

The Diabetic Foot (and renal disease)

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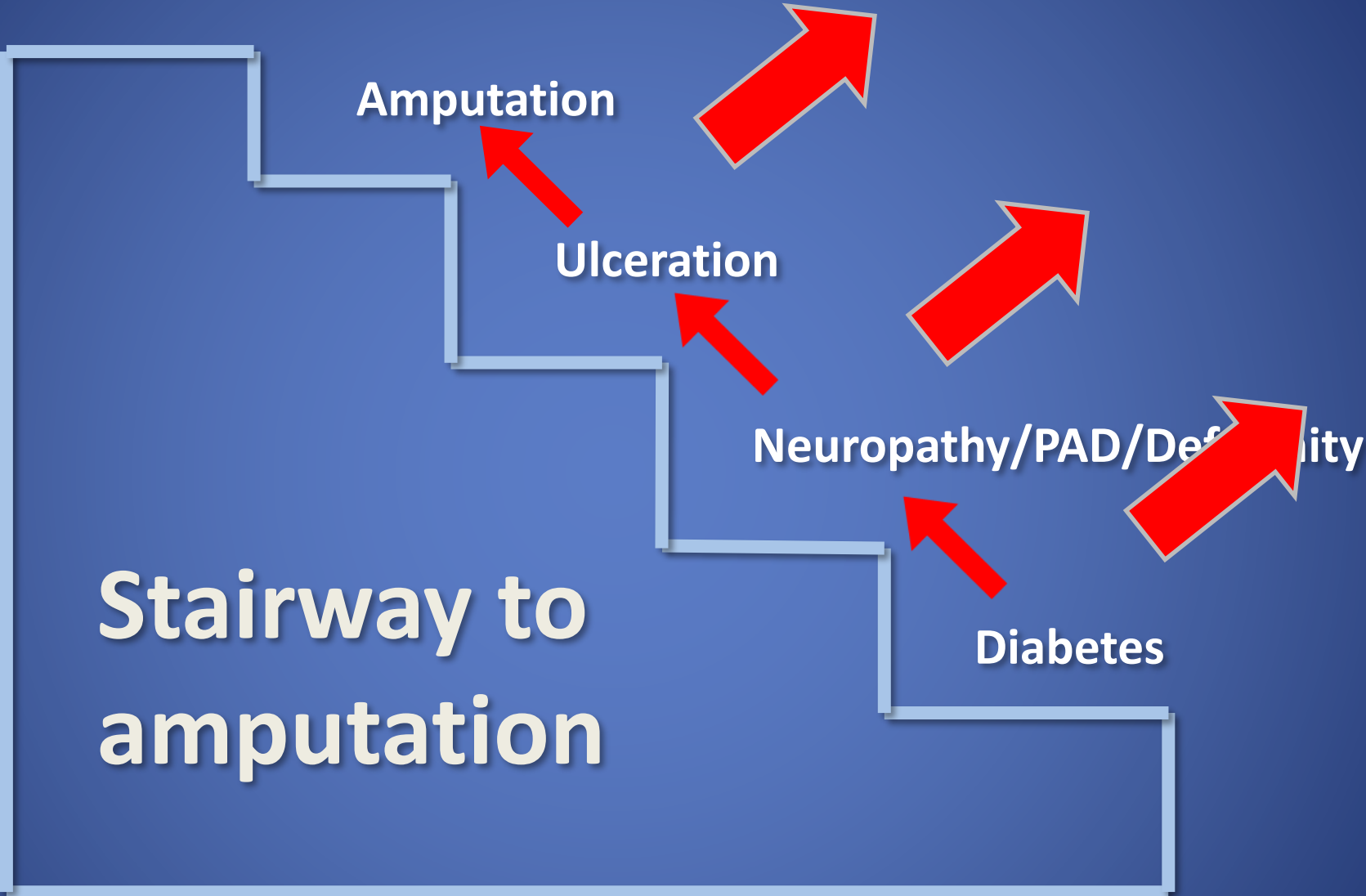
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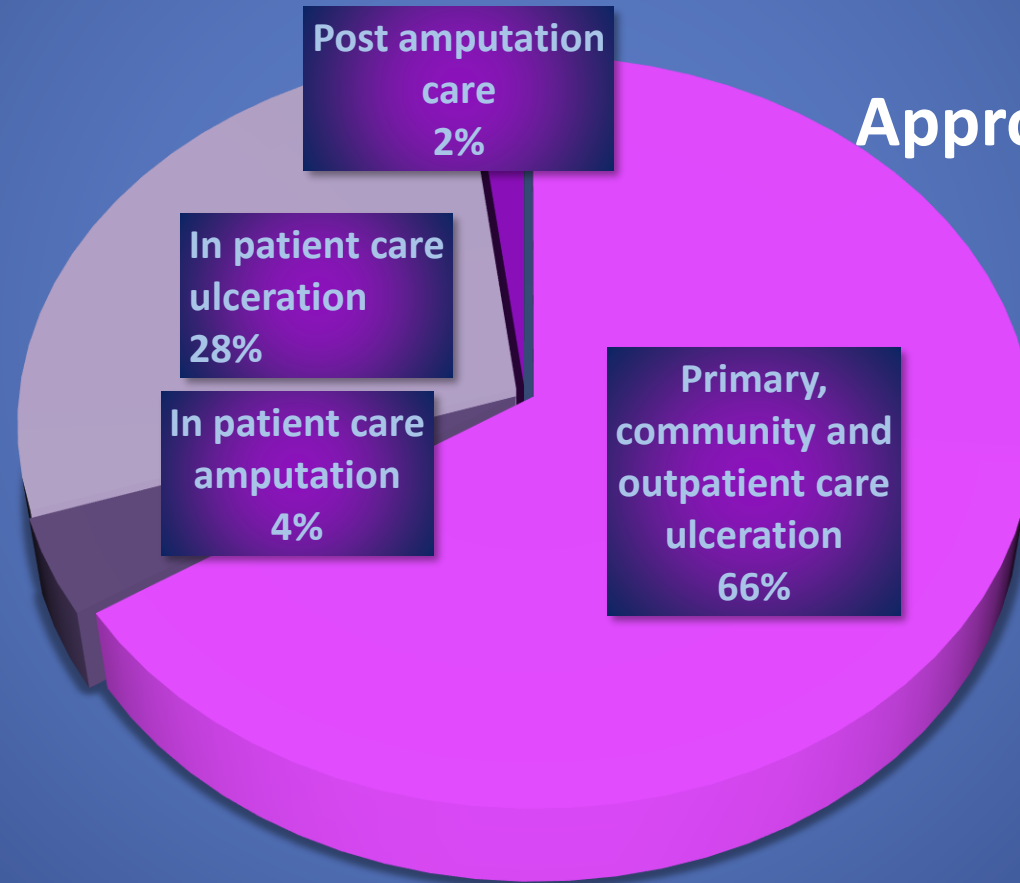
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Stairway to amputation

