

Vascular Access Placement in Patients with Incident CKD Stage 4 and 5 attending an Inner City Nephrology Clinic: A Cohort Study and Survey of Providers

Narender Goel et al.

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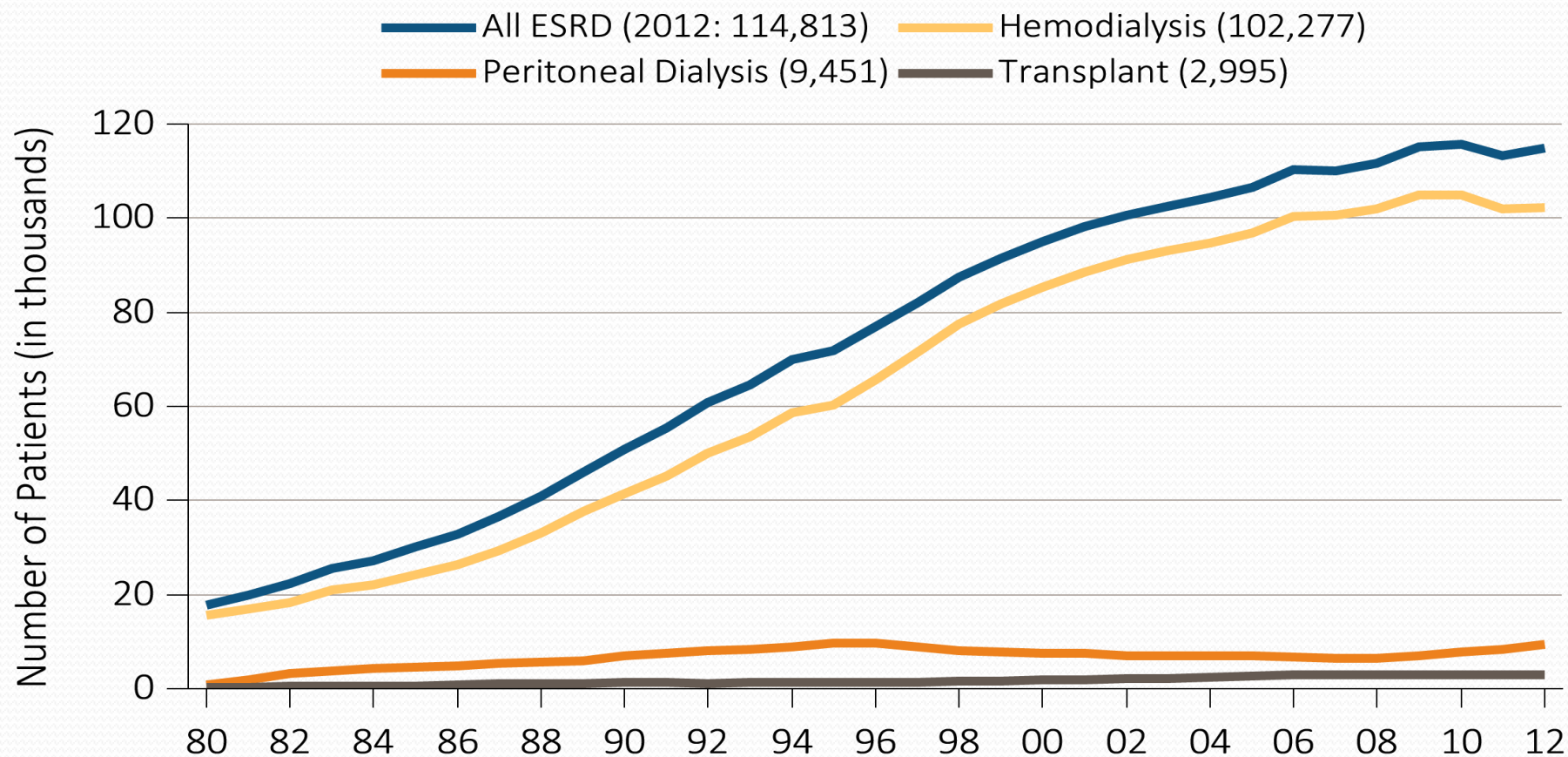
Montefiore Medical Center & Albert Einstein College of Medicine, New York

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Conflict of Interest

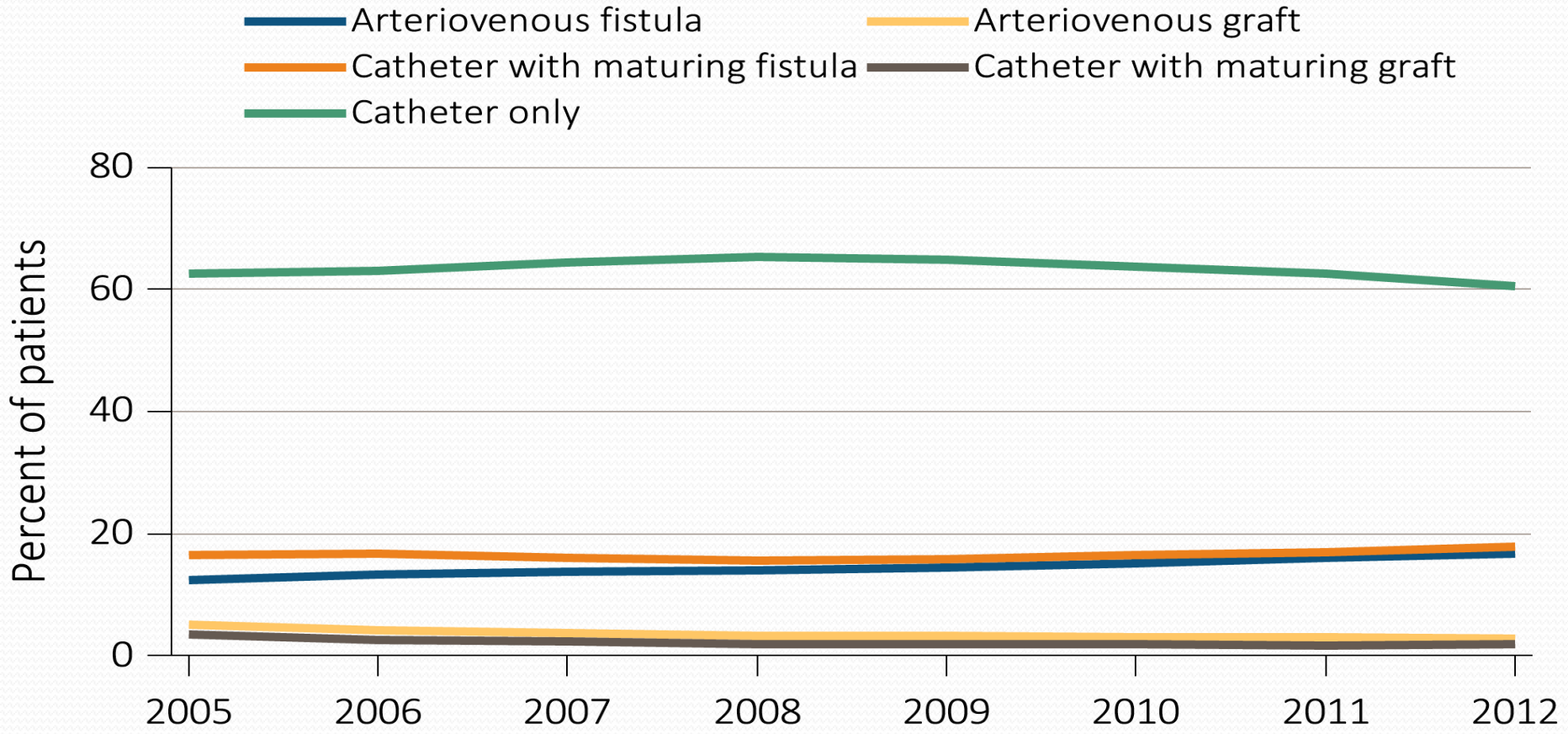
- Dr Narender Goel: None
- Dr Caroline Kwon: None
- Dr Teena P. Charalel: None
- Dr Carolyn Bauer: None
- Dr Michal L Melamed: None
- Dr. Vaughn Folkert: Member of the Fresenius Medical Advisory Board

