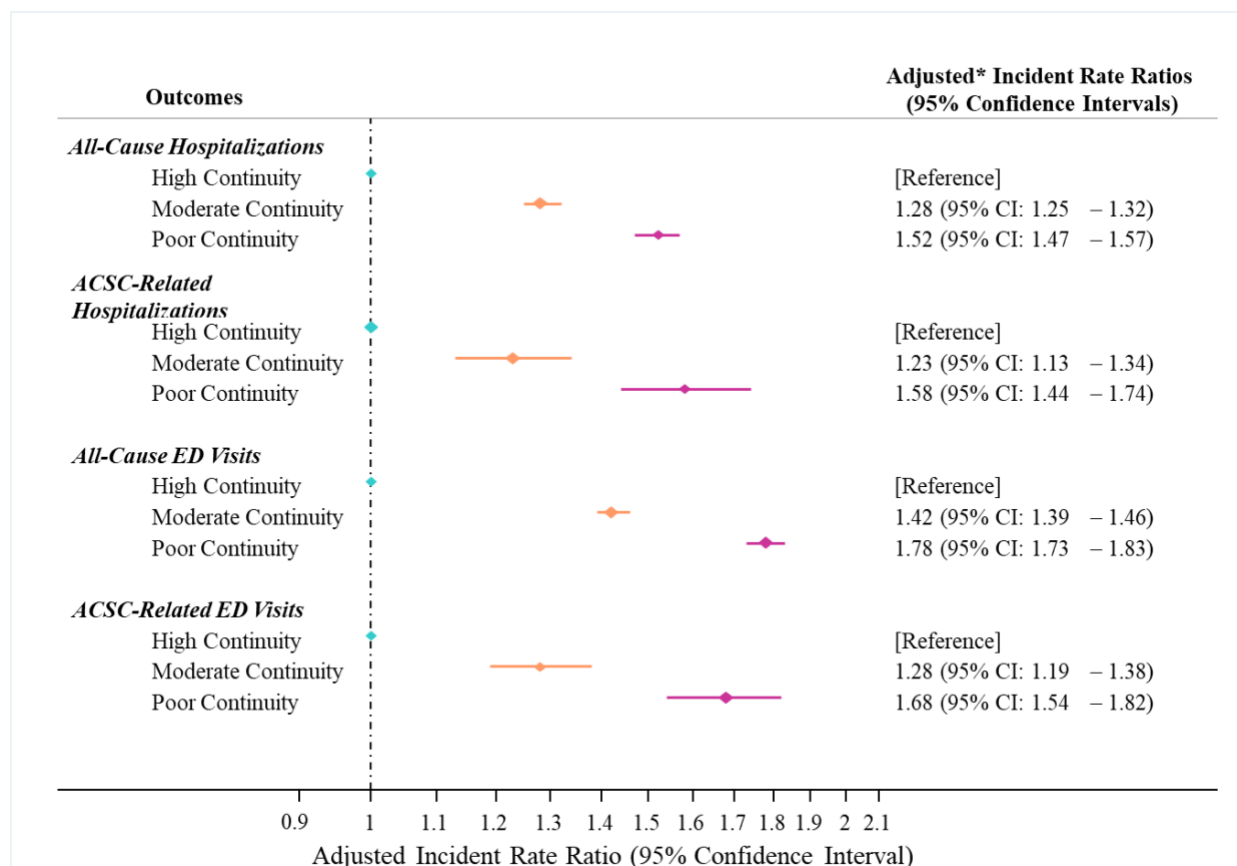
Supplemental Table 1. Patient demographic and clinical characteristics by continuity of primary care overall and across CKD stage.

