

Supplementary Appendix

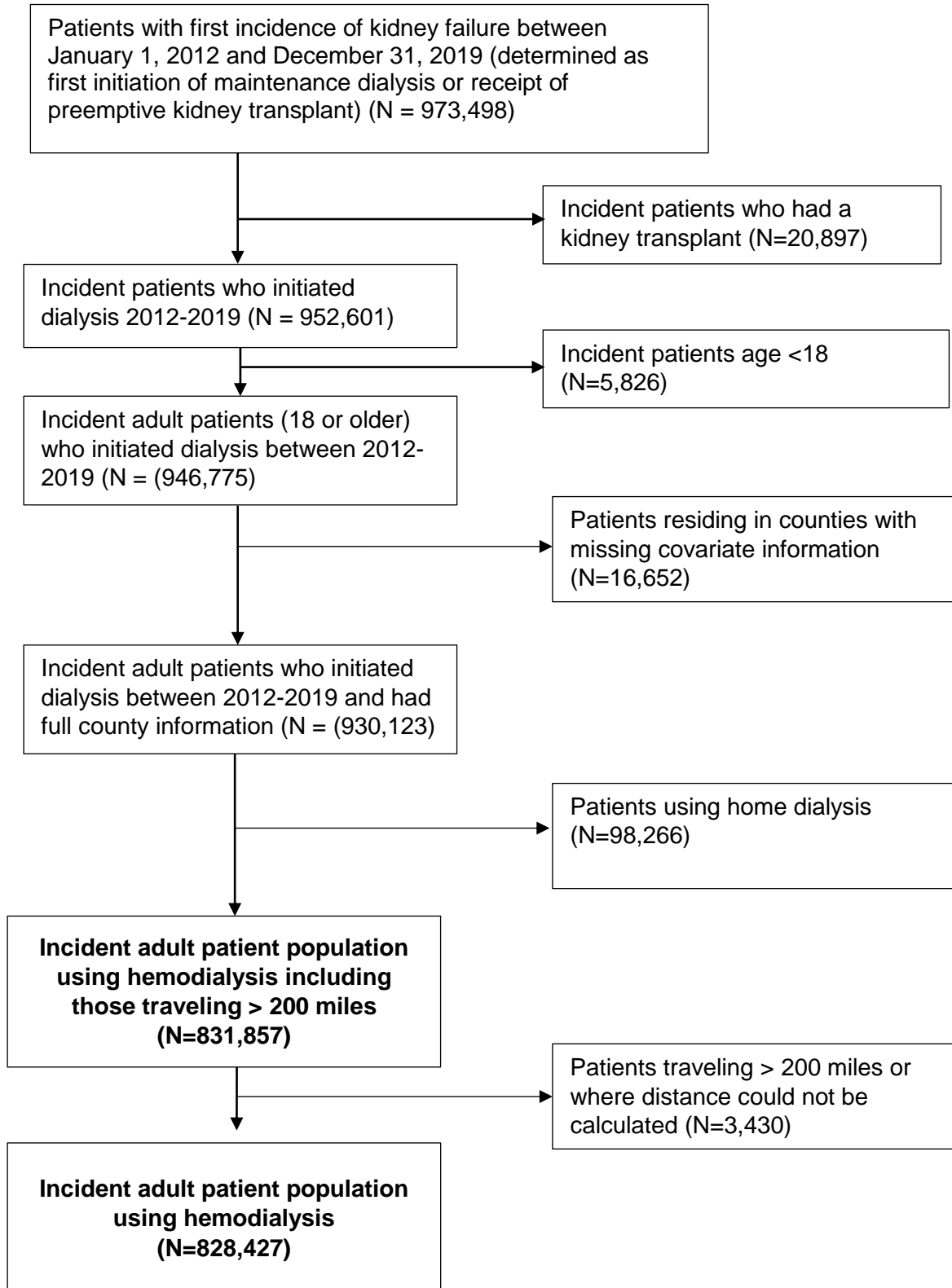
Table of Contents

Appendix Table 1. Data Sources	2
Appendix Figure 1. Study Sample Construction	3
Appendix Table 2. County-Level Characteristics by County-Level Number of Dialysis Facilities 2012-2019*	4
Appendix Table 3. Facility Characteristics by County-Level Number of Dialysis Facilities 2012-2019.....	5
Appendix Figure 2. Study Design and Findings.....	6
Appendix Table 4. Alternative Measures of Access to Dialysis Facility at Treatment Initiation Among Incident Kidney Failure Patients, 2012-2019	7
Appendix Table 5. Association Between Facilities per Capita and Distance to Dialysis Facility at Treatment Initiation Among Incident Kidney Failure Patients, 2012-2019	8
Appendix Table 6. Association Between Annual Number of Facilities per 1,000 Incident Kidney Failure Patients and Distance to Dialysis Facility at Treatment Initiation, 2012-2019	9
Appendix Table 7. Association Between Urban/Rural Designation and Distance Traveled to Dialysis Facility	10
Appendix Table 8. Unadjusted Changes in Distance to Dialysis Facility Before vs. After All Facilities in County Close, 2012-2019 (n=2,075).....	11
References	12

