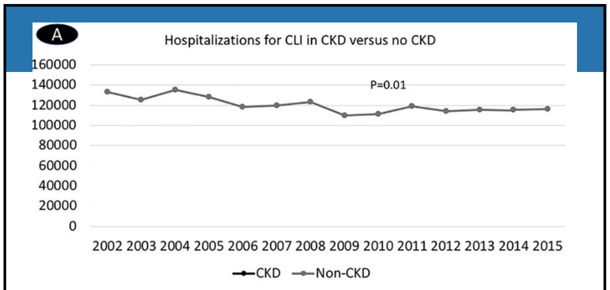
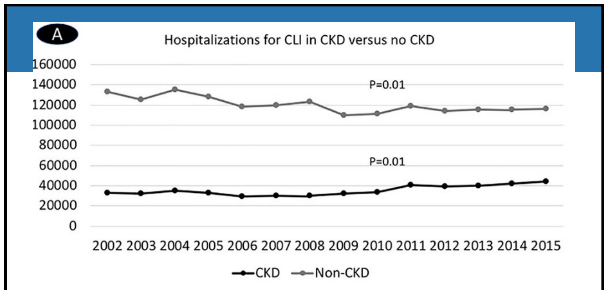
Renal Failure In CLTI Patients Should Not Be A Contraindication To Limb Salvage Attempts A

Vincent L. Rowe, M.D., F.A.C.S.
Professor and Chief
Gonda (Goldschmied) Vascular Center
Division of Vascular and Endovascular Surgery

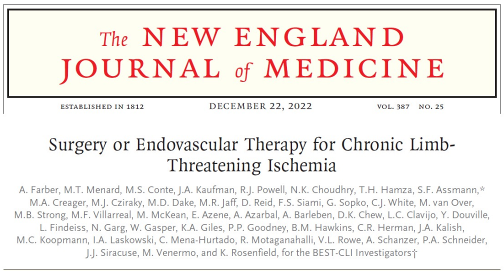
No Financial Disclosures



Vasc Med 2021 Apr;26(2):155-163



Vasc Med 2021 Apr;26(2):155-163



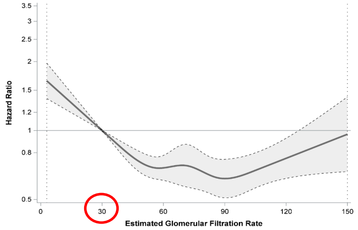
The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 DECEMBER 22, 2022 VOL. 387 NO. 25

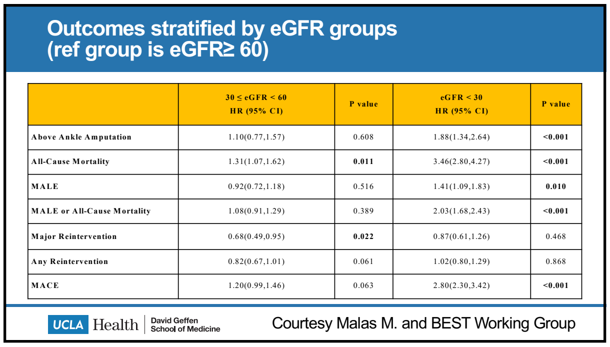
Surgery or Endovascular Therapy for Chronic Limb-Threatening Ischemia

A. Farber, M.T. Menard, M.S. Conte, J.A. Kaufman, R.J. Powell, N.K. Choudhry, T.H. Hamza, S.F. Assmann,* M.A. Creager, M.J. Cziraky, M.D. Dake, M.R. Jaff, D. Reid, F.S. Siami, G. Sopko, C.J. White, M. van Over, M.B. Strong, M.F. Villarreal, M. McKean, E. Azene, A. Azarbal, A. Barleben, D.K. Chew, L.C. Clavijo, Y. Douville, L. Findeiss, N. Garg, W. Gasper, K.A. Giles, P.P. Goodney, B.M. Hawkins, C.R. Herman, J.A. Kalish, M.C. Koopmann, I.A. Laskowski, C. Mena-Hurtado, R. Motaganahalli, V.L. Rowe, A. Schanzer, P.A. Schneider, J.J. Siracuse, M. Venermo, and K. Rosenfield, for the BEST-CLI Investigators†

Spline model analysis identified eGFR<30 as the inflection point of increased hazard of MALE/Death



Courtesy Malas M. and BEST Working Group

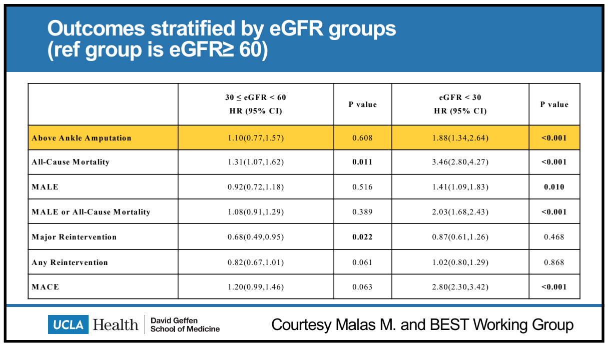


Outcomes stratified by eGFR groups (ref group is eGFR≥ 60)