	Variable	Level of relational continuity of primary care			Overall
		Poor (<50%)	Moderate (50 – 74%)	High (75-100%)	
CKD Stage 3a	Age, mean (SD)	74.9 (12.2)	74.4 (11.0)	75.1 (10.2)	74.8 (10.8)
	Female, n (%)	5,336 (58.3)	8,785 (56.7)	14,763 (54.1)	28,884 (55.6)
	Urban location of residence, n (%)	7,594 (83.0)	13,237 (85.5)	24,944 (91.5)	45,775 (88.2)
	<i>Albuminuria, n (%)</i>				
	Normal/mild (A1)	4,848 (53.0)	8,940 (57.7)	16,221 (59.5)	30,009 (57.8)
	Moderate (A2)	965 (10.5)	1,606 (10.4)	2,937 (10.8)	5,508 (10.6)
	Severe (A3)	547 (6.0)	772 (5.0)	1,208 (4.4)	2,527 (4.9)
	Unmeasured	2,793 (30.5)	4,171 (26.9)	6,908 (25.3)	13,872 (26.7)
	<i>Median household income quintile, n (%)</i>				
	1 (lowest)	2,524 (27.6)	3,904 (25.2)	6,520 (23.9)	12,948 (24.9)
	2	2,042 (22.3)	3,503 (22.6)	6,037 (22.1)	11,582 (22.3)
	3	1,655 (18.1)	2,969 (19.2)	5,376 (19.7)	10,000 (19.3)
	4	1,355 (14.8)	2,314 (14.9)	4,249 (15.6)	7,918 (15.3)
	5 (highest)	1,266 (13.8)	2,394 (15.5)	4,559 (16.7)	8,219 (15.8)
	6 = Unknown	311 (3.4)	405 (2.6)	533 (2.0)	1,249 (2.4)

	Number of comorbidities, mean (SD)	3.6 (2.2)	3.1 (1.9)	2.7 (1.7)	3.0 (1.9)
	Number of specialists seen, mean (SD)	3.8 (2.9)	3.3 (2.6)	2.9 (2.3)	3.2 (2.5)
CKD Stage 3b	Age, mean (SD)	78.0 (12.2)	77.8 (11.2)	78.1 (10.3)	78.0 (11.0)
	Female, n (%)	3,158 (61.4)	4,699 (59.0)	7,589 (57.0)	15,446 (58.5)
	Urban location of residence, n (%)	4,153 (80.7)	6,684 (84.0)	11,982 (90.0)	22,819 (86.4)
	<i>Albuminuria, n (%)</i>				
	Normal/mild (A1)	2,258 (43.9)	3,717 (46.7)	6,520 (49.0)	12,495 (47.3)
	Moderate (A2)	722 (14.0)	1,149 (14.4)	1,948 (14.6)	3,819 (14.5)
	Severe (A3)	487 (9.5)	697 (8.8)	1,078 (8.1)	2,262 (8.6)
	Unmeasured	1,678 (32.6)	2,397 (30.1)	3,767 (28.3)	7,842 (29.7)
	<i>Median household income quintile, n (%)</i>				
	1 (lowest)	1,540 (29.9)	2,276 (28.6)	3,538 (26.6)	7,354 (27.8)
	2	1,195 (23.2)	1,804 (22.7)	3,064 (23.0)	6,063 (23.0)
	3	973 (18.9)	1,571 (19.7)	2,647 (19.9)	5,191 (19.7)
	4	665 (12.9)	1,063 (13.4)	1,846 (13.9)	3,574 (13.5)
	5 (highest)	579 (11.3)	1,012 (12.7)	1,923 (14.4)	3,514 (13.3)
	6 = Unknown	193 (3.8)	234 (2.9)	295 (2.2)	722 (2.7)
	Number of comorbidities, mean (SD)	3.2 (1.8)	3.7 (2.0)	4.2 (2.2)	3.6 (2.0)
	Number of specialists seen, mean (SD)	4.1 (2.9)	3.6 (2.6)	3.2 (2.3)	3.5 (2.6)
CKD Stage 4	Age, mean (SD)	76.6 (14.8)	77.1 (13.2)	77.8 (12.0)	77.3 (13.1)
	Female, n (%)	1,077 (58.4)	1,418 (56.7)	2,131 (56.1)	4,626 (56.8)
	Urban location of residence, n (%)	1,474 (79.9)	2,057 (82.3)	3,413 (89.9)	6,944 (85.3)
	<i>Albuminuria, n (%)</i>				