Appendix Table 1. Data Sources

Variable	Data Source(s)
Number of dialysis facilities	
Incident kidney failure cases	End-Stage Renal Disease Medical Evidence Report (CMS 2728) ¹
County-level population of adults 18 and older	2012-2019 U.S. Census Bureau Annual County Population Estimates ²
County-Level Characteristics	
Percent of the population living below the poverty line	2012-2019 Small Area Income and Poverty Estimates ³
Percent of the population who are Hispanic	2012-2019 National Center for Health Statistics (NCHS) Bridged Race Files ^{4,5}
Percent of the population who are Black	2012-2019 NCHS Bridged Race Files ^{4,5}
Percent of the population who are Asian	2012-2019 NCHS Bridged Race Files ^{4,5}
Percent of the population who are American Indian or Alaska Native	2012-2019 NCHS Bridged Race Files ^{4,5}
Urban-Rural continuum code	U.S. Department of Agriculture (2013) ⁶
Educational attainment (percent of adults age 25 years and older with a high school diploma only)	American Community Survey 5-Year File (2014-18). Estimates made available by the U.S. Department of Agriculture Economic Research Service ⁷
Unemployment rate, age 16+	U.S. Bureau of Labor Statistics Local Area Unemployment Statistics (2012-2019) ⁸
Uninsurance rate, adults age 18-64	U.S. Census Small Area Health Insurance Estimates (2012-2019) ⁹

Appendix Figure 1. Study Sample Construction



Appendix Table 2. County-Level Characteristics by County-Level Number of Dialysis Facilities 2012-2019*

County Characteristics, Mean (SD)	Overall	County-Level Number of Dialysis Facilities			
		0	1	2	3 or more
County-Years, n (%)	25,128 (100%)	10,523 (41.9%)	7,652 (30.5%)	2,865 (11.4%)	4,088 (16.3%)
Facilities per County, Mean (SD)	2.0 (6.2)	0 (0)	1.1 (0.2)	2.2 (0.5)	5.9 (3.2)
Facilities per County, Median (IQR)	1 (2)	0 (0)	1.1 (2.9)	2.2 (3.1)	4.8 (1.5)
Facilities per Million, Mean(SD)	2.1 (2.9)	0 (0)	4.1 (3.3)	3.9 (3.0)	2.6 (1.6)
Facilities per 1,000 Incident Patients, Mean(SD)	63.4 (113.0)	0 (0)	132.9 (160.1)	103.0 (101.6)	70.8 (51.9)
Annual Average Population	102,341 (327,878)	12,574 (11,157)	37,595 (29,114)	69,678 (45,787)	424,987 (674,616)
Age					
Under 18	22.4 (3.4)	22.1 (3.8)	22.4 (3.4)	22.7 (2.9)	23.0 (2.9)
18-44	32.2 (5.1)	30.1 (4.7)	32.7 (4.7)	33.8 (4.7)	35.8 (4.5)
45-64	27.2 (2.9)	27.9 (3.0)	27.0 (2.8)	26.6 (2.6)	25.9 (2.5)
64-75	10.3 (2.6)	11.2 (2.7)	10.2 (2.4)	9.7 (2.1)	8.8 (2.2)
75+	7.8 (2.3)	8.7 (2.5)	7.7 (1.9)	7.1 (1.7)	6.4 (2.0)
Female	49.9 (2.3)	49.2 (2.7)	50.0 (2.0)	50.6 (1.4)	50.9 (1.1)
Race/Ethnicity					
White, non-Hispanic	76.7 (20.1)	81.4 (18.8)	77.3 (19.9)	75.3 (19.0)	64.6 (19.3)
Black, non-Hispanic	8.9 (14.3)	5.2 (11.3)	10.0 (16.2)	12.0 (15.4)	14.3 (14.2)
Hispanic/Latino	9.2 (13.6)	8.6 (13.5)	8.0 (12.8)	8.1 (12.6)	13.9 (15.0)
Other, non-Hispanic	5.1 (8.7)	4.8 (10.0)	4.6 (8.1)	4.6 (5.8)	7.1 (7.7)
Unemployment Rate	5.6 (2.5)	5.4 (2.6)	5.9 (2.5)	5.9 (2.4)	5.5 (2.2)
Uninsurance Rate	13.4 (5.8)	14.4 (6.1)	13.1 (5.5)	12.4 (5.3)	12.0 (5.4)
Living Below Poverty	16.0 (6.4)	15.9 (6.4)	17.0 (6.7)	16.4 (6.2)	14.5 (5.6)
Urban/Rural†					
Large central metropolitan	2.2	0.0	0.0	0.0	13.3
Large fringe metropolitan	11.7	5.4	8.6	17.4	29.8
Medium metropolitan	11.8	5.9	9.7	13.5	30.0
Small metropolitan	11.4	7.9	8.6	21.2	18.5
Micropolitan	20.4	10.2	36.0	34.8	7.4
Non-core	42.5	70.5	37.1	13.2	1.0