Costs of Diabetic Foot Disease to the NHS



Total:
Approximately £1billion per annum

Diabetic Foot Disease and Renal Disease

Common underlying pathologies

Diabetic foot disease

Microvascular disease : Neuropathy

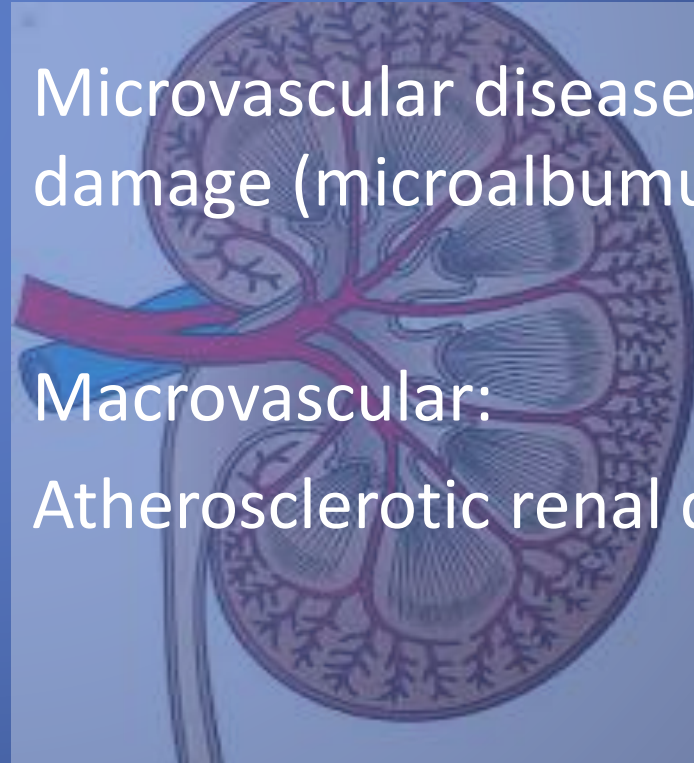
Macrovascular disease :
Atherosclerotic PAD



Diabetic Renal Disease

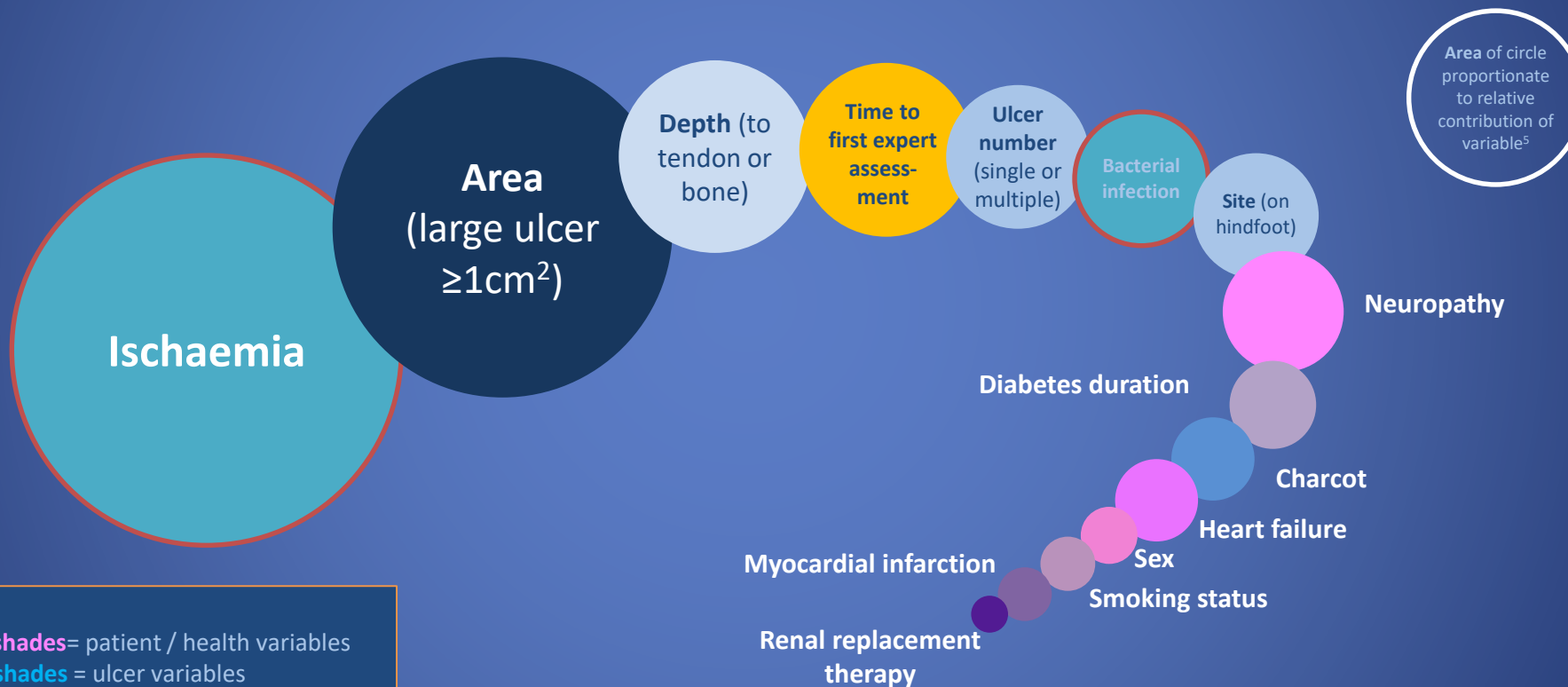
Microvascular disease: Glomerular damage (microalbuminuria)