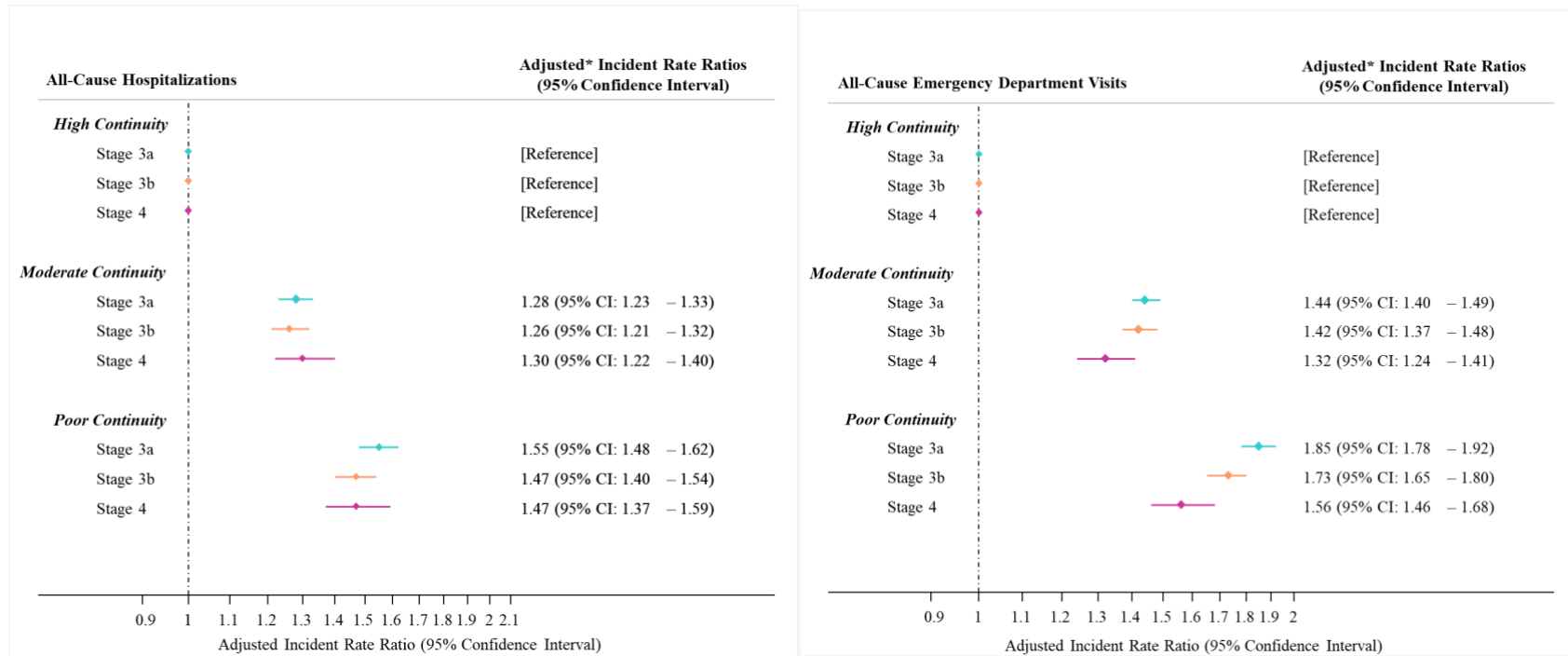
	Normal/mild (A1)	495 (26.8)	801 (32.1)	1,250 (32.9)	2,546 (31.3)
	Moderate (A2)	334 (18.1)	466 (18.7)	775 (20.4)	1,575 (19.4)
	Severe (A3)	406 (22.0)	538 (21.5)	693 (18.3)	1,637 (20.1)
	Unmeasured	610 (33.1)	694 (27.8)	1,079 (28.4)	2,383 (29.3)
	<i>Median household income quintile, n (%)</i>				
	1 (lowest)	563 (30.5)	764 (30.6)	1,072 (28.2)	2,399 (29.5)
	2	436 (23.6)	586 (23.5)	935 (24.6)	1,957 (24.0)
	3	330 (17.9)	472 (18.9)	712 (18.8)	1,514 (18.6)
	4	226 (12.3)	310 (12.4)	481 (12.7)	1,017 (12.5)
	5 (highest)	217 (11.8)	280 (11.2)	504 (13.3)	1,001 (12.3)
	6 = Unknown	73 (4.0)	87 (3.5)	93 (2.5)	253 (3.11)
	Number of comorbidities, mean (SD)	4.6 (2.3)	4.1 (2.2)	3.6 (1.9)	4.0 (2.1)
	Number of specialists seen, mean (SD)	4.5 (3.0)	4.0 (2.8)	3.5 (2.5)	3.9 (2.7)

Supplemental Figure 1. The association between continuity of primary care and incident rate ratios of all-cause and ambulatory care-sensitive conditions (ACSC) hospitalizations and Emergency Department (ED) visits.