	30 ≤ eGFR < 60 HR (95% CI)	P value	eGFR < 30 HR (95% CI)	P value
Above Ankle Amputation	1.10(0.77,1.57)	0.608	1.88(1.34,2.64)	**<0.001**
All-Cause Mortality	1.31(1.07,1.62)	**0.011**	3.46(2.80,4.27)	**<0.001**
MALE	0.92(0.72,1.18)	0.516	1.41(1.09,1.83)	**0.010**
MALE or All-Cause Mortality	1.08(0.91,1.29)	0.389	2.03(1.68,2.43)	**<0.001**
Major Reintervention	0.68(0.49,0.95)	**0.022**	0.87(0.61,1.26)	0.468
Any Reintervention	0.82(0.67,1.01)	0.061	1.02(0.80,1.29)	0.868
MACE	1.20(0.99,1.46)	0.063	2.80(2.30,3.42)	**<0.001**

UCLA Health | David Geffen School of Medicine

Courtesy Malas M. and BEST Working Group

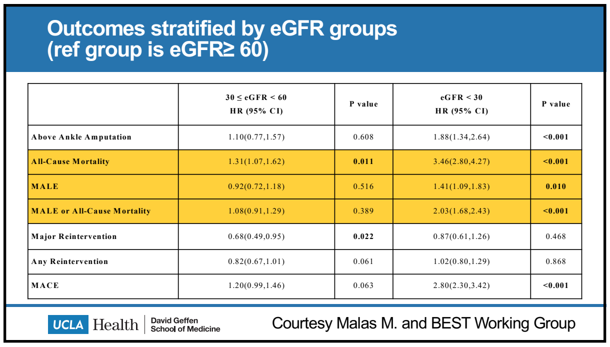


Outcomes stratified by eGFR groups (ref group is eGFR≥ 60)

	30 ≤ eGFR < 60 HR (95% CI)	P value	eGFR < 30 HR (95% CI)	P value
Above Ankle Amputation	1.10(0.77,1.57)	0.608	1.88(1.34,2.64)	**<0.001**
All-Cause Mortality	1.31(1.07,1.62)	**0.011**	3.46(2.80,4.27)	**<0.001**
MALE	0.92(0.72,1.18)	0.516	1.41(1.09,1.83)	**0.010**
MALE or All-Cause Mortality	1.08(0.91,1.29)	0.389	2.03(1.68,2.43)	**<0.001**
Major Reintervention	0.68(0.49,0.95)	**0.022**	0.87(0.61,1.26)	0.468
Any Reintervention	0.82(0.67,1.01)	0.061	1.02(0.80,1.29)	0.868
MACE	1.20(0.99,1.46)	0.063	2.80(2.30,3.42)	**<0.001**

UCLA Health | David Geffen School of Medicine

Courtesy Malas M. and BEST Working Group

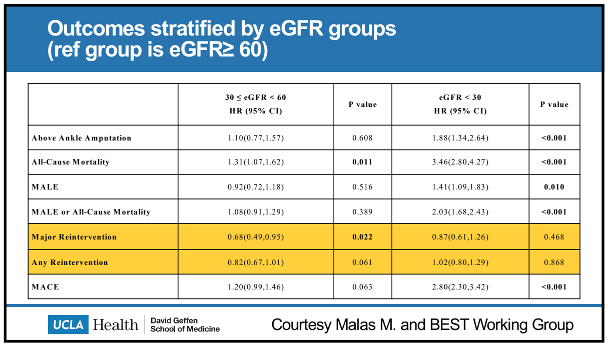


Outcomes stratified by eGFR groups (ref group is eGFR≥ 60)

	30 ≤ eGFR < 60 HR (95% CI)	P value	eGFR < 30 HR (95% CI)	P value
Above Ankle Amputation	1.10(0.77,1.57)	0.608	1.88(1.34,2.64)	**<0.001**
All-Cause Mortality	1.31(1.07,1.62)	**0.011**	3.46(2.80,4.27)	**<0.001**
MALE	0.92(0.72,1.18)	0.516	1.41(1.09,1.83)	**0.010**
MALE or All-Cause Mortality	1.08(0.91,1.29)	0.389	2.03(1.68,2.43)	**<0.001**
Major Reintervention	0.68(0.49,0.95)	**0.022**	0.87(0.61,1.26)	0.468
Any Reintervention	0.82(0.67,1.01)	0.061	1.02(0.80,1.29)	0.868
MACE	1.20(0.99,1.46)	0.063	2.80(2.30,3.42)	**<0.001**