Trends in the Number of Incident Cases of ESRD, in thousands, by Modality, in the U.S. population, 1980-2012



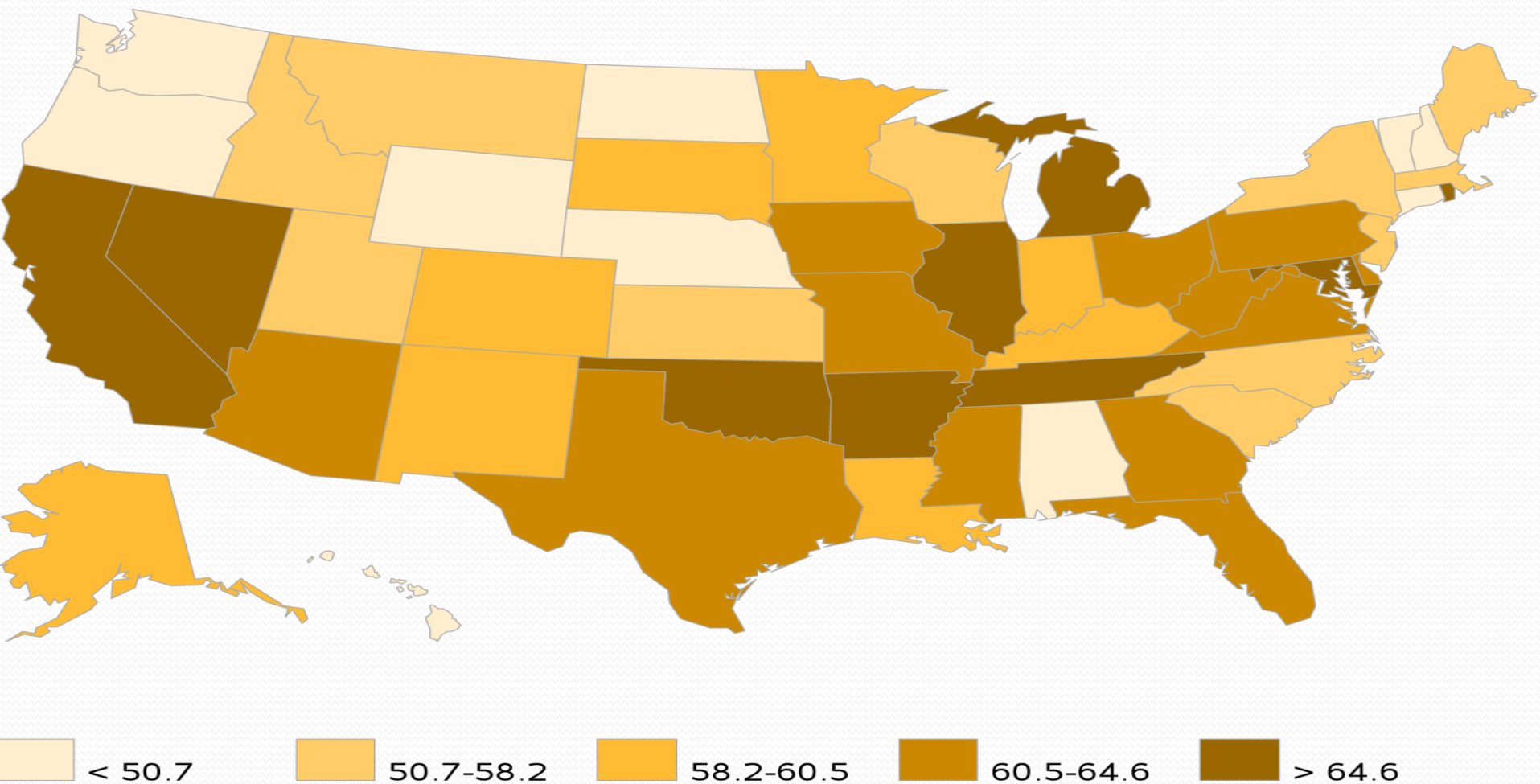
Data Source: USRDS ESRD Database (2014 Annual Date Report)

Vascular Access Use Among Hemodialysis Patients at Initiation of ESRD treatment, from the ESRD Medical Evidence Form (CMS 2728): Time Trend From 2005-2012



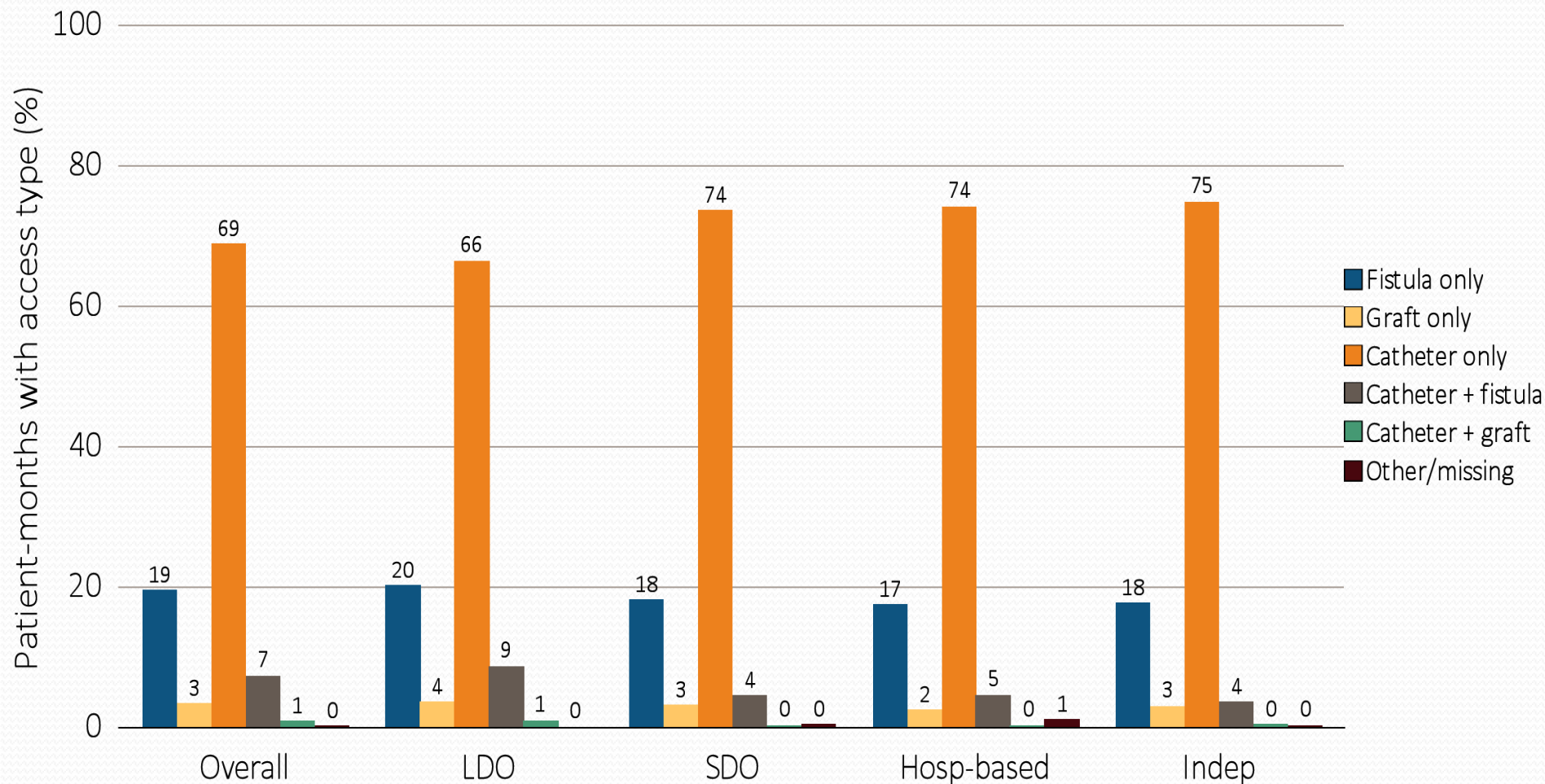
Data Source: Special analyses, USRDS ESRD Database (2014 Annual Date Report)