* All-cause models adjusted by age, sex, household location, median household income quintile, cirrhosis, chronic heart failure, peripheral vascular disease, atrial fibrillation, asthma, chronic obstructive pulmonary disease, cancer, diabetes, hypertension, and albuminuria severity. ACSC-related models adjusted by age, sex, household location, median household income quintile, cirrhosis, peripheral vascular disease, atrial fibrillation, asthma, chronic obstructive pulmonary disease, cancer, diabetes, and albuminuria severity

Supplemental Figure 2. The association between continuity of primary care and incident rate ratios of all-cause hospitalizations and Emergency Department (ED) visits by CKD stage.



* Adjusted by age, sex, household location, median household income quintile, cirrhosis, chronic heart failure, peripheral vascular disease, atrial fibrillation, asthma, chronic obstructive pulmonary disease, cancer, diabetes, hypertension, and albuminuria severity.

Supplemental Table 2. All-cause hospitalization characteristics by level of continuity of primary care, overall and across CKD stage.

	Variable	Level of relational continuity of primary care			Overall,
		Poor (<50%)	Moderate (50 – 74%)	High (75-100%)	
Overall	Number of individuals	7,938	11,020	15,852	34,810
	Total number of hospitalizations (% of all hospitalizations)	19,835 (25.4)	25,551 (32.8)	32,602 (41.8)	77,988 (100.0)
	Number of hospitalizations, median (IQR)	0 (0 – 2)	0 (0 – 1)	0 (0 – 1)	0 (0 – 1)
	Person-time, years (% of all person-time)	32,328.8 (17.9)	53,698.6 (29.7)	94,520.5 (52.4)	180,547.9 (100.0)
	Length of hospital stays, days, mean (SD)	13.7 (21.1)	12.8 (19.2)	12.7 (20.0)	12.9 (20.0)
	Length of hospital stays, days, median (IQR)	0 (0 – 7)	0 (0 – 5)	0 (0 – 4)	0 (0 – 5)
	Cumulative length of hospital stays, days, median (IQR)	15 (6 – 42)	13 (5 – 39)	11 (4 – 33)	13 (5 – 37)
	Unadjusted hospitalization rate (per 1,000 p-y) (95% CI)	613.5 (605.6 – 622.7)	475.8 (470.2 – 481.9)	344.9 (341.9 – 349.4)	432.0 (429.5 – 435.6)
CKD Stage 3a	Number of individuals	3,684	5,320	7,798	16,802
	Total number of hospitalizations (% of all hospitalizations)	8,282 (24.5)	10,919 (32.4)	14,543 (43.1)	33,744 (100.0)
	Number of hospitalizations, median (IQR)	0 (0 – 1)	0 (0 – 1)	0 (0 – 1)	0 (0 – 1)
	Person-time, years (% of all person-time)	17,409.1 (16.9)	30,430.3 (29.5)	55,277.2 (53.6)	103,116.6 (100.0)
	Length of hospital stays, days, mean (SD)	13.0 (22.4)	12.2 (20.8)	11.2 (18.1)	11.9 (20.0)