UCLA Health | David Geffen School of Medicine

Courtesy Malas M. and BEST Working Group

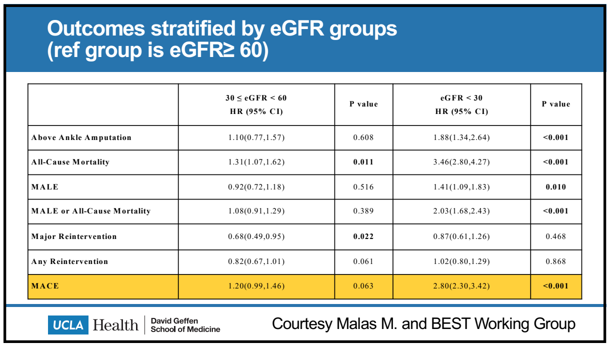


Outcomes stratified by eGFR groups (ref group is eGFR≥ 60)

	30 ≤ eGFR < 60 HR (95% CI)	P value	eGFR < 30 HR (95% CI)	P value
Above Ankle Amputation	1.10(0.77,1.57)	0.608	1.88(1.34,2.64)	**<0.001**
All-Cause Mortality	1.31(1.07,1.62)	**0.011**	3.46(2.80,4.27)	**<0.001**
MALE	0.92(0.72,1.18)	0.516	1.41(1.09,1.83)	**0.010**
MALE or All-Cause Mortality	1.08(0.91,1.29)	0.389	2.03(1.68,2.43)	**<0.001**
Major Reintervention	0.68(0.49,0.95)	**0.022**	0.87(0.61,1.26)	0.468
Any Reintervention	0.82(0.67,1.01)	0.061	1.02(0.80,1.29)	0.868
MACE	1.20(0.99,1.46)	0.063	2.80(2.30,3.42)	**<0.001**

UCLA Health | David Geffen School of Medicine

Courtesy Malas M. and BEST Working Group

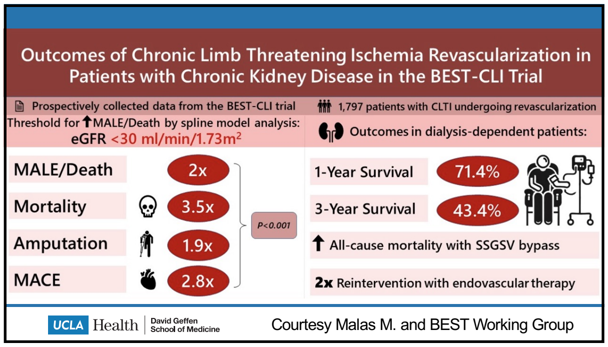


Outcomes stratified by eGFR groups (ref group is eGFR≥ 60)

	30 ≤ eGFR < 60 HR (95% CI)	P value	eGFR < 30 HR (95% CI)	P value
Above Ankle Amputation	1.10(0.77,1.57)	0.608	1.88(1.34,2.64)	**<0.001**
All-Cause Mortality	1.31(1.07,1.62)	**0.011**	3.46(2.80,4.27)	**<0.001**
MALE	0.92(0.72,1.18)	0.516	1.41(1.09,1.83)	**0.010**
MALE or All-Cause Mortality	1.08(0.91,1.29)	0.389	2.03(1.68,2.43)	**<0.001**
Major Reintervention	0.68(0.49,0.95)	**0.022**	0.87(0.61,1.26)	0.468
Any Reintervention	0.82(0.67,1.01)	0.061	1.02(0.80,1.29)	0.868
MACE	1.20(0.99,1.46)	0.063	2.80(2.30,3.42)	**<0.001**

UCLA Health | David Geffen School of Medicine

Courtesy Malas M. and BEST Working Group



Outcomes of Chronic Limb Threatening Ischemia Revascularization in Patients with Chronic Kidney Disease in the BEST-CLI Trial

Prospectively collected data from the BEST-CLI trial

1,797 patients with CLTI undergoing revascularization

Threshold for ↑MALE/Death by spline model analysis: eGFR <30 ml/min/1.73m²

MALE/Death	2x
Mortality	3.5x
Amputation	1.9x
MACE	2.8x

P<0.001

Outcomes in dialysis-dependent patients:

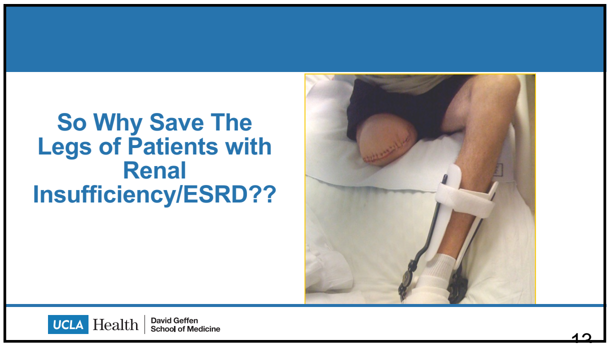
1-Year Survival	71.4%
3-Year Survival	43.4%

↑ All-cause mortality with SSGSV bypass

2x Reintervention with endovascular therapy

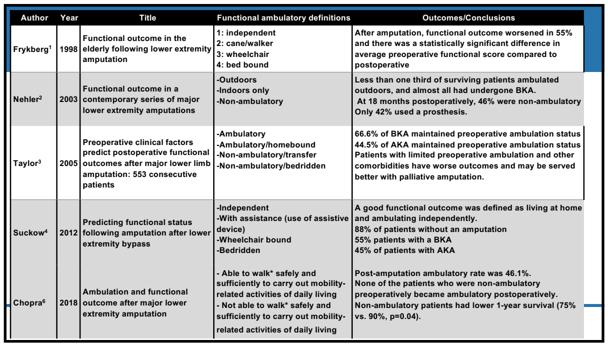
UCLA Health | David Geffen School of Medicine