Macrovascular:
Atherosclerotic renal disease

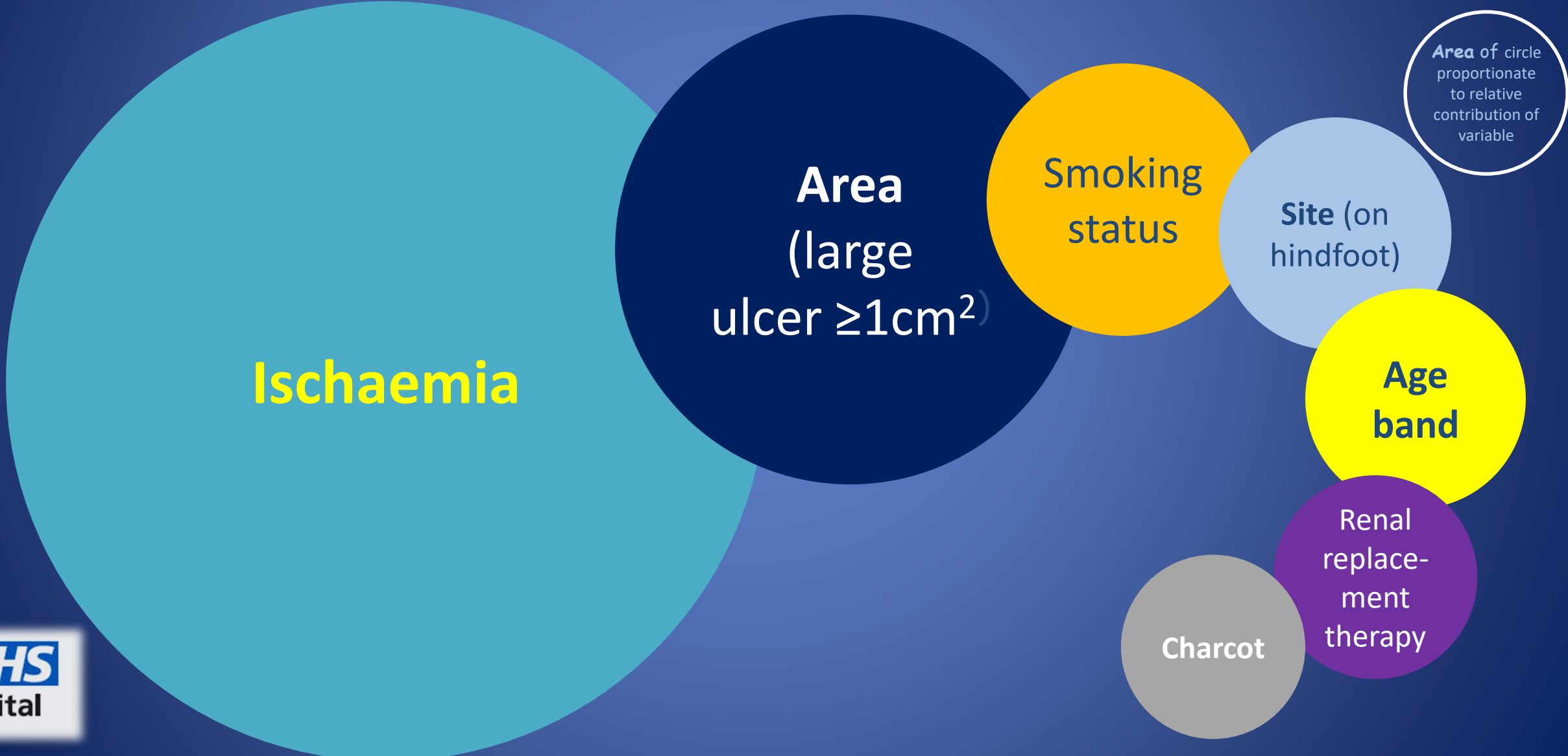


The National Diabetes Foot Care Audit (NDFA)

Alive and ulcer free 12 weeks: Variable strength



Major Amputation: 6 months



Diabetic Foot Disease and Renal Disease

Common underlying pathologies

Diabetic foot disease

Microvascular disease : Neuropathy

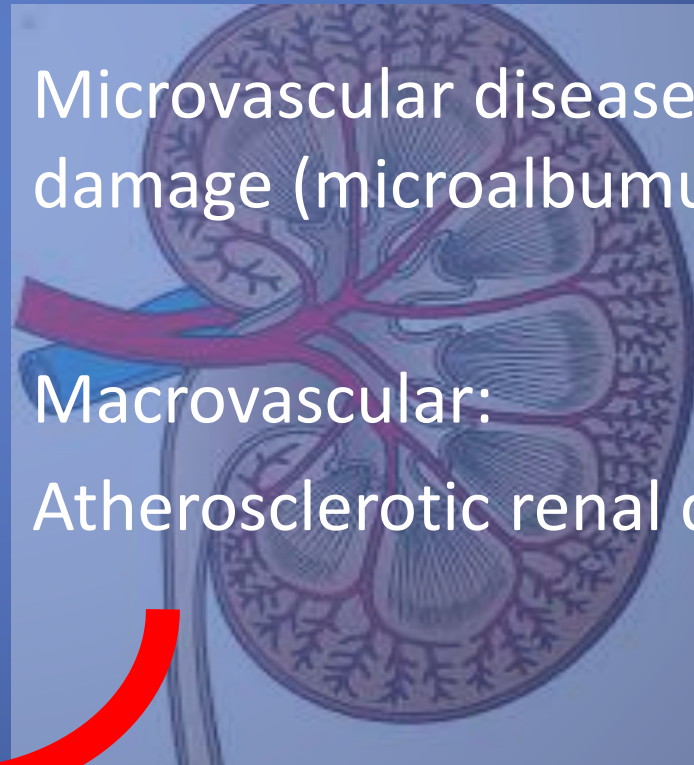
Macrovascular disease :
Atherosclerotic PAD



Diabetic Renal Disease

Microvascular disease: Glomerular damage (microalbuminuria)

Macrovascular:
Atherosclerotic renal disease



Risk factors for the development of foot ulcers in people with diabetes

Risk factor	RR
<i>History of ulcers: present</i>	5.3
<i>History of ulcers: past</i>	3.0
NDS >5	2.3
Inability to feel 10g monofilament	1.8
Foot pulses (failure to feel ≥ 2)	1.8
Deformity	1.6

Prevalence 2%
Incidence 2% pa

Multivariate analysis

Risk factors for the development of foot ulcers in people with diabetes

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<i>History of ulcers: present</i>	5.3
<i>History of ulcers: past</i>	3.0
NDS >5	2.3
Inability to feel 10g monofilament	1.8
Foot pulses (failure to feel ≥ 2)	
Deformity	1.6

Uraemia (indicated by a red arrow pointing to 'Inability to feel 10g monofilament')

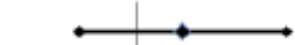



Arterial calcification (indicated by a red arrow pointing to 'Foot pulses (failure to feel ≥ 2)')

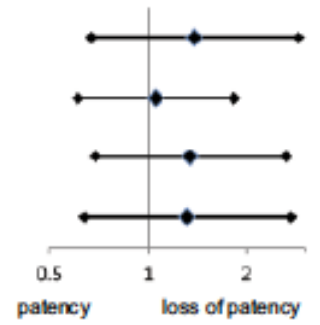
Oedema (indicated by a red arrow pointing to 'Deformity')

Multivariate analysis

Risk factors for the development of foot ulcers compounded by renal disease

Table 2. Loss of patency of the pedal-plantar arch.

	<i>n/n</i>	Adjusted OR (95% CI)	Adjusted* <i>p</i> -value	Adjusted OR* (95% CI)
PAD-control <i>versus</i> CKD	149/87	1.39 (0.67–2.87)	0.37	
PAD-control <i>versus</i> DM	149/183	1.05 (0.61–1.83)	0.85	
PAD-control/DM <i>versus</i> CKD	332/87	1.35 (0.69–2.64)	0.38	
DM <i>versus</i> CKD	183/87	1.32 (0.64–2.72)	0.46	



*Adjusted models included age, sex, hypercholesterolemia, arterial hypertension and smoking.
 CKD, chronic kidney disease; DM, diabetes; PAD, peripheral artery disease; OR, odds ratio; CI, confidence interval.

Deformity

1.6

Multivariate analysis

Risk factors for the development of foot ulcers compounded by renal disease

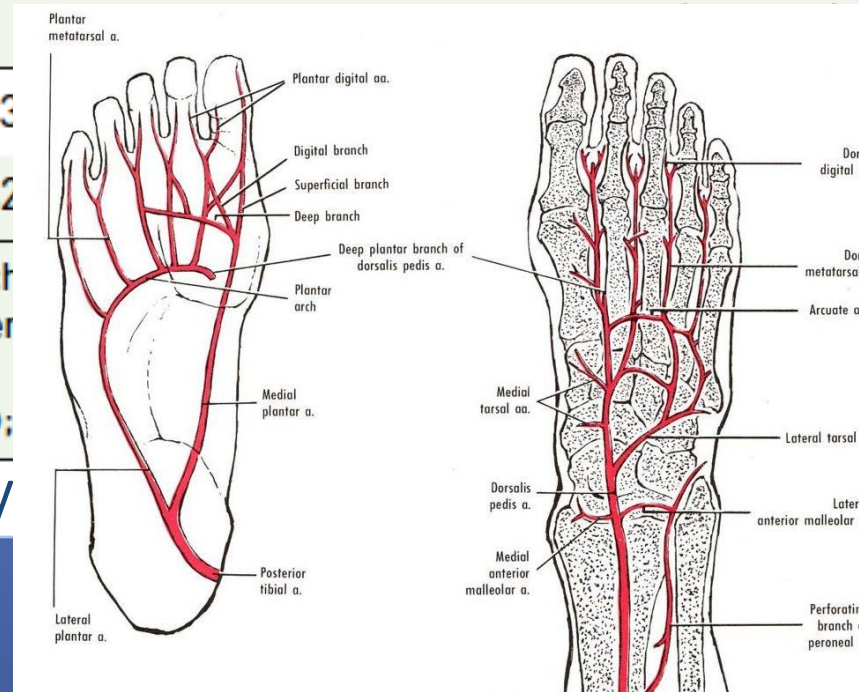
Risk factor

RR

Table 3. Association of severity of chronic kidney disease and loss of patency of pedal-plantar loop.