	Length of hospital stays, days, median (IQR)	0 (0 – 4.5)	0 (0 – 3)	0 (0 – 2)	0 (0 – 3)
	Cumulative length of hospital stays, days median (IQR)	12 (4 – 35)	10 (4 – 30)	9 (4 – 24)	10 (4 – 29)
	Unadjusted hospitalization rate (per 1,000 p-y) (95% CI)	475.7 (465.6 – 486.1)	358.8 (352.2 – 365.6)	263.1 (258.9 – 267.4)	327.2 (323.8 – 330.8)
CKD Stage 3b	Number of individuals	2,974	4,105	5,942	13,021
	Total number of hospitalizations (% of all hospitalizations)	7,823 (25.2)	10,187 (32.9)	12,983 (41.9)	30,993 (100.0)
	Number of hospitalizations, median (IQR)	1 (0 – 2)	1 (0 – 2)	0 (0 – 1)	0 (0 – 2)
	Person-time, years (% of all person-time)	11,014.5 (18.6)	17,789.3 (30.0)	30,451.5 (51.4)	59,255.4 (100.0)
	Length of hospital stays, days, mean (SD)	14.1 (19.7)	13.3 (17.8)	13.7 (21.6)	13.6 (20.1)
	Length of hospital stays, days, median (IQR)	2.7 (0 – 9)	1 (0 – 7.5)	0 (0 – 6.1)	0 (0 – 7)
	Cumulative length of hospital stays, days median (IQR)	17 (6 – 45)	16 (6 – 45)	14 (5 – 38)	15 (5 – 42)
	Unadjusted hospitalization rate (per 1,000 p-y) (95% CI)	710.2 (694.7 – 726.2)	572.6 (561.6 – 583.9)	426.4 (419.1 – 433.8)	523.0 (517.3 – 528.9)
CKD Stage 4	Number of individuals	1,280	1,595	2,112	4,987
	Total number of hospitalizations (% of all hospitalizations)	3,730 (28.1)	4,445 (33.5)	5,076 (38.3)	13,251 (100.0)
	Number of hospitalizations, median (IQR)	1 (0 – 3)	1 (0 – 3)	1 (0 – 2)	1 (0 – 2)
	Person-time, years (% of all person-time)	3,877 (21.6)	5,458.8 (30.4)	8,593.7 (47.9)	17,929.9 (100.0)
	Length of hospital stays, days, mean (SD)	15.1 (20.6)	13.8 (17.4)	15.7 (21.2)	14.9 (19.9)
	Length of hospital stays, days, median (IQR)	5.5 (0 – 13)	4 (0 – 11)	2 (0 – 10.8)	4 (0 – 11)
	Cumulative length of hospital stays, days median (IQR)	23 (9 – 55)	20 (7 – 50)	20 (7 – 49)	21 (8 – 51)

	Unadjusted hospitalization rate (per 1,000 p-y) (95% CI)	962.1 (931.6 – 993.4)	814.3 (790.7 – 838.6)	590.7 (574.6 – 607.1)	739.0 (726.6 – 751.7)
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Supplemental Table 3. All-cause Emergency Department (ED) visit characteristics by level of continuity of primary care, overall and across CKD stage.