Courtesy Malas M. and BEST Working Group

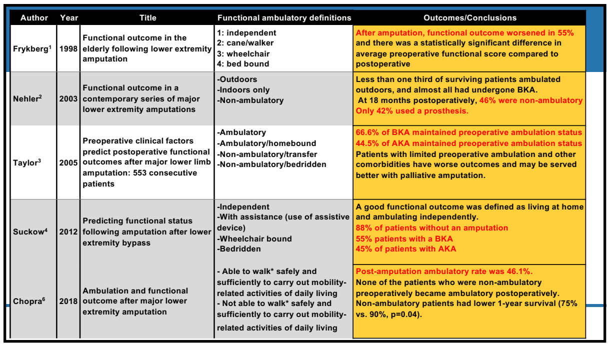


So Why Save The Legs of Patients with Renal Insufficiency/ESRD??

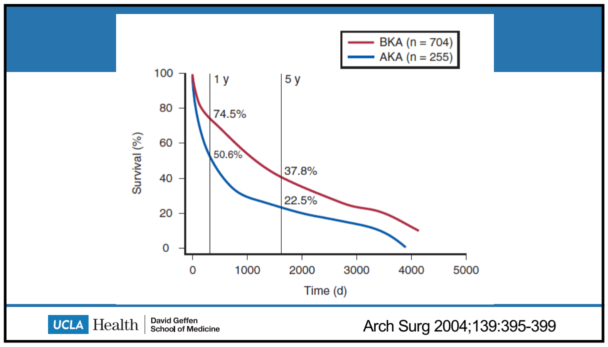
UCLA Health | David Geffen School of Medicine



Author	Year	Title	Functional ambulatory definitions	Outcomes/Conclusions
Frykberg[1]	1998	Functional outcome in the elderly following lower extremity amputation	1: independent 2: cane/walker 3: wheelchair 4: bed bound	After amputation, functional outcome worsened in 55% and there was a statistically significant difference in average preoperative functional score compared to postoperative
Nehler[2]	2003	Functional outcome in a contemporary series of major lower extremity amputations	-Outdoors -Indoors only -Non-ambulatory	Less than one third of surviving patients ambulated outdoors, and almost all had undergone BKA. At 18 months postoperatively, 46% were non-ambulatory Only 42% used a prosthesis.
Taylor[3]	2005	Preoperative clinical factors predict postoperative functional outcomes after major lower limb amputation: 553 consecutive patients	-Ambulatory -Ambulatory/homebound -Non-ambulatory/transfer -Non-ambulatory/bedridden	66.6% of BKA maintained preoperative ambulation status 44.5% of AKA maintained preoperative ambulation status Patients with limited preoperative ambulation and other comorbidities have worse outcomes and may be served better with palliative amputation.
Suckow[4]	2012	Predicting functional status following amputation after lower extremity bypass	-Independent -With assistance (use of assistive device) -Wheelchair bound -Bedridden	A good functional outcome was defined as living at home and ambulating independently. 88% of patients without an amputation 55% patients with a BKA 45% of patients with AKA
Chopra[6]	2018	Ambulation and functional outcome after major lower extremity amputation	- Able to walk* safely and sufficiently to carry out mobility-related activities of daily living - Not able to walk* safely and sufficiently to carry out mobility-related activities of daily living	Post-amputation ambulatory rate was 46.1%. None of the patients who were non-ambulatory preoperatively became ambulatory postoperatively. Non-ambulatory patients had lower 1-year survival (75% vs. 90%, p=0.04).