Geographic Variation in Percentage of Catheter Alone use at Hemodialysis Initiation, in year 2012, from the ESRD Medical Evidence Form (CMS 2728)



Data Source: Special analyses, USRDS ESRD Database (2014 Annual Data Report)

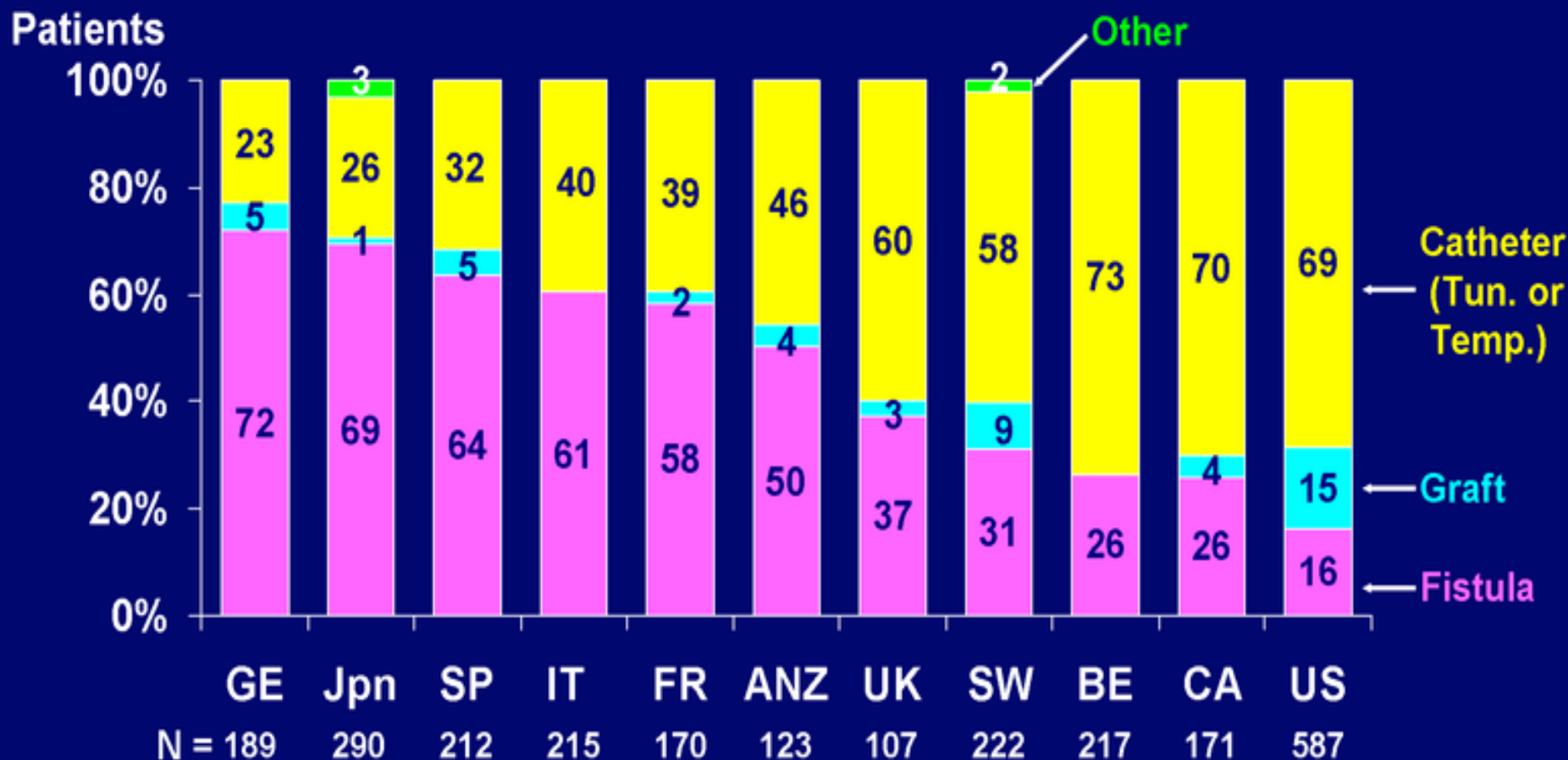
Prevalence of Vascular Access Type Among Incident Dialysis Patients by Unit Affiliation in 2012