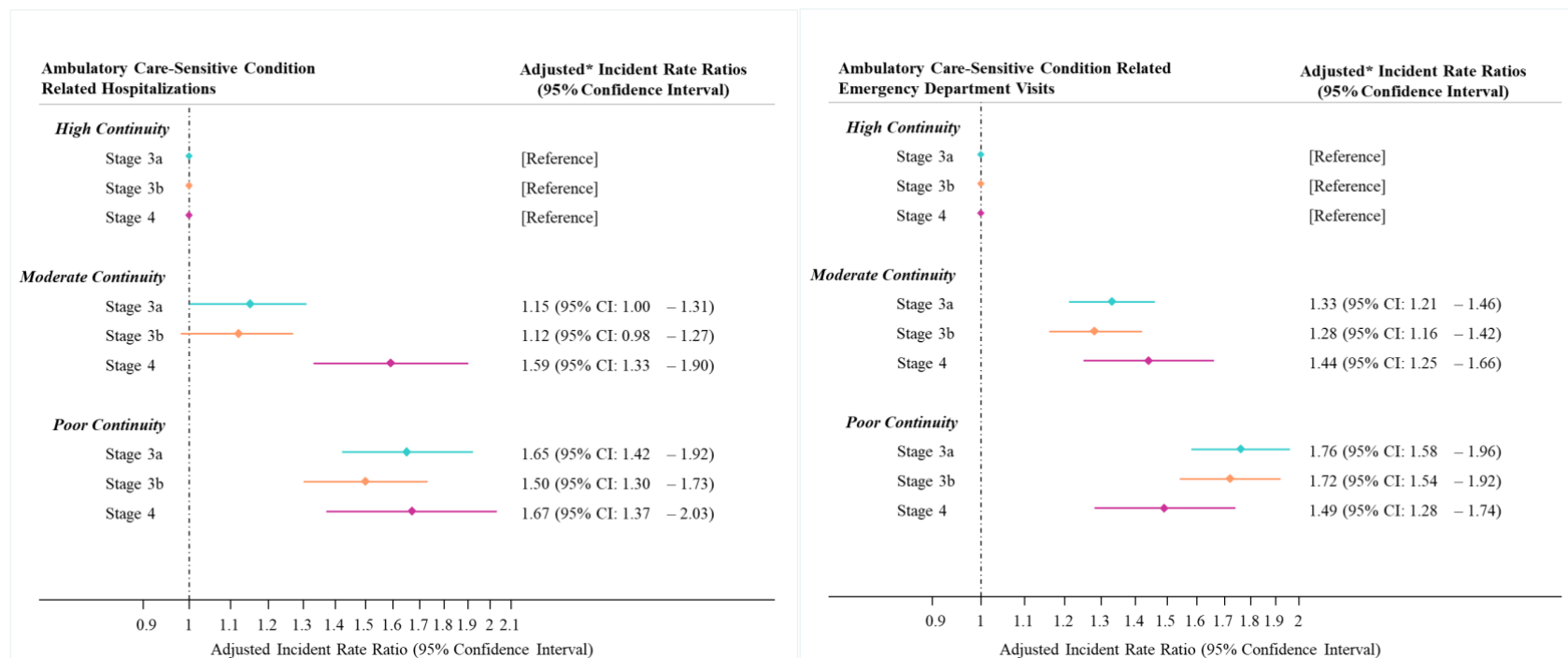
	Variable	Level of relational continuity of primary care			Overall
		Poor (<50%)	Moderate (50 – 74%)	High (75-100%)	
Overall	Number of individuals	11,234	16,237	23,681	51,152
	Total number of ED visits (%)	56,809 (27.8)	70,147 (34.3)	77,659 (38.0)	204,615 (100.0)
	Number of ED visits, median (IQR)	2 (0 – 4)	1 (0 – 3)	1 (0 – 2)	1 (0 – 3)
	Person-time, years (% of all person-time)	32,328.8 (17.9)	53,698.6 (29.7)	94,520.5 (52.4)	180,547.9 (100.0)
	Unadjusted ED visit rate (per 1,000 p-y) (95% CI)	1,757.2 (1,744.3 – 1,773.3)	1,306.3 (1,297.2 – 1,316.5)	823.4 (817.6 – 829.2)	1,133.3 (1,129.9 – 1,139.8)
CKD Stage 3a	Number of individuals	5,739	8,582	12,568	26,889
	Total number of ED visits (%)	25,137 (26.8)	32,359 (34.6)	36,134 (38.6)	93,630 (100.0)
	Number of ED visits, median (IQR)	1 (0 – 3)	1 (0 – 2)	0 (0 – 2)	1 (0 – 2)
	Person-time, years (% of all person-time)	17,409.1 (16.9)	30,430.3 (29.5)	55,277.2 (53.6)	103,116.6 (100.0)
	Unadjusted ED visit rate (per 1,000 p-y) (95% CI)	1,443.9 (1,426.2 – 1,461.9)	1,063.4 (1,051.9 – 1,075.0)	653.7 (647.0 – 660.5)	908.0 (902.2 – 913.8)
CK	Number of individuals	3,930	5,673	8,318	17,921

	Total number of ED visits (%)	22,244 (28.1)	26,978 (34.1)	29,928 (37.8)	79,150 (100.0)
	Number of ED visits, median (IQR)	2 (1 – 5)	2 (0 – 4)	1 (0 – 3)	1 (0 – 4)
	Person-time, years (% of all person-time)	11,014.5 (18.6)	17,789.3 (30.0)	30,451.5 (51.4)	59,255.4 (100.0)
	Unadjusted ED visit rate (per 1,000 p-y) (95% CI)	2,019.5 (1,993.2 – 2,046.2)	1,516.5 (1,498.5 – 1,534.7)	982.8 (971.8 – 994.1)	1,335.7 (1,326.5 – 1,345.1)
CKD Stage 4	Number of individuals	1,565	1,982	2,795	6,342
	Total number of ED visits (%)	9,428 (29.6)	10,810 (34.0)	11,597 (36.4)	31,835 (100.0)
	Number of ED visits, median (IQR)	3 (1 – 6)	2 (1 – 6)	2 (0 – 4)	2 (1 – 5)
	Person-time, years (% of all person-time)	3,877 (21.6)	5,458.8 (30.4)	8,593.7 (47.9)	17,929.9 (100.0)
	Unadjusted ED visit rate (per 1,000 p-y) (95% CI)	2,431.8 (2,382.9 – 2,481.1)	1,980.3 (1,943.3 – 2,018.0)	1,349.5 (1,325.1 – 1,374.3)	1,775.5 (1,756.1 – 1795.1)

Supplemental Table 4. Number and percentage of encounters for individual CKD-related ACSC hospitalizations and emergency department visits.