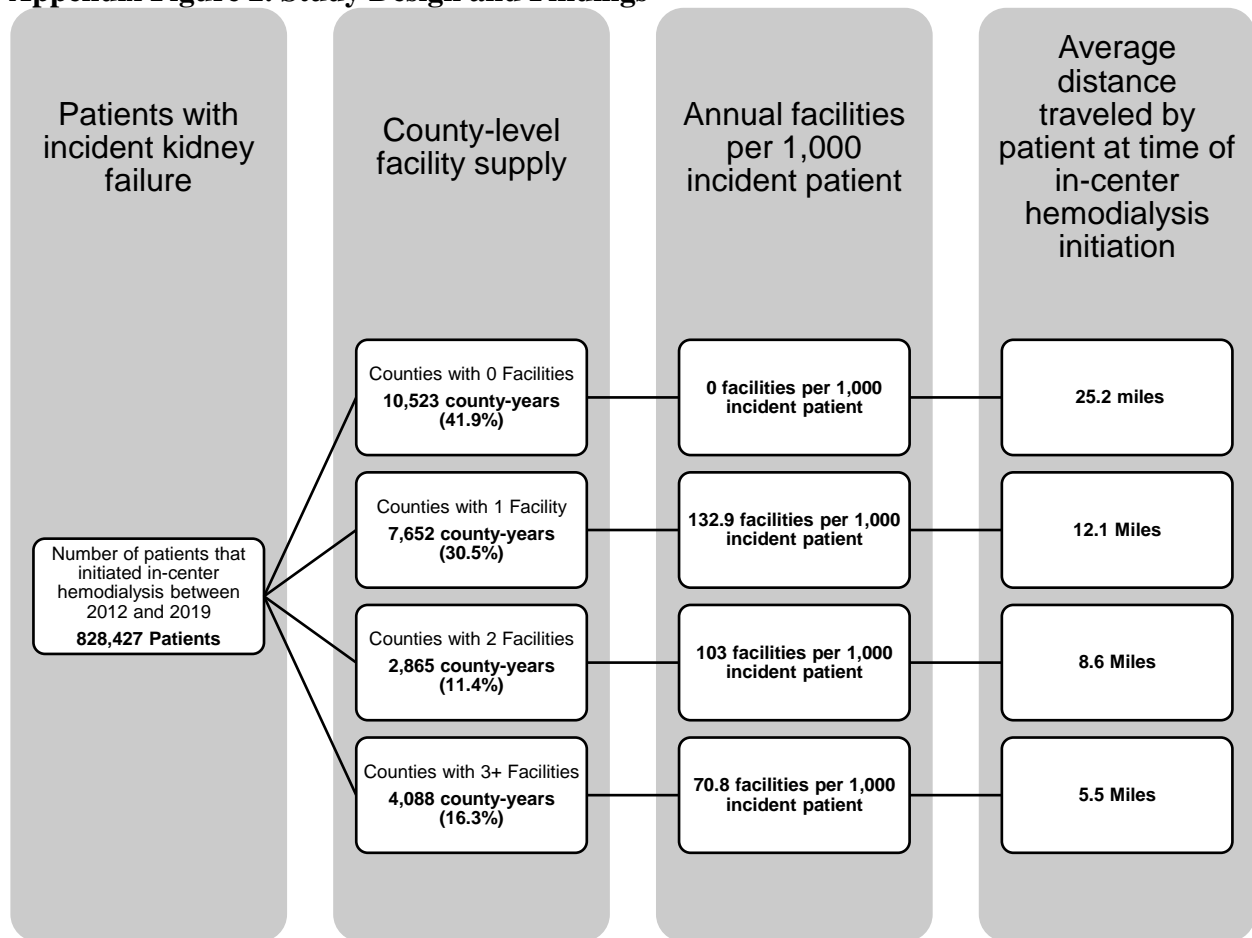
*p<0.001 for all comparisons. †Urban/rural designation was based on 2013 classification using U.S. Department of Agriculture classifications. Values represent county-level means overall and by county-level dialysis facility supply. For example, an average of 22.1% (SD 3.8%) of the population was under the age of 18 in counties that had 0 facilities.