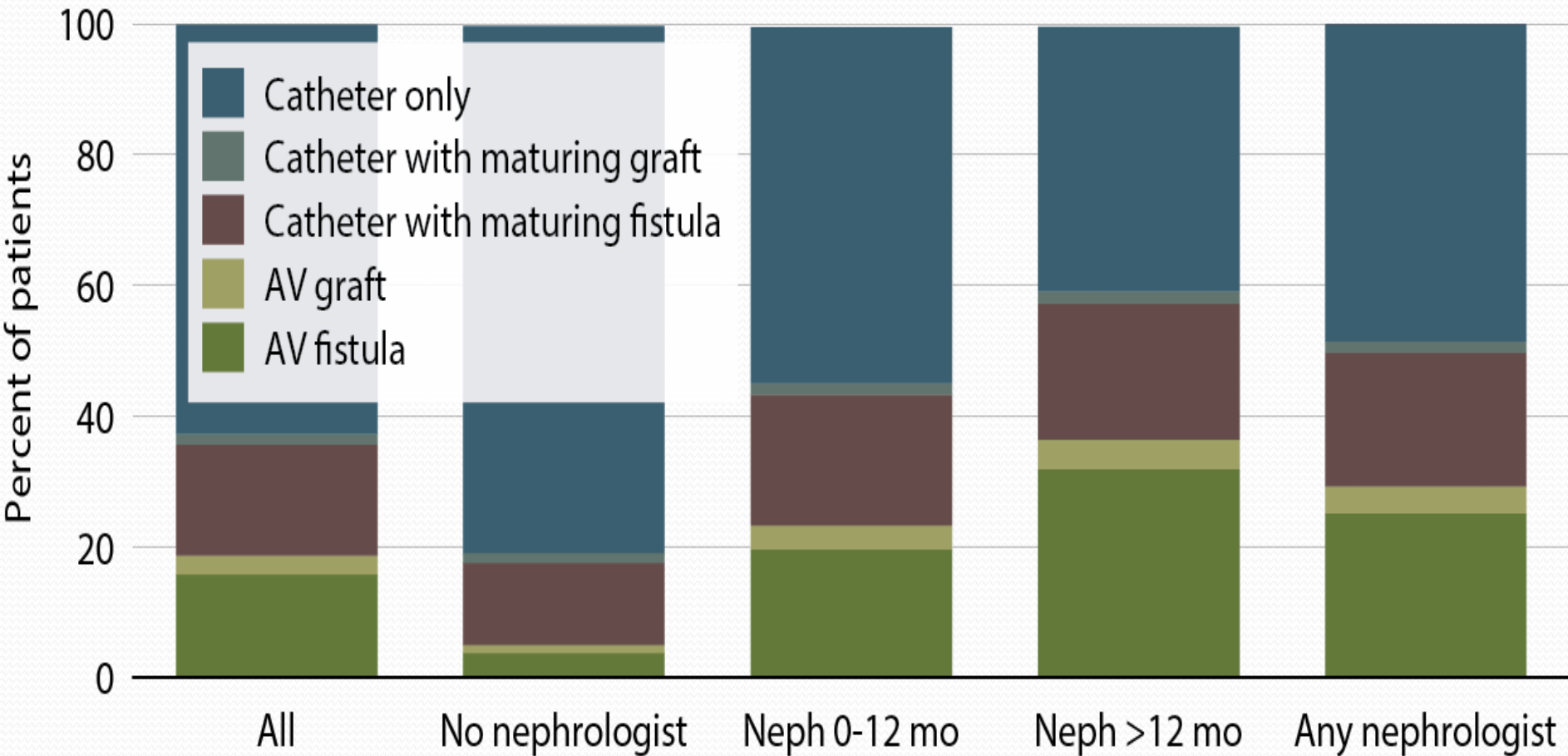
Data source: Special analyses, USRDS ESRD Database (2014 Annual Data Report)

Abbreviations: Hosp-based, hospital-based dialysis centers; Indep, independent dialysis providers; LDO, large dialysis organizations; SDO, small dialysis organizations

Figure 2: Vascular Access Use, by Country Among Incident HD Patients



Access Use at First Outpatient Hemodialysis, by Pre-ESRD Nephrology Care, 2011



Data Source: USRDS ESRD Database (2013 Annual Data Report)

KDOQI/NKF Clinical Practice Guidelines

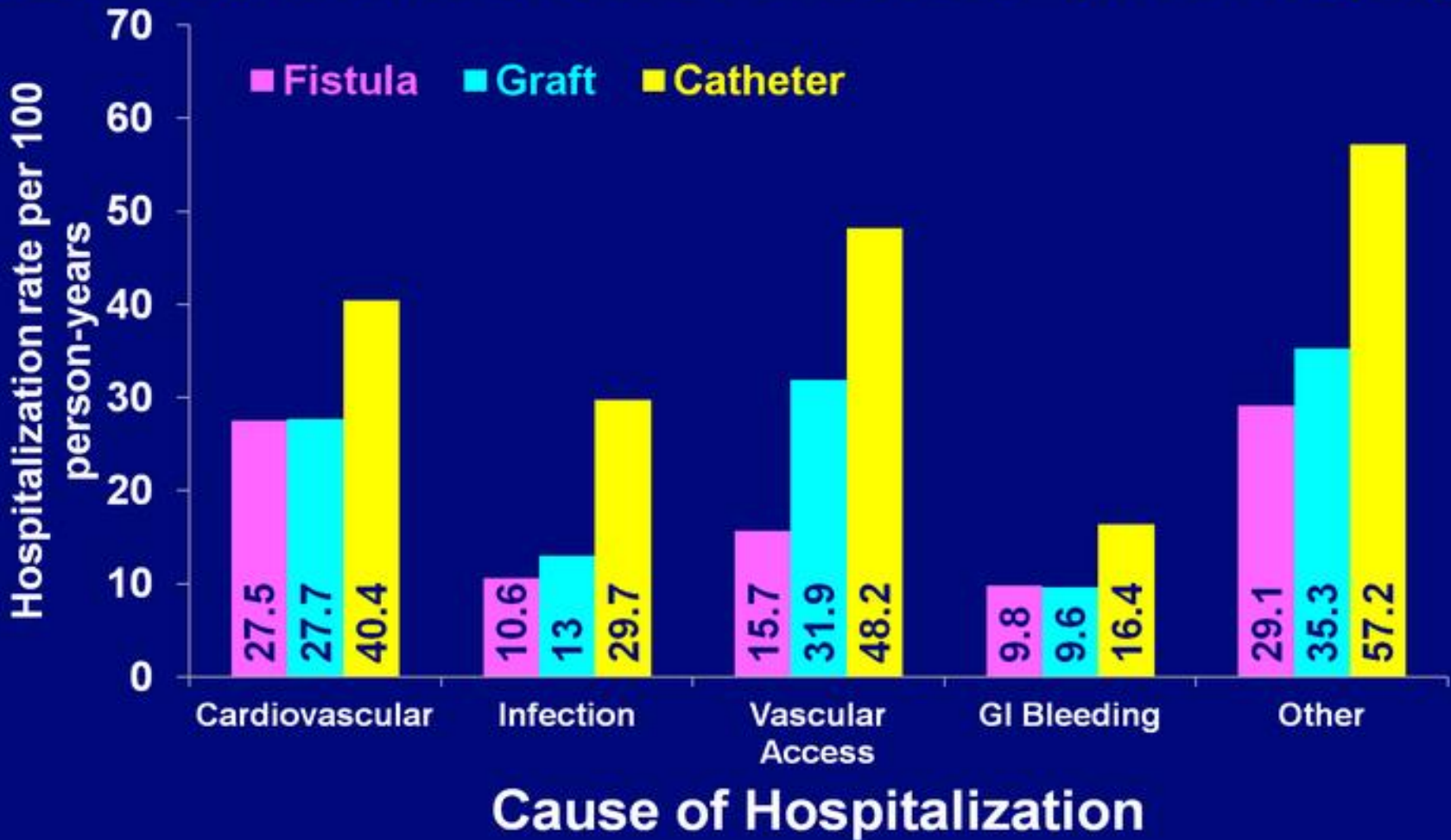
Timing of Access Placement

- Patients with chronic kidney disease should be referred for surgery to attempt construction of a primary AV fistula when their **creatinine clearance is <25 mL/min**, their serum **creatinine level is >4 mg/dL**, or **within 1 year of an anticipated need for dialysis**. (Opinion)
- Dialysis **AV Fistula** should be placed **6 months prior** and **AV grafts** should be placed at least **3 to 6 weeks prior** to an anticipated need for hemodialysis in patients who are not candidates for primary AVF. (Opinion)

Goals of Access Placement–Maximizing Primary AV Fistulae

- Primary AV fistulae should be **constructed in at least 50%** of all new kidney failure patients electing to receive hemodialysis as their initial form of renal replacement therapy. (Opinion)

Cause-specific hospitalization rates according to VA type among patients accounting for conversions occurring within the first 6 months (time-varying)



Variables Associated With Catheter Versus Permanent Access Use at Hemodialysis Start