		Level of continuity of primary care			
		High	Moderate	Poor	Overall
Hospitalizations	# of ACSC encounters	2,730	2,045	1,714	6,489
	% of all ACSC encounters	42.1	31.5	26.4	100.0
	Volume overload	20	2	5	27
	% of all Volume overload encounters	74.0	0.7	1.9	100.0
	Hyperkalemia	76	69	71	216
	% of all Hyperkalemia encounters	35.2	31.9	32.9	100.0
	Malignant hypertension	5	3	4	12
	% of all Malignant hypertension encounters	41.7	25.0	33.3	100.0
Emergency Department Visits	Heart failure	2,653	1,989	1,649	6,291
	% of all Heart failure encounters	42.2	31.6	26.2	100.0
	# of ACSC encounters	3,441	2,726	2,294	8,461
	% of all ACSC encounters	40.7	32.2	27.1	100.0
	Volume overload	25	7	10	42
	% of all Volume overload encounters	59.5	16.7	23.8	100.0
	Hyperkalemia	419	365	332	1,116
	% of all Hyperkalemia encounters	37.5	32.7	29.7	100.0
	Malignant hypertension	14	5	6	25
	% of all Malignant hypertension encounters	56.0	20.0	24.0	100.0
	Heart failure	3,057	2,425	2,024	7,506
	% of all Heart failure encounters	40.7	32.3	27.0	100.0

Supplemental Figure 3. The association between continuity of primary care and incident rate ratios of ambulatory care-sensitive conditions (ACSC) hospitalizations and Emergency Department (ED) visits by CKD stage.



* Adjusted by age, sex, household location, median household income quintile, cirrhosis, peripheral vascular disease, atrial fibrillation, asthma, chronic obstructive pulmonary disease, cancer, diabetes, and albuminuria severity.

Supplemental Table 5. Ambulatory care-sensitive condition (ACSC) related hospitalization characteristics by level of continuity of primary care, overall and across CKD stage.

	Variable	Level of relational continuity of primary care			Overall
		Poor (<50%)	Moderate (50 – 74%)	High (75-100%)	
Overall	Number of individuals	1,095	1,369	1,842	4,306
	Total number of ACSC hospitalizations (%)	1,714 (26.4)	2,045 (31.5)	2,730 (42.1)	6,489 (100.0)
	Number of ACSC hospitalizations, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	32,328.8 (17.9)	53,698.6 (29.7)	94,520.5 (52.4)	180,547.9 (100.0)
	Unadjusted ACSC hospitalization rate (per 1,000 p-y) (95% CI)	53.1 (50.6 – 55.6)	38.1 (36.5 – 39.8)	28.9 (27.9 – 30.1)	36.0 (35.1 – 36.9)
CKD Stage 3a	Number of individuals	391	489	706	1,586
	Total number of ACSC hospitalizations (%)	594	689	1,024	2,307
	Number of ACSC hospitalizations, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	17,409.1 (16.9)	30,430.3 (29.5)	55,277.2 (53.6)	103,116.6 (100.0)
	Unadjusted ACSC hospitalization rate (per 1,000 p-y) (95% CI)	34.1 (31.5 – 37.0)	22.6 (21.0 – 24.4)	18.5 (17.4 – 19.7)	22.4 (21.5 – 23.3)
CKD Stage 3b	Number of individuals	453	555	762	1,770
	Total number of ACSC hospitalizations (%)	699	817	1,154	2,670
	Number of ACSC hospitalizations, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	11,014.5 (18.6)	17,789.3 (30.0)	30,451.5 (51.4)	59,255.4 (100.0)
	Unadjusted ACSC hospitalization rate (per 1,000 p-y) (95% CI)	63.5 (58.9 – 68.3)	45.9 (42.9 – 49.2)	37.9 (35.8 – 40.2)	45.1 (43.4 – 46.8)
CK	Number of individuals	251	325	374	950