Appendix Table 3. Facility Characteristics by County-Level Number of Dialysis Facilities 2012-2019

	Overall Sample	0	1	2	3 or more
Facility Characteristics, Mean(SD)					
Number of Stations	15.7 (6.1)	-	8.7 (28.2)	10.5 (22.3)	19.0 (21.3)
Chain Owned	83.9 (33.0)	-	80.9 (39.3)	86.3 (28.2)	87.8 (20.2)
Fresenius	38.0 (41.3)	-	14.5 (6.9)	16.2 (5.5)	17.6 (4.1)
DaVita	36.1 (40.4)	-	99.8 (5.0)	98.6 (8.1)	97.0 (7.7)
Offers Late Shift	11.9 (25.7)	-	39.6 (48.9)	55.0 (37.9)	55.6 (23.9)
Offers Peritoneal Dialysis	47.1 (41.9)	-	19.6 (39.7)	29.7 (34.1)	31.8 (22.3)
Offers Home Hemodialysis Training	25.0 (35.0)	-	38.5 (48.7)	40.6 (37.7)	35.4 (29.6)

p<0.001 for all comparisons. Values represent county-level means by county-level dialysis facility supply.

Appendix Figure 2. Study Design and Findings



Appendix Table 4. Alternative Measures of Access to Dialysis Facility at Treatment Initiation Among Incident Kidney Failure Patients, 2012-2019

	Unadjusted Rate, %	Unadjusted Difference (95% CI)	Adjusted Difference (95% CI)
Having No Dialysis Facilities in County at Treatment Initiation	4.7	18.7 (17.6, 19.7)***	13.0 (12.0, 13.9)***
Cross County lines	18.7	14.8 (14.2, 15.6)***	13.2 (12.5, 13.9)***
Cross State Lines	1.8	17.6 (14.6, 20.5)***	14.7 (12.4, 16.9)***

*p<0.05, **p<0.01, ***p<0.001. Models estimate the association between county-level number of facilities and distance to dialysis facility in miles. Adjusted model covariates include patient age, sex, race/ethnicity, health insurance type, county-level employment rate, county-level uninsurance rate, county-level proportion of the population living below the poverty level, and urban/rural status. Models also include a linear time trend and standard errors are clustered at the county level.

Appendix Table 5. Association Between Facilities per Capita and Distance to Dialysis Facility at Treatment Initiation Among Incident Kidney Failure Patients, 2012-2019

	Number of Facilities per Capita, Mean (SD)	Average Distance in Miles, Mean (SD)	Unadjusted Difference (95% CI)	Adjusted Difference (95% CI)
Referent Group: Quartile 4 (n=86,315)	5.9 (3.3)	7.6 (13.0)	Ref	Ref
Quartile 1 (n=39,322)	0 (0)	24.7 (20.3)	17.1 (16.0, 18.2)***	13.2 (12.3, 14.0)***
Quartile 2 (n=238,002)	1.1 (0.2)	6.3 (9.6)	-1.3 (-2.1, -0.5)**	0.9 (0.4, 1.5)**
Quartile 3 (n=86,315)	2.2 (0.5)	6.1 (10.0)	-1.5 (2.2, -0.9)***	0.5 (0.1, 0.9)*

*p<0.05, **p<0.01, ***p<0.001. Models estimate the association between county-level number of facilities and distance to dialysis facility in miles. Adjusted model covariates include patient age, sex, race/ethnicity, health insurance type, primary cause of kidney failure, county-level employment rate, county-level uninsurance rate, county-level proportion of the population living below the poverty level, and urban/rural status. Models also include a linear time trend and standard errors are clustered at the county level.