Variable	OR (95% CI)
Physician factors	
First nephrology review <3 mo before dialysis start (vs >3 mo)	32.77 (8.66-123.97)
First nephrology review <12 mo before dialysis start (vs >12 mo)	8.20 (5.92-11.36)
Predialysis education (vs no education)	0.44 (0.27-0.71) ^e
eGFR at AVF/AVG creation (/5-mL/min/1.73 m ² increase)	0.22 (0.10-0.50) ^d
Patient factors	
Female sex	1.95 (1.22-3.11) ^e
Age (/10-y increase)	0.99 (0.87-1.12)
Current smoking	0.70 (0.45-1.09)
Racial origin	
White	1.00 (reference)
Aboriginal/Maori/Pacific Islander	3.11 (2.35-4.13) ^d
Asian	1.53 (0.72-3.22)
Other/unknown	2.76 (1.34-5.68) ^e
Cause of ESKD	
Diabetes mellitus	1.00 (reference)
Glomerulonephritis	0.44 (0.31-0.61) ^d
Hypertension/vascular	0.34 (0.10-1.22)
Adult PKD	0.17 (0.04-0.69) ^f
Other/unknown	0.85 (0.44-1.66)
Peripheral vascular disease	1.48 (0.97-2.27)
Presentation type	
Predialysis	1.00 (reference)
Failed transplant	0.28 (0.17-0.47) ^d
Failed peritoneal dialysis	1.58 (0.80-3.11)
Peritoneal dialysis rest	0.32 (0.08-1.28)

Odds of Having Functional Permanent Access at the Start of Hemodialysis

Covariate	N = 1909	OR (95% CI)	P value	aOR (95% CI) ^a	P value
Age decades	1878	1.05 (0.99, 1.11)	0.14	1.10 (0.99, 1.22)	0.08
<55 years	606	1		1	
55-70 years	681	1.31 (1.03, 1.65)	0.02	1.39 (0.96, 2.01)	0.08
>70 years	600	1.13 (0.89, 1.44)	0.33	1.29 (0.87, 1.90)	0.21
Serum albumin per mg/dL	1810	1.58 (1.31, 1.89)	<0.001	1.55 (1.16, 2.08)	0.003
Use of erythropoetin prior to starting HD	1668	2.04 (1.58, 2.65)	<0.001	1.79 (1.23, 2.61)	0.002
Visits to a nephrologist prior to starting HD			<0.001		<0.001
>5	464	1		1	
2-5	268	0.63 (0.46, 0.85)	0.003	0.73 (0.50, 1.05)	0.09
1	94	0.28 (0.16, 0.47)	<0.001	0.21 (0.10, 0.43)	<0.001
0	319	0.21 (0.15, 0.29)	<0.001	0.36 (0.23, 0.57)	<0.001
When patient was told about renal disease					<0.001
>1 year before start of hemodialysis	589	1	<0.001	1	
1-12 months before start of hemodialysis	391	0.67 (0.51, 0.87)	0.003	0.93 (0.66, 1.31)	0.69
1-4 weeks before start of hemodialysis	108	0.23 (0.13, 0.40)	<0.001	0.33 (0.16, 0.68)	0.002
<1 week before start of hemodialysis	114	0.09 (0.04, 0.19)	<0.001	0.16 (0.06, 0.42)	<0.001
Body mass index per SD	1760	1.18 (1.00, 1.40)	0.05		
History of diabetes	1867	1.26 (1.04, 1.53)	0.02		
Hematocrit at start of dialysis per SD	1850	1.16 (1.05, 1.28)	0.004		
Ability to independently ambulate	1889	1.44 (1.10, 1.87)	0.02		
Method of modality choice	1226		<0.001		
Medical team took the lead		1			
Medical team and patient took the lead		1.03 (1.00, 1.74)	0.04		
Patient took the lead		2.36 (1.72, 3.25)	<0.001		

Vascular Access Placement in Patients with Incident CKD Stage 4 and 5 attending an Inner City Nephrology Clinic: A Cohort Study and Survey of Providers

Narender Goel MD, Caroline Kwon MD, Teena P. Charalel MD, Vaughn W. Folkert MD, Carolyn Bauer MD, Michal L Melamed MD, MHS

Design

- Retrospective chart review

Study Period

- June 1, 2011 to August 31, 2012
- Patients were followed via chart review until August 31, 2013

Objective:

- Assess associations of key variables with vascular surgery referral, AV access placement and initiation of dialysis
- Survey of nephrologists at our institution to assess their perceptions of the access placement process.

Inclusion Criterion:

- All adult patients, age >18 years seeing a nephrologist with new CKD stage 4 or 5 during the study period.
- Patients (n=31) who had prior nephrologist follow-up for CKD stage 2 or 3 but were seen during the study period for the first time with a diagnosis of CKD stage 4 or 5 were also included

Exclusion Criterion:

- Patients choosing Peritoneal Dialysis as mode of dialysis
- Patients declined to accept dialysis
- Patients had arm access placed before study period
- If patients were seeing a nephrologist at our institution for CKD stage 4 or 5 prior to June 1st, 2011

Nephrologists Survey

- We also conducted a web-based anonymous survey of all of the nephrology faculty members and fellows (PGY 4 and 5)
- Questions and responses in the survey included:
 - ❑ **In your opinion, what is the main limiting factor in referring patients with CKD stage 4 and 5 to a vascular surgeon?**
 - ❑ *Possible answers:*
 - i. Patients' refusal
 - ii. Patients' non-compliance
 - iii. Patients not decided about modality of dialysis
 - iv. Nephrologists
 - v. Insurance status
 - vi. Co-morbidities