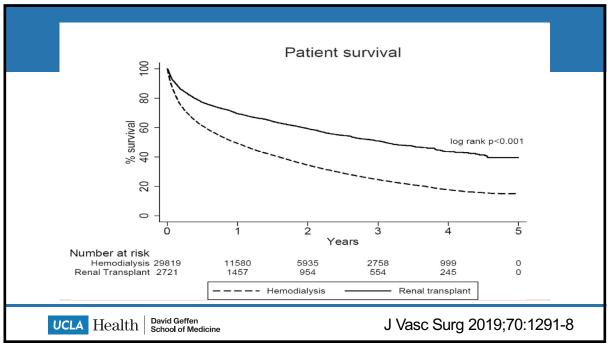


Author	Year	Title	Functional ambulatory definitions	Outcomes/Conclusions
Frykberg[1]	1998	Functional outcome in the elderly following lower extremity amputation	1: independent 2: cane/walker 3: wheelchair 4: bed bound	After amputation, functional outcome worsened in 55% and there was a statistically significant difference in average preoperative functional score compared to postoperative
Nehler[2]	2003	Functional outcome in a contemporary series of major lower extremity amputations	-Outdoors -Indoors only -Non-ambulatory	Less than one third of surviving patients ambulated outdoors, and almost all had undergone BKA. At 18 months postoperatively, 46% were non-ambulatory Only 42% used a prosthesis.
Taylor[3]	2005	Preoperative clinical factors predict postoperative functional outcomes after major lower limb amputation: 553 consecutive patients	-Ambulatory -Ambulatory/homebound -Non-ambulatory/transfer -Non-ambulatory/bedridden	66.6% of BKA maintained preoperative ambulation status 44.5% of AKA maintained preoperative ambulation status Patients with limited preoperative ambulation and other comorbidities have worse outcomes and may be served better with palliative amputation.
Suckow[4]	2012	Predicting functional status following amputation after lower extremity bypass	-Independent -With assistance (use of assistive device) -Wheelchair bound -Bedridden	A good functional outcome was defined as living at home and ambulating independently. 88% of patients without an amputation 55% patients with a BKA 45% of patients with AKA
Chopra[6]	2018	Ambulation and functional outcome after major lower extremity amputation	- Able to walk* safely and sufficiently to carry out mobility-related activities of daily living - Not able to walk* safely and sufficiently to carry out mobility-related activities of daily living	Post-amputation ambulatory rate was 46.1%. None of the patients who were non-ambulatory preoperatively became ambulatory postoperatively. Non-ambulatory patients had lower 1-year survival (75% vs. 90%, p=0.04).



UCLA Health | David Geffen School of Medicine

Arch Surg 2004;139:395-399

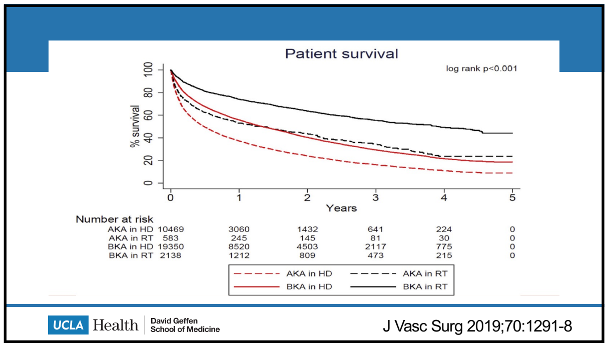


Patient survival

Number at risk	0	1	2	3	4	5
Hemodialysis	29819	11580	5935	2758	999	0
Renal Transplant	2721	1457	954	554	245	0

UCLA Health | David Geffen School of Medicine

J Vasc Surg 2019;70:1291-8

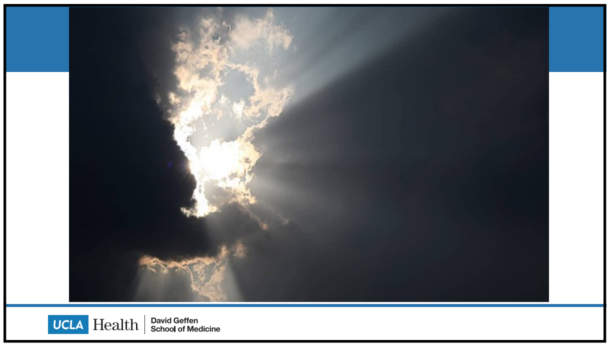


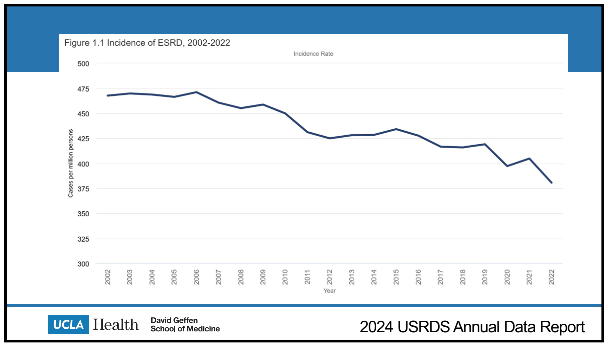
Patient survival

Number at risk	0	1	2	3	4	5
AKA in HD	10469	3060	1432	641	224	0
AKA in RT	583	245	145	81	30	0
BKA in HD	19350	8520	4503	2117	775	0
BKA in RT	2138	1212	809	473	215	0

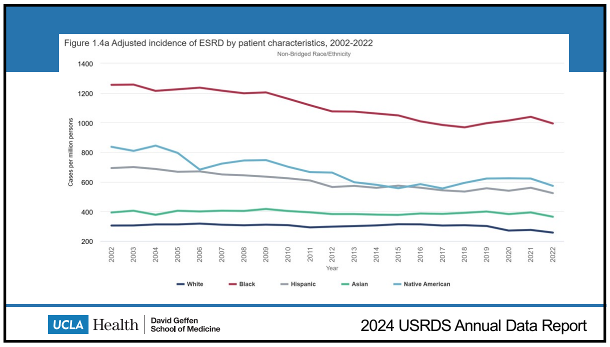
UCLA Health | David Geffen School of Medicine