	Total number of ACSC hospitalizations (%)	421	539	552	1,512
	Number of ACSC hospitalizations, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	3,877 (21.6)	5,458.8 (30.4)	8,593.7 (47.9)	17,929.9 (100.0)
	Unadjusted ACSC hospitalization rate (per 1,000 p-y) (95% CI)	108.6 (98.7 – 119.5)	98.7 (90.7 – 107.4)	64.2 (59.1 – 69.8)	84.3 (80.2 – 88.7)

Supplemental Table 6. Ambulatory care-sensitive condition (ACSC) related Emergency Department (ED) characteristics by level of continuity of primary care, overall and across CKD stage.

	Variable	Level of relational continuity of primary care			Overall
		Poor (<50%)	Moderate (50 – 74%)	High (75-100%)	
Overall	Number of individuals	1,414	1,731	2,272	5,417
	Total number of ACSC ED visits (%)	2,294 (27.1)	2,726 (32.2)	3,441 (40.7)	8,461 (100.0)
	Number of ACSC ED visits, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	32,328.8 (17.9)	53,698.6 (29.7)	94,520.5 (52.4)	180,547.9 (100.0)
	Unadjusted ACSC ED visit rate (per 1,000 p-y) (95% CI)	71.0 (68.2 – 74.0)	50.8 (48.9 – 62.7)	36.5 (35.3 – 37.7)	46.9 (45.9 – 47.9)
CKD Stage 3a	Number of individuals	514	633	876	2,023
	Total number of ACSC ED visits (%)	827	972	1,283	3,082
	Number of ACSC ED visits, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	17,409.1 (16.9)	30,430.3 (29.5)	55,277.2 (53.6)	103,116.6 (100.0)
	Unadjusted ACSC ED visit rate (per 1,000 p-y) (95% CI)	47.5 (44.4 – 50.9)	31.9 (30.0 – 34.0)	23.2 (22.0 – 24.5)	29.9 (28.9 – 31.0)
CKD Stage 3b	Number of individuals	569	695	920	2,184
	Total number of ACSC ED visits (%)	935	1,080	1,415	3,430
	Number of ACSC ED visits, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	11,014.5 (18.6)	17,789.3 (30.0)	30,451.5 (51.4)	59,255.4 (100.0)
	Unadjusted ACSC ED visit rate (per 1,000 p-y) (95% CI)	85.9 (79.6 – 90.5)	60.7 (57.2 – 64.4)	46.5 (44.1 – 49.0)	57.9 (56.0 – 59.9)

CKD Stage 4	Number of individuals	331	403	476	1,210
	Total number of ACSC ED visits (%)	532	674	743	1,949
	Number of ACSC ED visits, median (IQR)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
	Person-time, years (% of all person-time)	3,877 (21.6)	5,458.8 (30.4)	8,593.7 (47.9)	17,929.9 (100.0)
	Unadjusted ACSC ED visit rate (per 1,000 p-y) (95% CI)	137.2 (126.0 – 149.4)	123.5 (114.5 – 133.2)	86.5 (80.5 – 92.9)	108.7 (104.0 – 113.6)

Supplemental Table 7. Proportion of individuals who were prescribed a RAAS inhibitor or statin in the year prior to CKD diagnosis date by continuity of primary care.

		Level of continuity of primary care			Overall
		Poor (<50%)	Moderate (50 – 74%)	High (75-100%)	
RAAS inhibitor in the year prior to index	No, n (%)	6,606 (41.3)	11,203 (43.6)	19,069 (43.5)	36,878 (43.1)
	Yes, n (%)	9,387 (58.7)	14,500 (56.4)	24,761 (56.5)	48,648 (56.9)
	Overall, n	15,993	25,703	43,830	85,526
Statin in the year prior to index	No, n (%)	15,102 (94.4)	24,056 (93.6)	40,615 (92.7)	79,773 (93.3)
	Yes, n (%)	891 (5.6)	1,647 (6.4)	3,215 (7.3)	5,753 (6.7)
	Overall, n	15,993	25,703	43,830	85,526