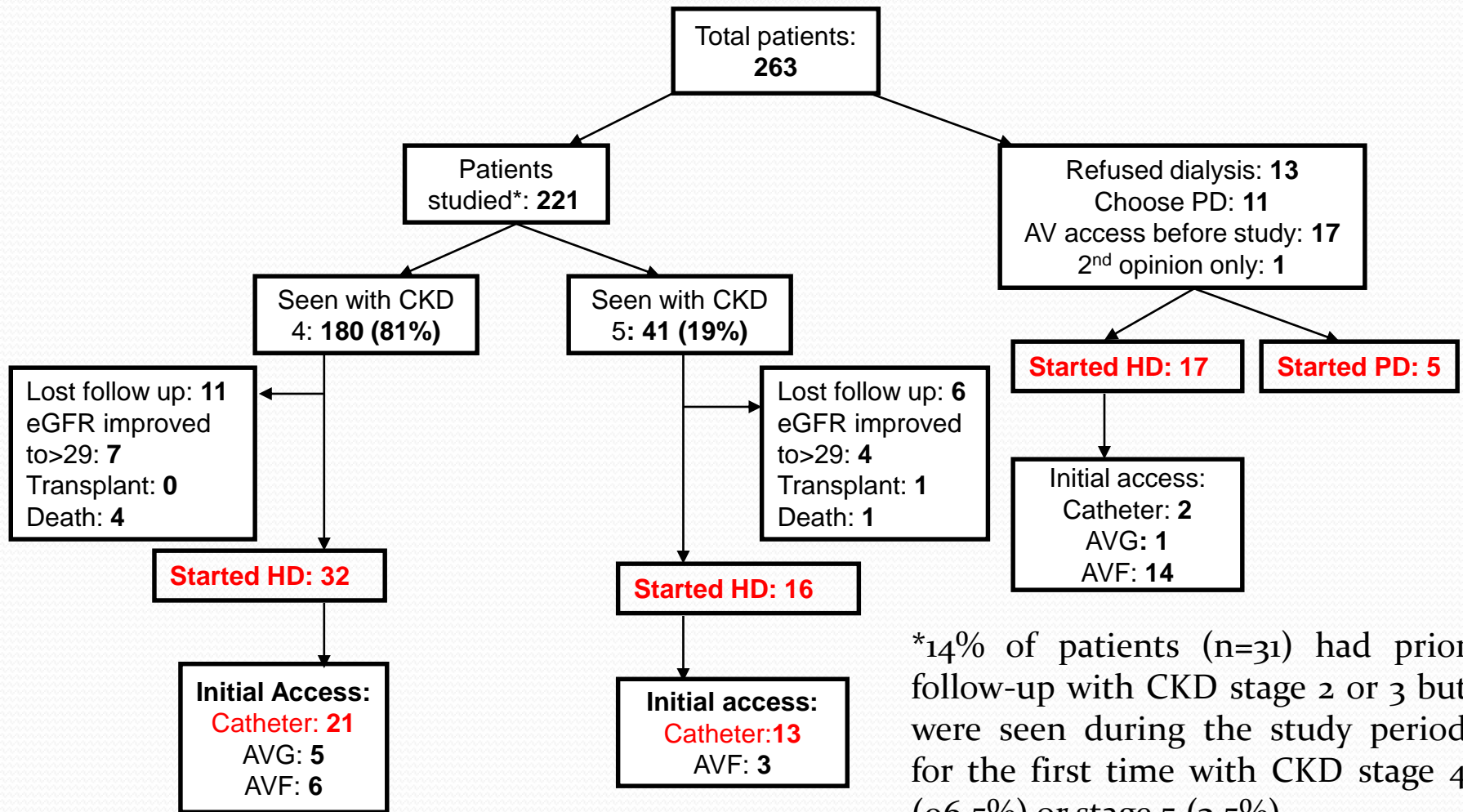


- **In your opinion, what is the main limiting factor in obtaining timely vascular access?**

- Possible answers:*

- i. Nephrologists
- ii. Vascular surgeon
- iii. Hospital system and appointments
- iv. Patients
- v. I am not sure

Study Flow Diagram



*14% of patients (n=31) had prior follow-up with CKD stage 2 or 3 but were seen during the study period for the first time with CKD stage 4 (96.5%) or stage 5 (3.5%).

Baseline Demographics

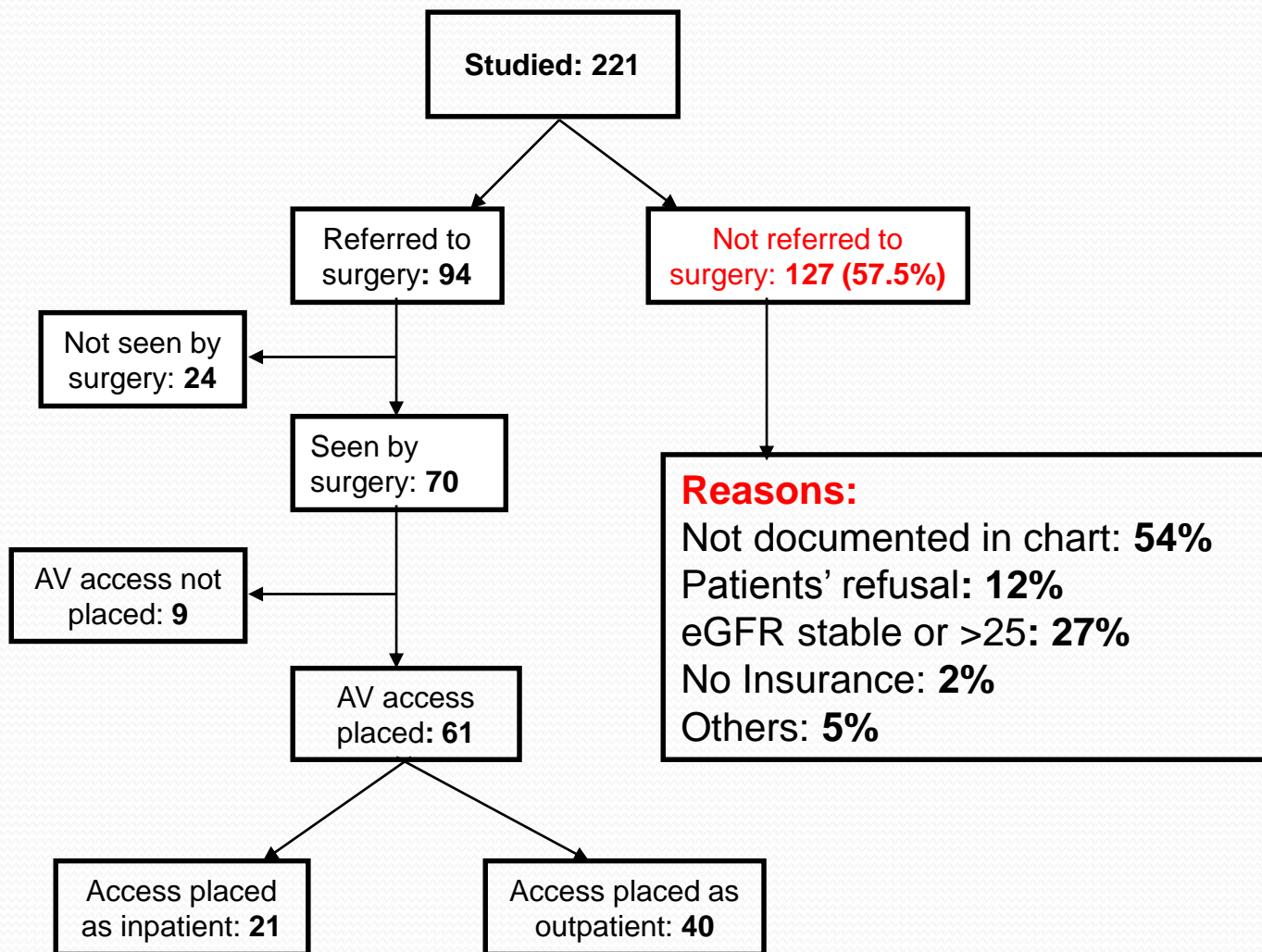
	Total-221	Faculty (141)	Fellow (80)	p-value
Age [years]	64.8 (13.6)	67.2 (12.9)	60.6 (13.7)	<0.001
Female (%)	124 (56)	91 (64.5)	33 (41.2)	0.001
Mean BMI [Kg/m ²]	30.4 (7.0)	30.7 (7.1)	29.7 (6.9)	0.14
Co-morbidities				
Hypertension (%)	206 (93.2)	130 (92.2)	76 (95)	0.58
Diabetes Mellitus (%)	146 (66)	93 (65.9)	53 (66.3)	0.9
Congestive Heart Failure (%)	96 (43.4)	58 (41.1)	38 (47.5)	0.39
Peripheral Vascular Disease (%)	33 (14.9)	23 (16.3)	10 (12.5)	0.55
Race/ Ethnicity				0.06
White (%)	17 (7.7)	14 (9.9)	3 (3.7)	
African-American (%)	68 (30.8)	49 (34.7)	19 (23.7)	
Hispanic (%)	107 (48.4)	63 (44.7)	44 (55)	
Other (%)	29 (13.1)	15 (10.6)	14 (17.5)	