J Vasc Surg 2019;70:1291-8

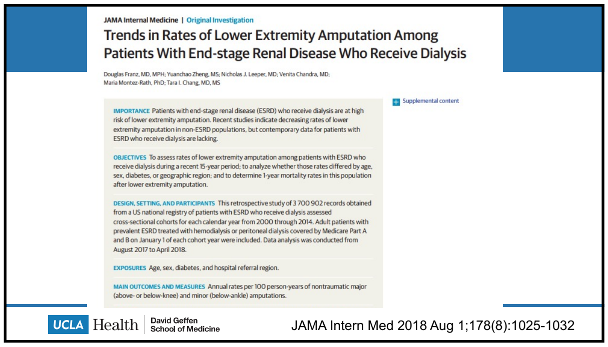




2024 USRDS Annual Data Report



2024 USRDS Annual Data Report



JAMA Internal Medicine | Original Investigation

Trends in Rates of Lower Extremity Amputation Among Patients With End-stage Renal Disease Who Receive Dialysis

Douglas Franz, MD, MPH; Yuanchao Zheng, MS; Nicholas J. Leeper, MD; Venita Chandra, MD; Maria Montez-Rath, PhD; Tara I. Chang, MD, MS

Supplemental content

IMPORTANCE Patients with end-stage renal disease (ESRD) who receive dialysis are at high risk of lower extremity amputation. Recent studies indicate decreasing rates of lower extremity amputation in non-ESRD populations, but contemporary data for patients with ESRD who receive dialysis are lacking.

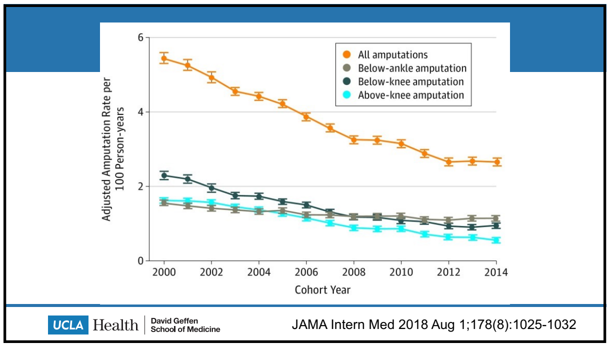
OBJECTIVES To assess rates of lower extremity amputation among patients with ESRD who receive dialysis during a recent 15-year period; to analyze whether those rates differed by age, sex, diabetes, or geographic region; and to determine 1-year mortality rates in this population after lower extremity amputation.

DESIGN, SETTING, AND PARTICIPANTS This retrospective study of 3 700 902 records obtained from a US national registry of patients with ESRD who receive dialysis assessed cross-sectional cohorts for each calendar year from 2000 through 2014. Adult patients with prevalent ESRD treated with hemodialysis or peritoneal dialysis covered by Medicare Part A and B on January 1 of each cohort year were included. Data analysis was conducted from August 2017 to April 2018.

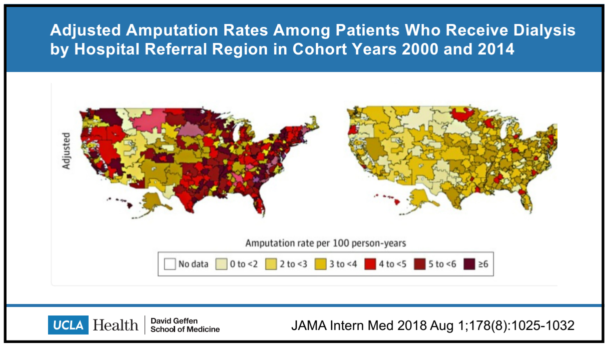
EXPOSURES Age, sex, diabetes, and hospital referral region.

MAIN OUTCOMES AND MEASURES Annual rates per 100 person-years of nontraumatic major (above- or below-knee) and minor (below-ankle) amputations.

JAMA Intern Med 2018 Aug 1;178(8):1025-1032

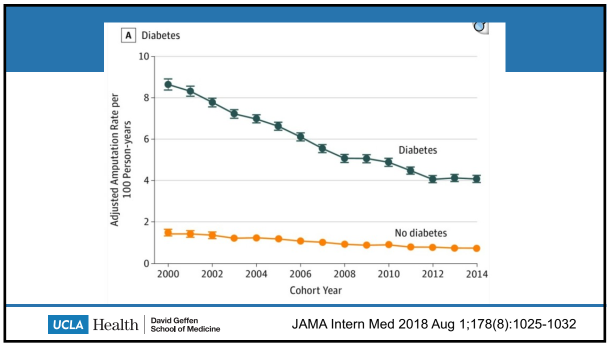


JAMA Intern Med 2018 Aug 1;178(8):1025-1032

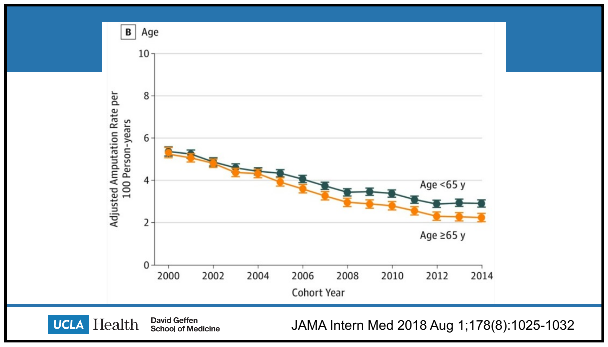


Adjusted Amputation Rates Among Patients Who Receive Dialysis by Hospital Referral Region in Cohort Years 2000 and 2014