	OR (95% CI)	p value	Adjusted OR*	Adjusted* p value
No CKD <i>versus</i> moderate CKD	1.43		(-2.01)	0.85
No CKD <i>versus</i> severe CKD	5.42		(-68.36)	0.05

*Adjusted models included age, sex, hypercholesterolemia, diabetes, and peripheral artery disease.
 No CKD eGFR ≥ 60 ml/min (n = 332); moderate CKD eGFR 30–59 ml/min (n = 23); severe CKD eGFR <29 ml/min (n = 10).
 eGFR, estimated glomerular filtration rate.



Deformity

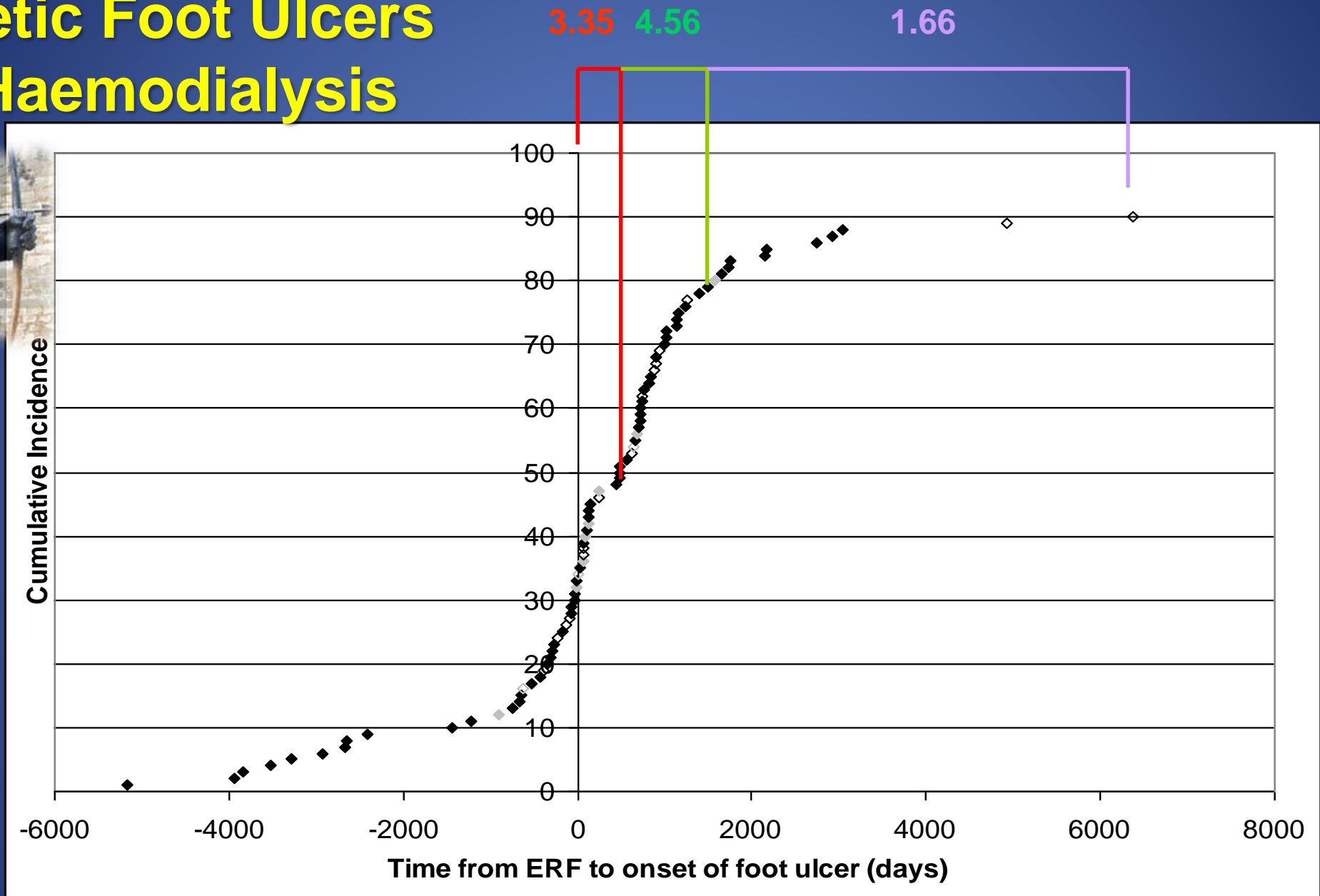
Multivariate analysis

Haemodialysis and foot ulcer prevalence

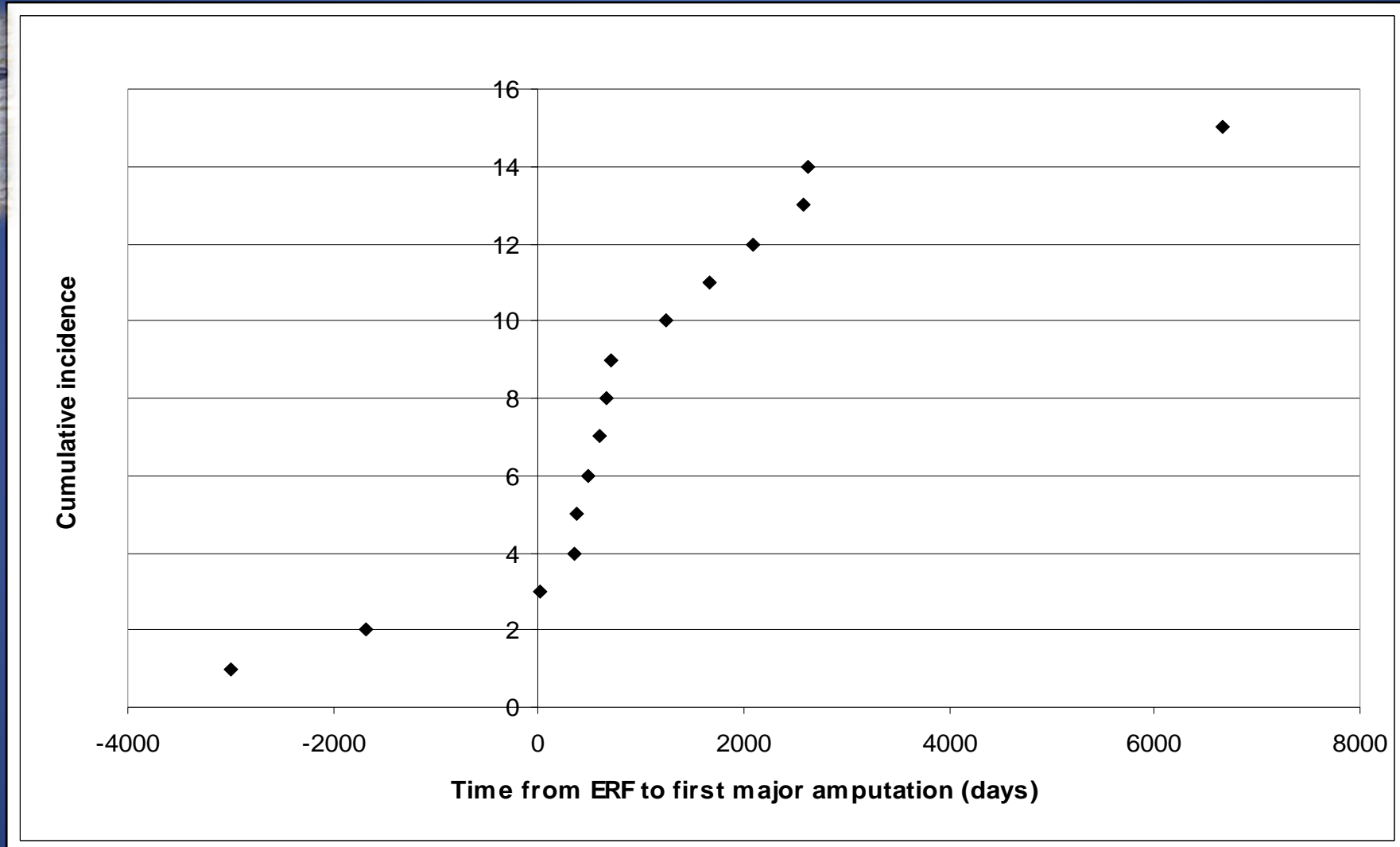


	Total (N = 450)	Foot ulceration		P-value*
		Yes (n = 45)	No (n = 405)	
Peripheral neuropathy ^a	228 (50.7)	43 (95.6)	185 (45.7)	<0.001*
Peripheral arterial disease ^b	236 (52.4)	42 (93.3)	194 (47.9)	<0.001*
Arterial calcification	184 (40.9)	20 (44.4)	164 (40.5)	0.73
Foot deformity	341 (75.8)	39 (86.7)	302 (74.6)	0.107
Limited range of motion of first MTPJ ^c	421 (93.6)	39 (86.7)	382 (94.3)	0.29
Median peak plantar pressure (IQR), <i>kg/cm^{2c}</i>				
Total left foot ^d	1.74 (1.50 to 2.06)	2.00 (1.74 to 2.40)	1.73 (1.50 to 2.04)	0.007*
Total right foot ^d	1.72 (1.50 to 2.09)	2.11 (1.68 to 2.42)	1.71 (1.49 to 2.05)	0.002*
Skin pathology	395 (87.8)	42 (93.3)	353 (87.2)	0.34
Nail pathology	319 (70.9)	37 (82.2)	282 (69.6)	0.112
Inappropriate footwear	297 (66.0)	25 (55.6)	272 (67.2)	0.164
Poor foot-health care	136 (30.2)	10 (22.2)	126 (31.1)	0.289