Demographics	Total-221	Faculty (141)	Fellow (80)	p-value
Primary Language				
English (%)	164 (74.2)	108 (76.5)	56 (70)	0.3
Spanish (%)	51 (23.2)	30 (21.3)	21 (26.2)	0.4
Insurance				
Medicaid (%)	77 (34.8)	33 (23.4)	44 (55)	<0.001
Medicare (%)	70 (31.8)	54 (38.3)	16 (20)	0.006
Never smoker (%)	118 (53.4)	76 (53.9)	42 (52.5)	0.8
Hemoglobin, mean (SD) [gm/dL]	10.7 (1.8)	10.9 (1.8)	10.3 (1.8)	0.04
Albumin, mean [gm/dL]	3.8 (0.6)	3.96 (0.6)	3.53 (0.7)	<0.001
Creatinine, mean [mg/dL]	2.88 (1.2)	2.7 (1.2)	3.18 (1.2)	0.005
Renal Clinic Visits, mean (SD)	5.4 (4.1)	5.3 (4.2)	5.5 (4.1)	0.8
eGFR [ml/min/1.73 m²] at the study entry, mean (SD)	20.8 (6.4)	21.3 (6.2)	19.8 (6.5)	0.07
Urine Albumin/creatinine ratio	0.78 (0.18, 3.73)	0.51 (0.13, 2.08)	2.64 (0.44, 5.31)	<0.001
Follow up (years), median (IQR)	1.26 (0.6-1.68)	1.3(0.75-1.69)	1.2 (0.4-1.6)	0.1

CKD Etiology

	N=221	%
Diabetes Mellitus	68	30.8
Hypertension	57	25.8
Multi-factorial	11	4.9
Acute Kidney Injury	10	4.5
Glomerular disease	9	4.1
Polycystic Kidney Disease	2	0.9
HIV	1	0.4
unknown	40	18.2
Others	23	10.4

Vascular Surgery Referral and AV Access Placement



- A total of 94 patients (42.5%) were referred to vascular surgery with a mean eGFR at the time of referral of 16.3 ± 5.5 ml/min/1.73m².
- Access surgery was done in 61 (27.6%) patients (55 AVF and 6 AVG) with mean eGFR of 14.3 ± 6.2 ml/min/1.73m²
- The median time of referral to the surgeon from the initial nephrology study visit was 28 days (IQR, 0-133)
- The median time to see the surgeon from the time of referral was 52 days (IQR, 27-106).
- The median time to surgery after an appointment with the surgeon was 30 days (IQR, 15-85).

- The predominant reasons for not undergoing an access surgery (n=160) were as follows:
 - I. 43% of patients were not referred for unknown reasons
 - II. 20% of patients had stable eGFR or eGFR >25 ml/min/1.73m²
 - III. 10% of patients refused
 - IV. 7% of patients missed their appointment

Odds Ratio of Vascular Surgery Referral and AV Access Placement

	Vascular surgery referral (n=94)			AV access placement (n= 61)			Initiated Dialysis (n = 48)		
	OR*	95% CI	p-value	OR*	95% CI	p-value	OR*	95% CI	p-value
Age, per year	0.99	0.96 - 1.02	0.33	0.97	0.94 - 1.00	0.06	0.98	0.95 - 1.01	0.27
African-American Race (compared to white)	4.65	1.00 - 21.6	0.05	1.10	0.27 - 4.46	0.89	0.72	0.15 - 3.43	0.68
Hispanic Ethnicity (compared to non- Hispanic white)	2.81	0.64 - 12.44	0.17	0.70	0.18 - 2.76	0.61	0.51	0.11 - 2.31	0.38
Diabetes Mellitus	1.29	0.58 - 2.88	0.53	0.91	0.40 - 2.06	0.82	1.76	0.66 - 4.71	0.26
Log urine protein/ creatinine ratio	1.45	1.13 - 1.86	0.003	1.36	1.05 - 1.75	0.02	1.72	1.28 - 2.32	<0.001

All models for age, sex, race/ethnicity, diabetes mellitus, log urinary albumin/creatinine ratio and baseline eGFR. Renal fellow visit, number of renal visits, number of hospitalization, and the presence of AKI during a hospitalization put in individually with the above adjusters.

Abbreviations: OR-odds ratio; CI-confidence interval

Odds Ratio of Vascular Surgery Referral and AV access Placement

	Vascular surgery referral (n=94)			AV access placement (n= 61)			Initiated Dialysis (n = 48)		
	OR*	95% CI	p-value	OR*	95% CI	p-value	OR	95% CI	p-value
eGFR at the study entry	0.87	0.82 - 0.93	<0.001	0.89	0.83- 0.94	<0.001	0.90	0.84- 0.97	0.003
Patient seen with renal fellow	1.45	0.67 - 3.13	0.34	1.10	0.25- 1.49	0.82	1.35	0.56- 3.27	0.50
Number of nephrology visits	1.27	1.12 - 1.45	<0.001	1.13	1.01- 1.25	0.03	1.02	0.92- 1.14	0.68
Hospitalization during follow-up	0.97	0.41 - 2.29	0.94	2.46	0.94 - 6.4	0.07	13.0	2.3 - 73.3	0.004
AKI during hospitalization	0.78	0.35 - 1.72	0.53	1.84	0.79- 4.28	0.226	6.6	1.89- 22.8	0.003

All models for age, sex, race/ethnicity, diabetes mellitus, log urinary albumin/creatinine ratio and baseline eGFR. Renal fellow visit, number of renal visits, number of hospitalization, and the presence of AKI during a hospitalization put in individually with the above adjusters.
Abbreviations: OR-odds ratio; CI-confidence interval)

- By the end of study, 48 patients had started hemodialysis with mean eGFR of 9.0 ± 4.9 ml/min/1.73m²
- Out of those, 28 patients with CKD stage 4 and 16 patients with CKD stage 5 diagnosis were referred to nephrologist.
- Of all the patients started on hemodialysis, 30 patients (62.5%) saw a nephrologist for less than a year and 17 patients (35%) had seen the nephrologist for <6 months.
- The mean time from the study visit to hemodialysis was similar in patients with initial nephrology visit with CKD 5 vs. CKD 4 (0.68 ± 0.5 years vs 0.83 ± 0.5 years, $p=0.4$)
- Of the 48 patients who started dialysis, 44 of them had a hospitalization with an AKI episode, compared to 4 such hospitalizations in 173 patients who did not start dialysis (p-value <0.001 for comparison).

Reasons for Non-placement of Vascular Access

Limiting Factors	Vascular Surgery Referral (n=94)			AV Access Placement (n= 61)		
	Nephrologist Survey	Observed by chart Review	p-value	Nephrologist Survey	Observed by chart review	p-value
Patients	88.2 ¹ %	15 %	<0.001	41.2 %	17.5 %	0.01
Nephrologists	5.9 %	51%	<0.001	5.9 %	43.7 %	<0.001
Health system problems ²	5.9%	2%	0.19	41.2%	11.2%	<0.001
Vascular surgeon	NA	NA	NA	0%	0%	NA
Stable GFR ³	NA	27 %	NA	NA	20 %	NA
Others	NA	5 %	NA	11.8 ⁴ %	8.2 %	0.5

¹Patient refusal (47%), patient non-compliance (29.4%) and patient not decided about modality of dialysis (11.8%);

²Health system problems include insurance problems and hospital system and appointment problems including time delay in waiting for surgery or appointment.