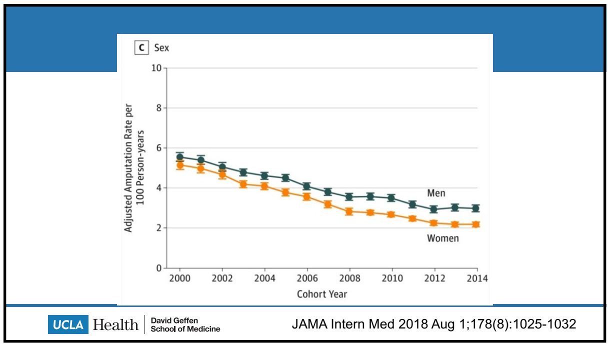
JAMA Intern Med 2018 Aug 1;178(8):1025-1032



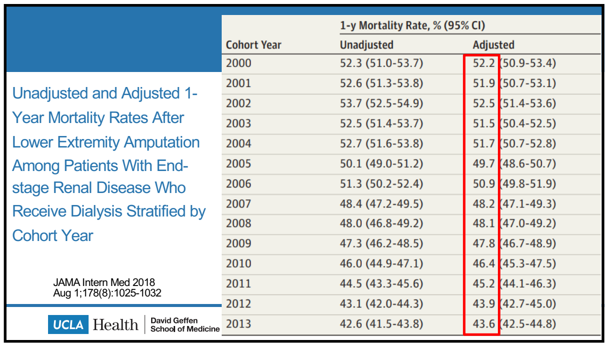
JAMA Intern Med 2018 Aug 1;178(8):1025-1032



JAMA Intern Med 2018 Aug 1;178(8):1025-1032



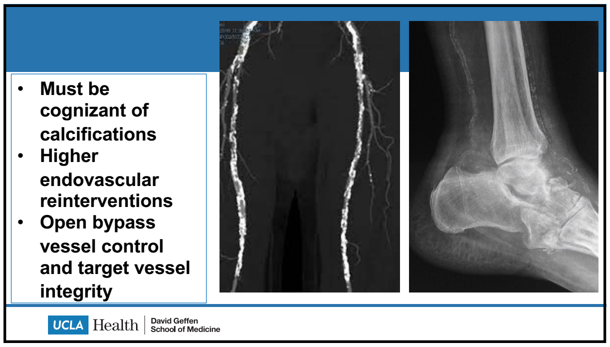
JAMA Intern Med 2018 Aug 1;178(8):1025-1032



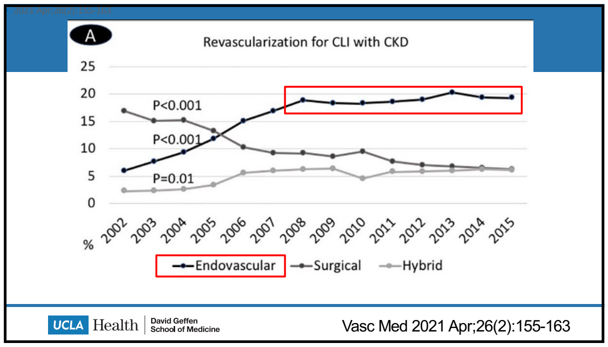
Unadjusted and Adjusted 1-Year Mortality Rates After Lower Extremity Amputation Among Patients With End-stage Renal Disease Who Receive Dialysis Stratified by Cohort Year

Cohort Year	1-y Mortality Rate, % (95% CI) Unadjusted	Adjusted
2000	52.3 (51.0-53.7)	52.2 (50.9-53.4)
2001	52.6 (51.3-53.8)	51.9 (50.7-53.1)
2002	53.7 (52.5-54.9)	52.5 (51.4-53.6)
2003	52.5 (51.4-53.7)	51.5 (50.4-52.5)
2004	52.7 (51.6-53.8)	51.7 (50.7-52.8)
2005	50.1 (49.0-51.2)	49.7 (48.6-50.7)
2006	51.3 (50.2-52.4)	50.9 (49.8-51.9)
2007	48.4 (47.2-49.5)	48.2 (47.1-49.3)
2008	48.0 (46.8-49.2)	48.1 (47.0-49.2)
2009	47.3 (46.2-48.5)	47.8 (46.7-48.9)
2010	46.0 (44.9-47.1)	46.4 (45.3-47.5)
2011	44.5 (43.3-45.6)	45.2 (44.1-46.3)
2012	43.1 (42.0-44.3)	43.9 (42.7-45.0)
2013	42.6 (41.5-43.8)	43.6 (42.5-44.8)