Diabetic Foot Ulcers and Haemodialysis



Major amputation



Other case series



Manchester, UK

326 patients with CKD 4 and 5 and diabetes:
139 dialysis, 187 no dialysis

Risk Factor for amputation	OR	p
Dialysis Treatment	4.2	0.002

CKD and level of amputation



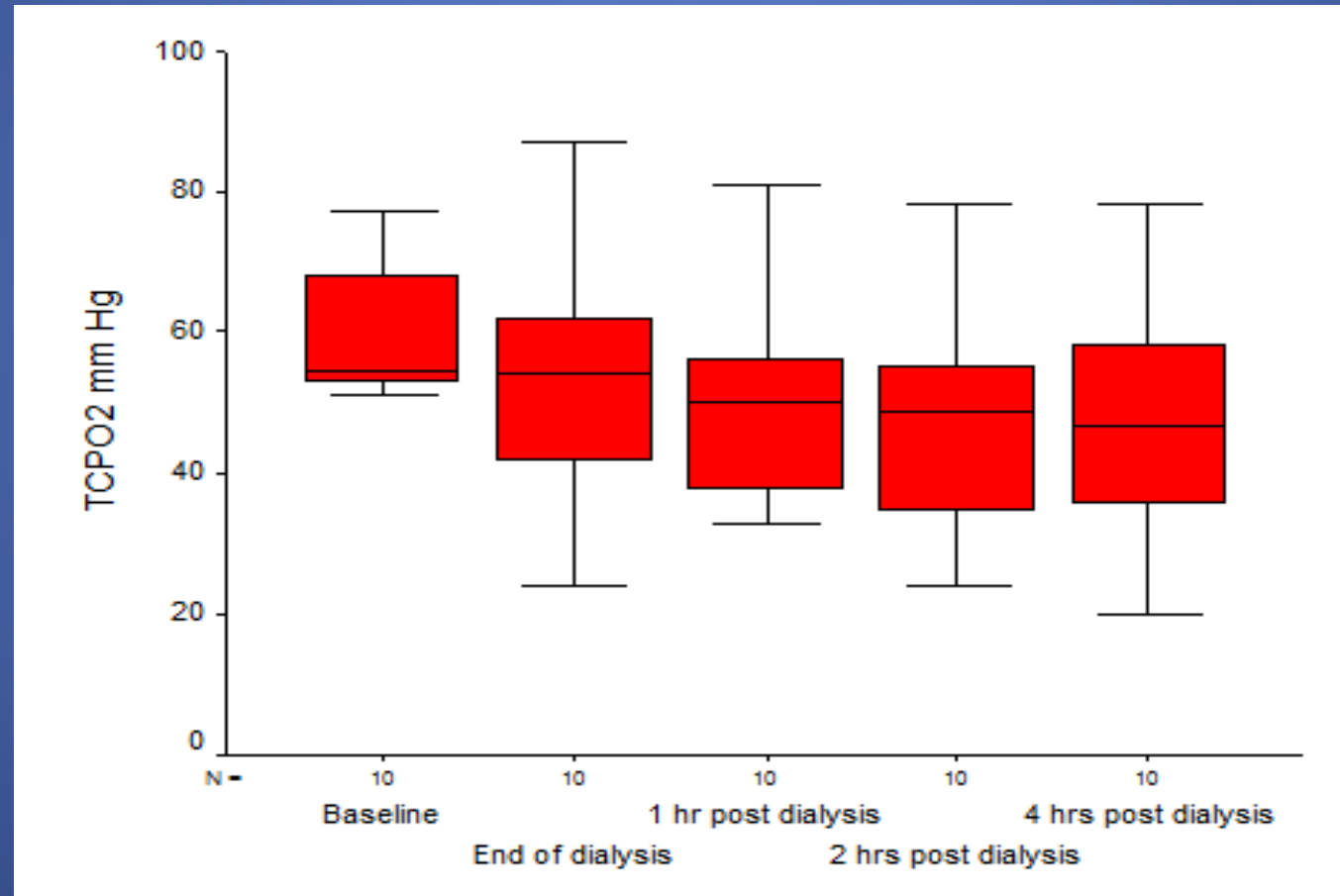
Texas, USA

1043 patients with lower extremity amputations and diabetes

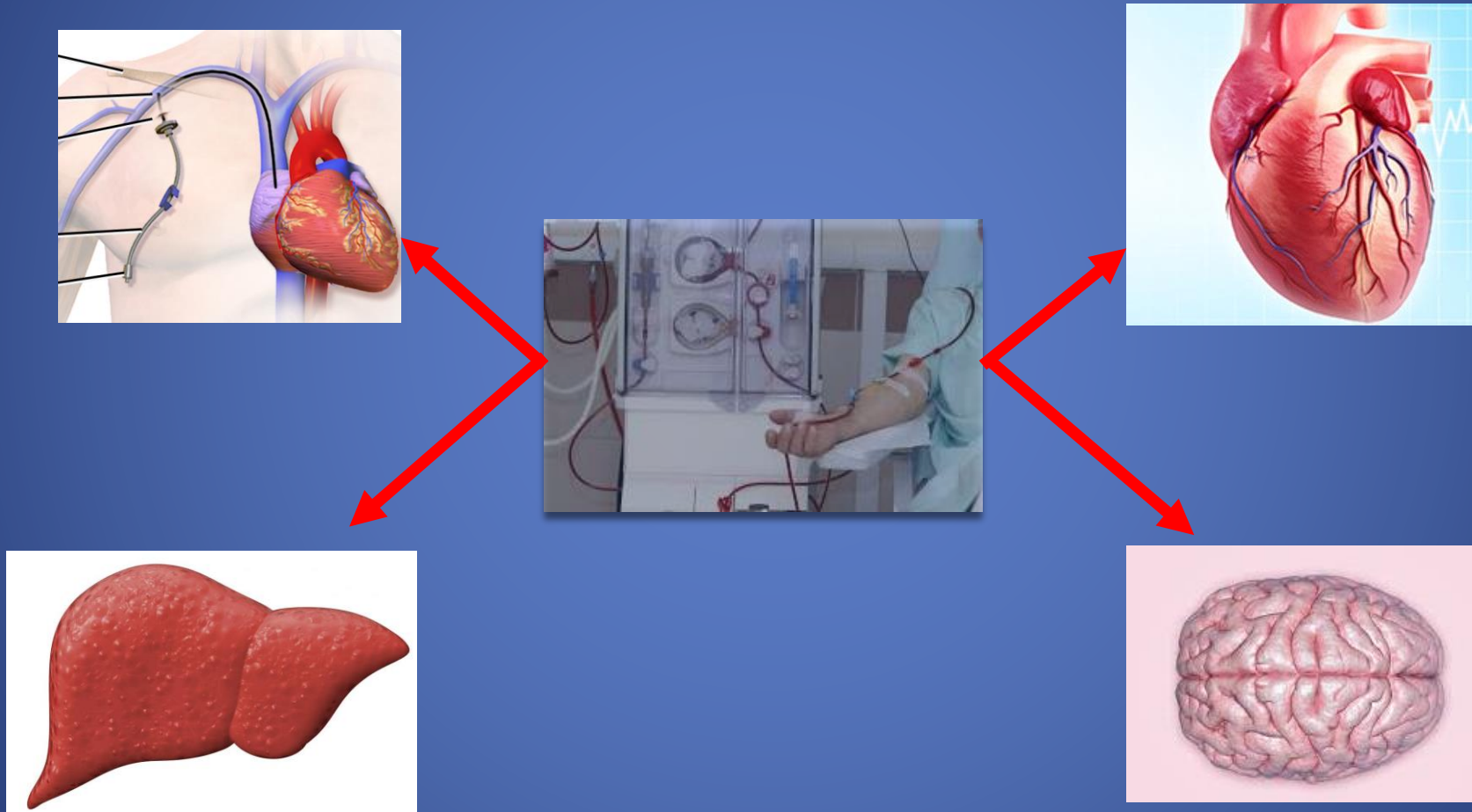
Amputation level	No CKD	CKD	Haemodialysis	p
Foot	53.8	40.4	28.9	<0.001
Below knee	27.0	35.7	43.8	<0.001
Above knee	19.2	23.9	27.3	<0.001

TcPO₂ through haemodialysis

10 patients with diabetes on haemodialysis
LEA and previous foot ulcers excluded



Haemodialysis and major organ damage



*Dying to Feel Better: The Central Role of Dialysis–Induced Tissue Hypoxia C McIntyre, L Crowley
Clin J Am Soc Nephrol 11: 549–551, 2016.*

Haemodialysis and Foot Ulcer Risk

Possible mechanisms:

- Tissue hypoxia
- Immobilisation
- Deformity – variation in foot size due to fluctuating oedema
- Access to podiatry

RRT and foot ulcer prevalence



	Total (N = 450)	Foot ulceration		P-value*
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Skin pathology	395 (87.8)	42 (93.3)	353 (87.2)	0.34
Nail pathology	319 (70.9)	37 (82.2)	282 (69.6)	0.112
Attendance at podiatry past 12 months - 49.6%		25 (55.6)	272 (67.2)	0.164
		10 (22.2)	126 (31.1)	0.289

Diabetic foot problems: prevention and management

NICE guideline