³It was not known to be a barrier at the time of survey hence was not included in survey;

⁴Actual answer: "I am not sure";

Abbreviation: NA-Not applicable

Conclusions

- Late referrals to nephrologists, limited follow-up time, and the nephrologists' lack of prompt referrals to surgery: All together resulted in the predominant use of catheters as an initial vascular access.
- One factor associated with placement of a vascular access was frequent nephrology visits, suggesting that late stage CKD patients may require more frequent clinical visits.
- Nephrologists perceive patients as the major limiting factor to vascular access placement, however, our chart review showed the nephrologist as a potential barrier.

- 
- Nephrologists may not be referring the correct patients to get an AV access surgery.
 - In our late stage CKD population, hospitalizations, especially ones with an AKI episode, were strongly associated with the need for dialysis suggesting that nephrologists need to be vigilant with these patients and follow them frequently in clinic.

A Predictive Model for Progression of Chronic Kidney Disease to Kidney Failure

P (event) = Probability of kidney failure at 5 years

Risk Factor	Categories	Points	Risk Factor	Categories	Points	
eGFR	10-14	-35	Albumin	<= 2.5	-5	
	15-19	-30		2.6-3	0	
	20-24	-25		3.1-3.5	2	
	25-29	-20		>= 3.6	4	
	30-34	-15		Phosphorous	< 3.5	3
	35-39	-10			3.5-4.5	0
	40-44	-5			4.6-5.5	-3
	45-49	0			> 5.5	-5
	50-54	5			Bicarbonate	< 18
	55-59	10		18-22		-4
Male	No	0	23-25	-1		
	ACR	Yes	-2	>25	0	
		<30	0	Calcium	<= 8.5	-3
30-300		-14	8.6-9.5		0	
> 300	-22	>9.6	2			
Age	< 30	-4				
	30-39	-2				
	40-49	0				
	50-59	2				
	60-69	4				
	70-79	6				
	80-89	8				
	> 90	10				

Score	P(event)	Score	P(event)
-41	89.0%	-21	26.4%
-40	86.9%	-20	24.2%
-39	84.1%	-19	22.2%
-38	81.0%	-18	20.3%
-37	77.8%	-17	18.6%
-36	74.4%	-16	17.0%
-35	70.9%	-15	15.5%
-34	67.3%	-14	14.1%
-33	63.6%	-13	12.9%
-32	59.9%	-12	11.7%
-31	56.3%	-11	10.7%
-30	52.8%	-10	9.7%
-29	49.3%	-9	8.8%
-28	45.9%	-8	8.0%
-27	42.7%	-7	7.3%
-26	39.6%	-6	6.6%
-25	36.6%	-5	6.0%
-24	33.8%	-4	5.5%
-23	31.2%		
-22	28.7%		

Interpretation

Score < -41 = P (Kidney Failure) > 90%

Score > -3 = P (Kidney Failure) < 5%

Between -3 and -41, please refer to the chart

Tangri N et al. *JAMA*. 2011;305(15):1553-1559.

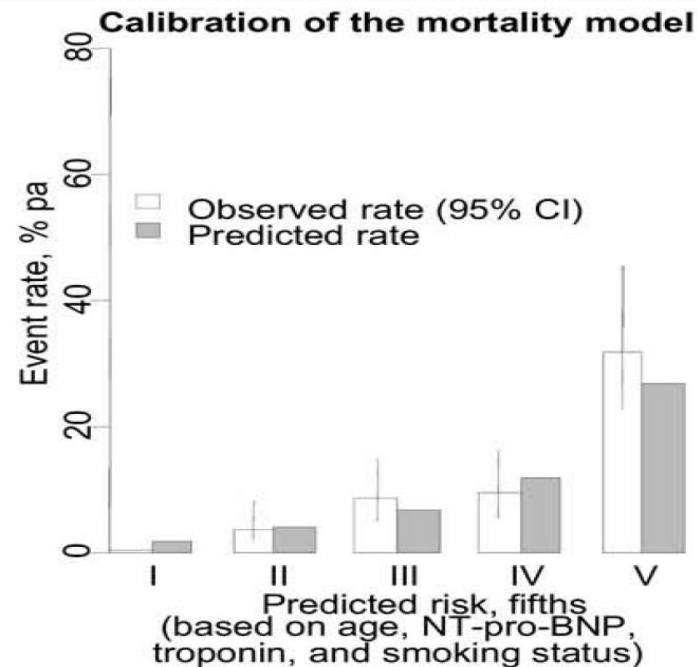
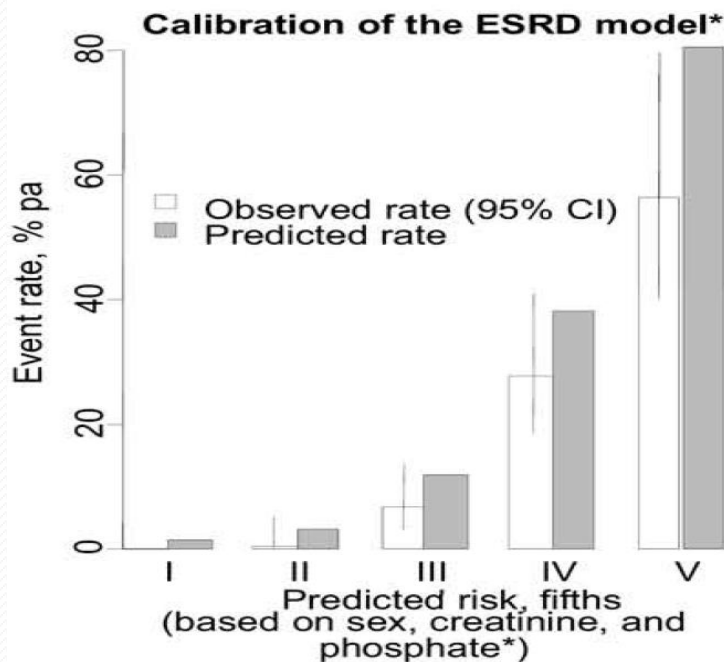
A smartphone app is available at

<http://www.qxmd.com/Kidney-Failure-Risk-Equation>.

Prediction of ESRD and Death Among People With CKD: The Chronic Renal Impairment in Birmingham (CRIB) Prospective Cohort Study

Landray et al. Am J Kidney Dis. 2010 Dec;56(6):1082-94.

Model	Baseline Measurement	Comparison	RR (95% CI)
ESRD	Creatinine	Per 50% higher level ^a	3.25 (2.69-3.92) ^b
	Phosphate	Per 30% higher level ^a	1.46 (1.21-1.77)
	ACR	Per 5-fold higher level ^a	1.51 (1.24-1.85)
	Sex	Female vs male	1.54 (1.13-2.09)
Death	Age	Per 15 y older ^a	1.95 (1.54-2.45)
	NT-pro-BNP	Per 5-fold higher level ^a	1.72 (1.41-2.12)
	Cigarette smoking	Current vs not current	2.36 (1.56-3.59)
	TnT	Increased vs not increased ^c	1.83 (1.26-2.66)



Limitations

- It is a single center study with small numbers
- The chart review was performed retrospectively and thus we didn't have information on reasons for not referring to surgeon when not documented in chart.
- We also lacked information on patients who may have initiated HD at other institutions or at an outpatient HD unit and were never seen at our institution thereafter.

Thank
you