JAMA Intern Med 2018 Aug 1;178(8):1025-1032

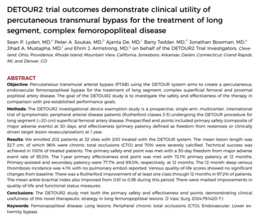


- **Must be cognizant of calcifications**
- **Higher endovascular reinterventions**
- **Open bypass vessel control and target vessel integrity**



Vasc Med 2021 Apr;26(2):155-163

Percutaneous Transmural Arterial Bypass



DETOUR2 trial outcomes demonstrate clinical utility of percutaneous transmural bypass for the treatment of long segment, complex femoropopliteal disease

Sean P. Lyden, MD,[a] Peter A. Soukas, MD,[b] Ajanta De, MD,[c] Barry Tedder, MD,[d] Jonathan Bowman, MD,[e] Jihad A. Mustapha, MD,[f] *and* Ehrin J. Armstrong, MD,[g] on behalf of the DETOUR2 Trial Investigators, *Cleveland, Ohio; Providence, Rhode Island; Mountain View, California; Jonesboro, Arkansas; Darien, Connecticut; Grand Rapids, MI; and Denver, CO*

ABSTRACT

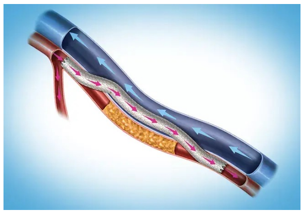
Objective: Percutaneous transmural arterial bypass (PTAB) using the DETOUR system aims to create a percutaneous, endovascular femoropopliteal bypass for the treatment of long segment, complex superficial femoral and proximal popliteal artery disease. The goal of the DETOUR2 study is to investigate the safety and effectiveness of the therapy in comparison with pre-established performance goals.

Methods: The DETOUR2 investigational device exemption study is a prospective, single-arm, multicenter, international trial of symptomatic peripheral arterial disease patients (Rutherford classes 3-5) undergoing the DETOUR procedure for long segment (>20 cm) superficial femoral artery disease. Prespecified end points included primary safety (composite of major adverse events) at 30 days, and effectiveness (primary patency defined as freedom from restenosis or clinically driven target lesion revascularization) at 1 year.

Results: We enrolled 202 patients at 32 sites with 200 treated with the DETOUR system. The mean lesion length was 32.7 cm, of which 96% were chronic total occlusions (CTO) and 70% were severely calcified. Technical success was achieved in 100% of treated patients. The primary safety end point was met with a 30-day freedom from major adverse event rate of 93.0%. The 1-year primary effectiveness end point was met with 72.1% primary patency at 12 months. Primary-assisted and secondary patency were 77.7% and 89.0%, respectively, at 12 months. The 12 month deep venous thrombosis incidence was 4.1% with no pulmonary emboli reported. Venous quality-of-life scores showed no significant changes from baseline. There was a Rutherford improvement of at least one class through 12 months in 97.2% of patients. The mean ankle-brachial index also improved from 0.61 to 0.95 during this period. There were marked improvements in quality-of-life and functional status measures.

Conclusions: The DETOUR2 study met both the primary safety and effectiveness end points, demonstrating clinical usefulness of this novel therapeutic strategy in long femoropopliteal lesions. (J Vasc Surg 2024;79:1420-7.)

Keywords: Femoropopliteal disease; Long lesions; Peripheral chronic total occlusions (CTO); Endovascular; Lower extremity bypass



UCLA Health | David Geffen School of Medicine

J Vasc Surg 2024;79:1420-1427

Deep Venous Arterialization

The NEW ENGLAND JOURNAL *of* MEDICINE

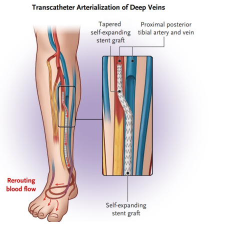
ORIGINAL ARTICLE

Transcatheter Arterialization of Deep Veins in Chronic Limb-Threatening Ischemia

Authors: Mehdi H. Shishehbor, D.O., M.P.H., Ph.D., Richard J. Powell, M.D., Miguel F. Montero-Baker, M.D., Anahita Dua, M.D., Jorge L. Martínez-Trabal, M.D., Matthew C. Bunte, M.D., Arthur C. Lee, M.D., Andrew S. Mugglin, Ph.D., Joseph L. Mills, M.D., Alik Farber, M.D., and Daniel G. Clair, M.D., for the PROMISE II Investigators* Author Info & Affiliations

Published March 29, 2023 | N Engl J Med 2023;388:1171-1180

DOI: 10.1056/NEJMoa2212754 | VOL. 388 NO. 13 | Copyright © 2023



UCLA Health | David Geffen School of Medicine

N Engl J Med;388:1171-1180

Conclusion

- CLTI patients with ESRD pose a significant challenge in limb salvage
- **Higher**: Amputations, MACE, MALE, Mortality, reinterventions
- Amputations are more devastating
- Amputations in ESRD patients may be decreasing
- Technical advances will help in saving limbs

UCLA Health | David Geffen School of Medicine