Published: 26 August 2015

Last updated: 11 October 2019

www.nice.org.uk/guidance/ng19

- Low risk:
 - no risk factors present except callus alone.
- Moderate risk:
 - deformity **or**
 - neuropathy **or**
 - peripheral arterial disease.
- High risk:
 - previous ulceration **or**
 - previous amputation **or**
 - on renal replacement therapy **or**
 - neuropathy and peripheral arterial disease together **or**
 - neuropathy in combination with callus and/or deformity **or**
 - peripheral arterial disease in combination with callus and/or deformity.
- Active diabetic foot problem:
 - ulceration **or**
 - infection **or**
 - chronic limb-threatening ischaemia **or**
 - gangrene **or**
 - suspicion of an acute Charcot arthropathy, or an unexplained hot, swollen foot with a change in colour, with or without pain. [2023]

Assessing the risk of developing a diabetic foot problem

Implementation of monthly foot checks on Dialysis

Retrospective cohort study in 934 dialysis units in US

2004-2007: Pre-implementation cohort (n=35513)

2007-2011: Post implementation cohort (n=25779)

Reduction of 17% in major limb amputation
1.3/100 pt years vs 1.07/100 pt years (p=0.034)

Diabetic Foot Disease and Renal Disease

Common underlying pathologies

Diabetic foot disease

Microvascular disease : Neuropathy

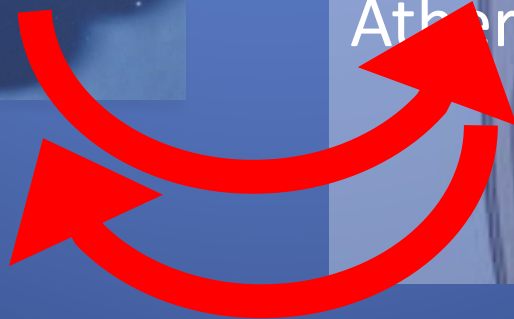
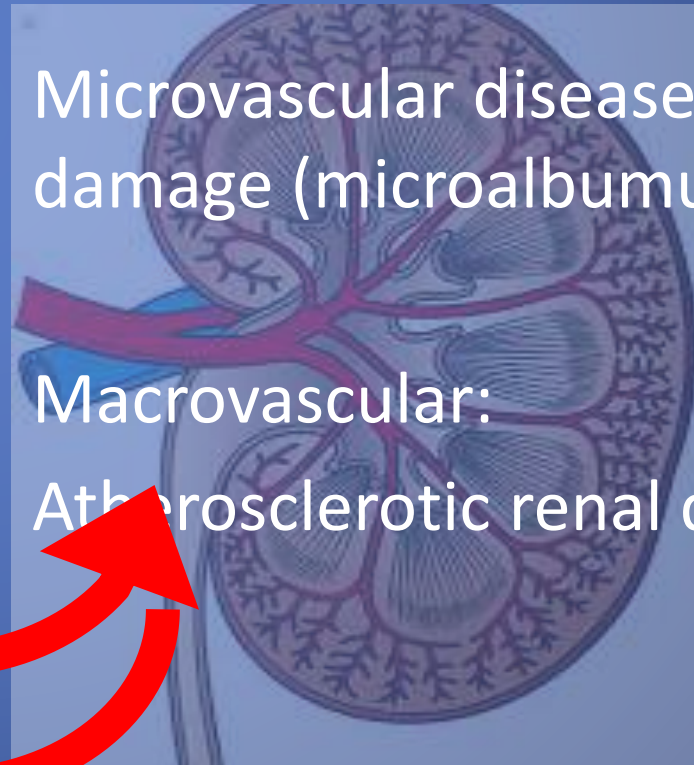
Macrovascular disease :
Atherosclerotic PAD