Appendix Table 6. Association Between Annual Number of Facilities per 1,000 Incident Kidney Failure Patients and Distance to Dialysis Facility at Treatment Initiation, 2012-2019

	Number of Facilities per 1,000 Incident Patient, Mean (SD)	Average Distance in Miles, Mean (SD)	Unadjusted Difference (95% CI)	Adjusted Difference (95% CI)
Referent Group: Quartile 4 (n=143,490)	189.3 (175.2)	8.5 (14.2)	Ref	Ref
Quartile 1 (n=39,322)	0 (0)	24.7 (20.3)	12.8 (12.0, 13.7)****	12.8 (12.0, 13.7)***
Quartile 2 (n=167,941)	33.7 (6.2)	6.1 (9.7)	0.1 (-0.3, 0.5)	0.1 (-0.3, 0.5)
Quartile 3 (n=477,674)	62.2 (11.9)	6.2 (10.2)	-0.1 (-0.4, 0.2)	-0.1 (-0.4, 0.2)

*p<0.05, **p<0.01, ***p<0.001. Models estimate the association between county-level number of facilities and distance to dialysis facility in miles. Adjusted model covariates include patient age, sex, race/ethnicity, health insurance type, primary cause of kidney failure, county-level employment rate, county-level uninsurance rate, county-level proportion of the population living below the poverty level, and urban/rural status. Models also include a linear time trend and standard errors are clustered at the county level.

Appendix Table 7. Association Between Urban/Rural Designation and Distance Traveled to Dialysis Facility

	Average Distance to Dialysis Facility in Miles, Mean (SD)	Unadjusted Difference (95% CI)	Adjusted Difference (95% CI)
Referent Group: Large central metropolitan (n=279,735)	4.59 (7.44)	Ref	Ref
Large fringe metropolitan (n=181,222)	6.64 (9.16)	2.28 (1.79, 2.76)***	1.90 (1.37, 2.43)***
Medium metropolitan (n=168,540)	6.49 (10.01)	2.11 (1.66, 2.57)***	1.86 (1.41, 2.32)***
Small metropolitan (n=74,156)	7.86 (12.59)	3.49 (2.97, 4.01)***	3.26 (2.76, 3.77)***
Micropolitan (n=72,338)	11.05 (16.86)	7.74 (7.05, 8.43)***	7.48 (6.82, 8.15)***
Non-core (n=52,436)	20.36 (21.73)	17.94 (17.03, 18.86)***	17.68 (16.79, 18.58)***

*p<0.05, **p<0.01, ***p<0.001. Models estimate the association between county-level urban/rural designation and distance to dialysis facility in miles. The referent group is with 3 or more facilities in a county. Adjusted model covariates include patient age, sex, race/ethnicity, health insurance type, primary cause of kidney failure, county-level employment rate, county-level uninsurance rate, and county-level proportion of the population living below the poverty level. Models also include a linear time trend and standard errors are clustered at the county level.

Appendix Table 8. Unadjusted Changes in Distance to Dialysis Facility Before vs. After All Facilities in County Close, 2012-2019 (n=2,075)

	Before Closure	After Closure	Unadjusted Difference (95% CI)
Distance to Dialysis Facility (miles)	17.23	20.09	2.86 (0.42, 6.14)

*p<0.05, **p<0.01, ***p<0.001

References

1. US Department of Health and Human Services. End Stage Renal Disease Medical Evidence Report Medicare Entitlement and/or Patient Registration: Form CMS-2728-U3. *Centers for Medicare and Medicaid Services* 2006.
2. US Census Bureau. Annual Resident Population Estimates, Estimated Components of Resident Population Change, and Rates of the Components of Resident Population Change for States and Counties. 2020; <https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-total.html>. Accessed August 28, 2020.
3. US Census Bureau. Small area income and poverty estimates (SAIPE) program. 2018; <https://www.census.gov/programs-surveys/saipe.html>.
4. National Center for Health Statistics. Documentation for Revised 2000-2009 Bridged-Race Intercensal Population Estimates for Calculating Vital Rates. 2012; https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm.
5. National Center for Health Statistics. Documentation for Bridged-Race Postcensal Vintage 2017 population estimates for April 1, 2010-July 1, 2017. 2018; https://www.cdc.gov/nchs/data/nvss/bridged_race/Documentation_bridge_postcenv2017.pdf.
6. US Department of Agriculture. Urban Rural Continuum Codes. 2012; <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx>.
7. US Department of Agriculture Economic Research Service. County-Level Datasets - Education. 2020; <https://data.ers.usda.gov/reports.aspx?ID=17829>. Accessed August 28, 2020.
8. Bureau of Labor Statistics. Local area unemployment statistics. 2019; <https://www.bls.gov/lau/>. Accessed August 28, 2020.
9. US Census Bureau. Small area health insurance estimates (SAHIE) program. 2019; <https://www.census.gov/programs-surveys/sahie.html>. Accessed August 28, 2020.