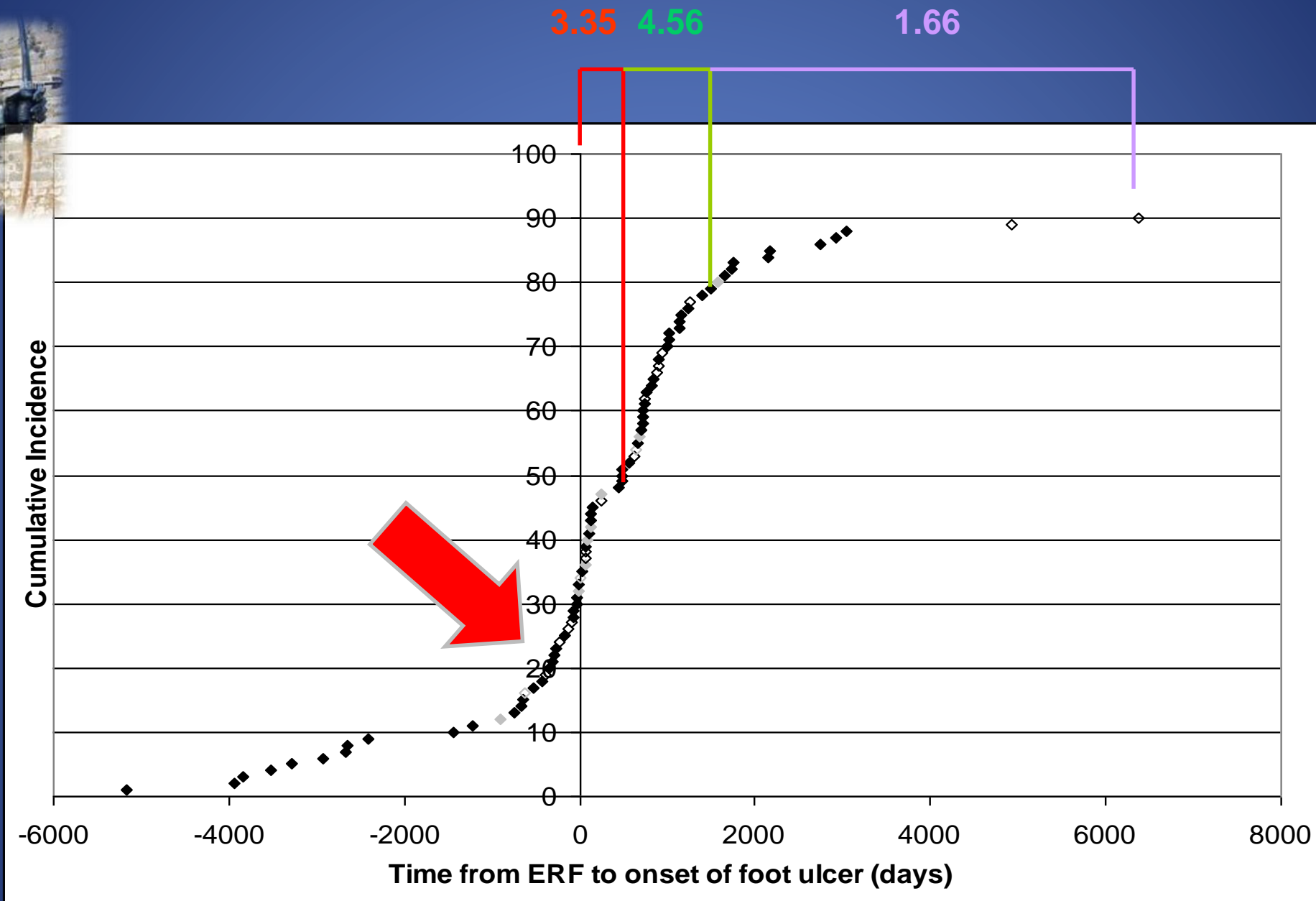


Diabetic Renal Disease

Microvascular disease: Glomerular damage (microalbuminuria)

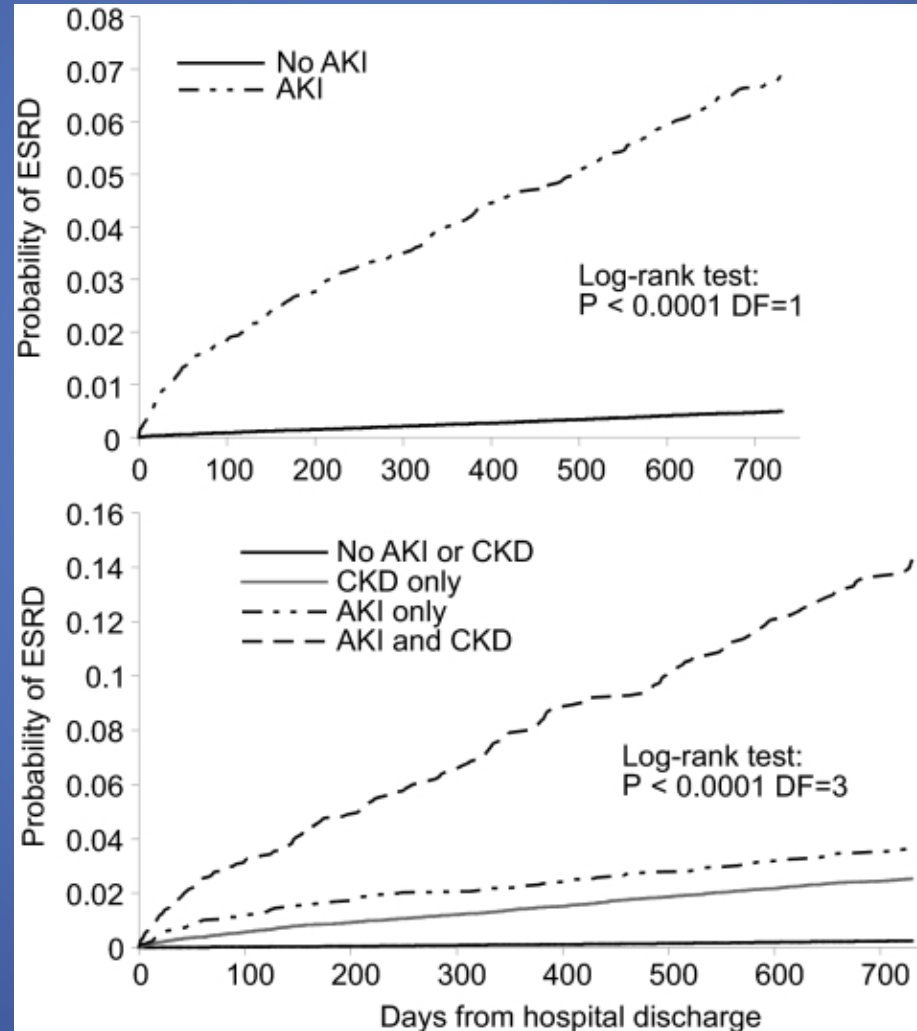
Macrovascular:
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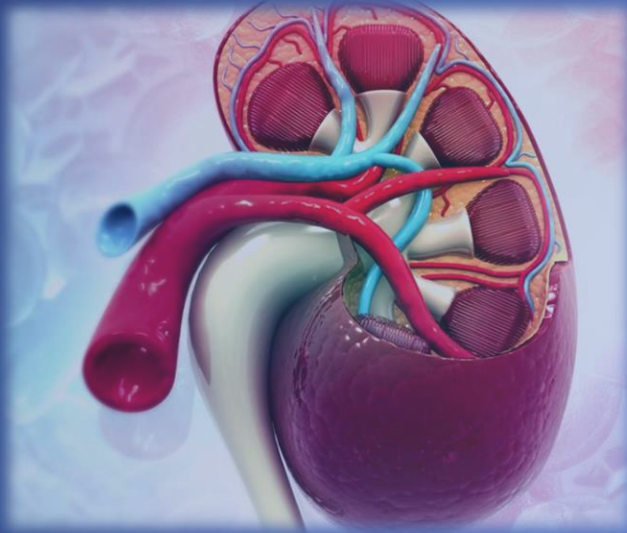


Acute Kidney Injury and the risk of ESRD

Medicare data
>20,000 patients



Causes of AKI



Pre-renal:

Hypoxia

Hypovolaemia

Sepsis

Intra-renal:

Nephrotoxins eg. antibiotics
iv contrast agents.

National Diabetes In patient Audit England and Wales 2016

Approximately 1 in 5 beds in acute hospitals are occupied by people with diabetes. Of these:

- 13% had a history of previous diabetic foot disease,
- 9% had active foot disease on admission.
- 5% had been admitted because of their foot disease

Association between Diabetic Foot Ulcers, acute kidney injury and chronic kidney disease

95 patients admitted with Diabetic Foot Infections

Median serum creatinine (micromol/L)

6 month pre admission	6 month post admission
95 (IQR 72,124)	103 (IQR 74,135)

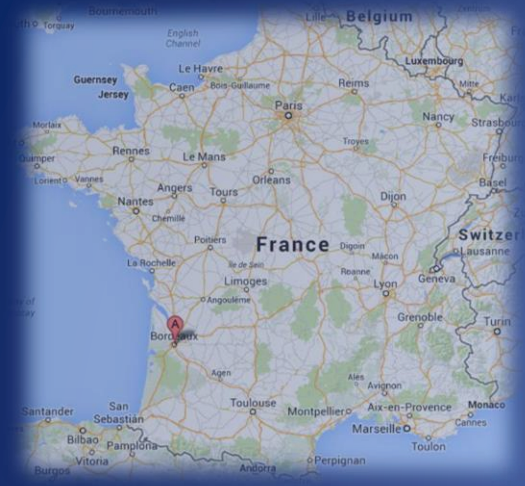
67 cases had AKI

Median decline in eGFR (ml/min/1.73m²/year)

No AKI	AKI
-2 (IQR 6, -11)	-5 (IQR 2,-28)

Median increase in ACR

No AKI	AKI
7 (2,35)	15 (5,90)



ELSEVIER

Diabetes & Metabolism

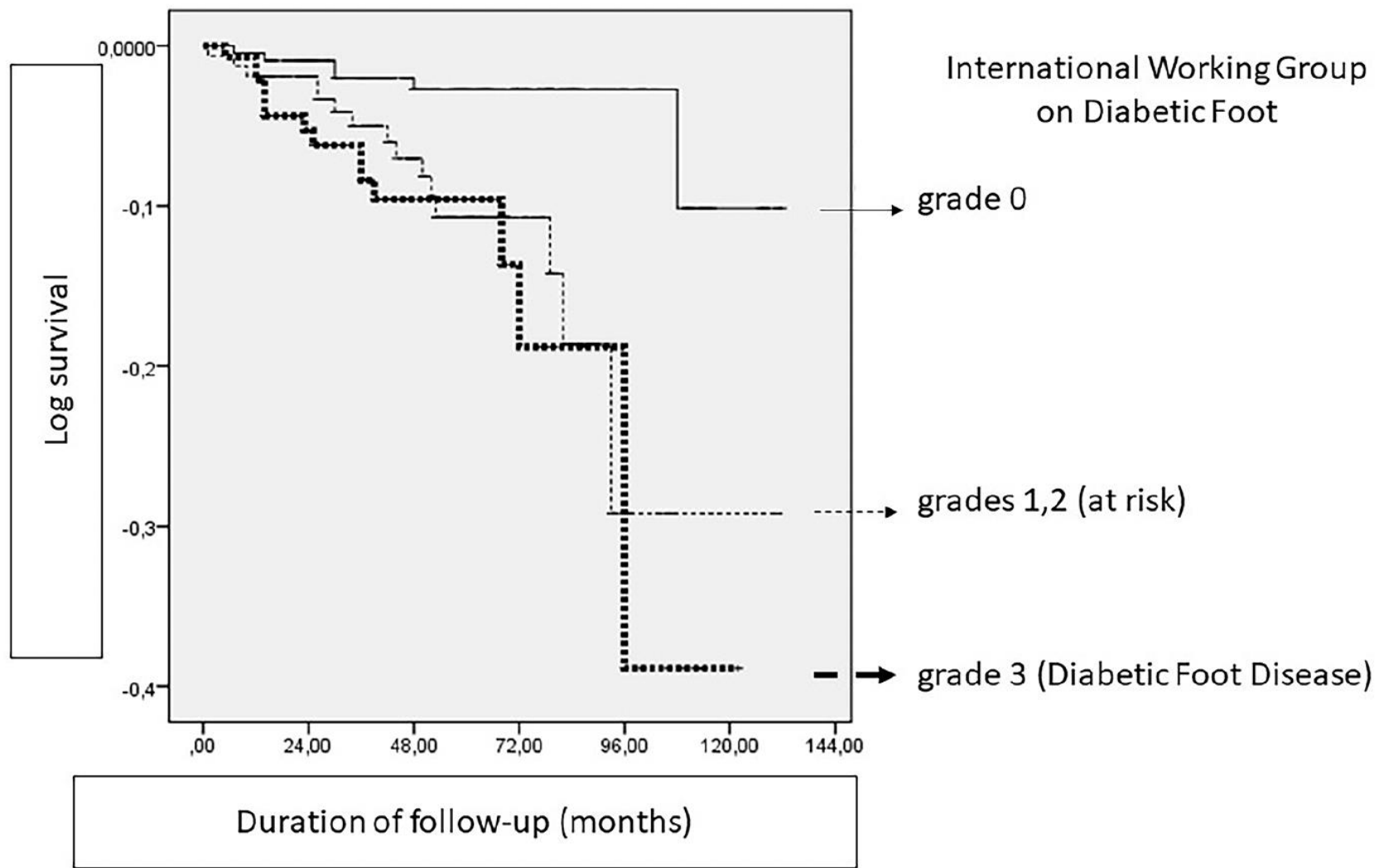
journal homepage: www.elsevier.com/locate/diabet

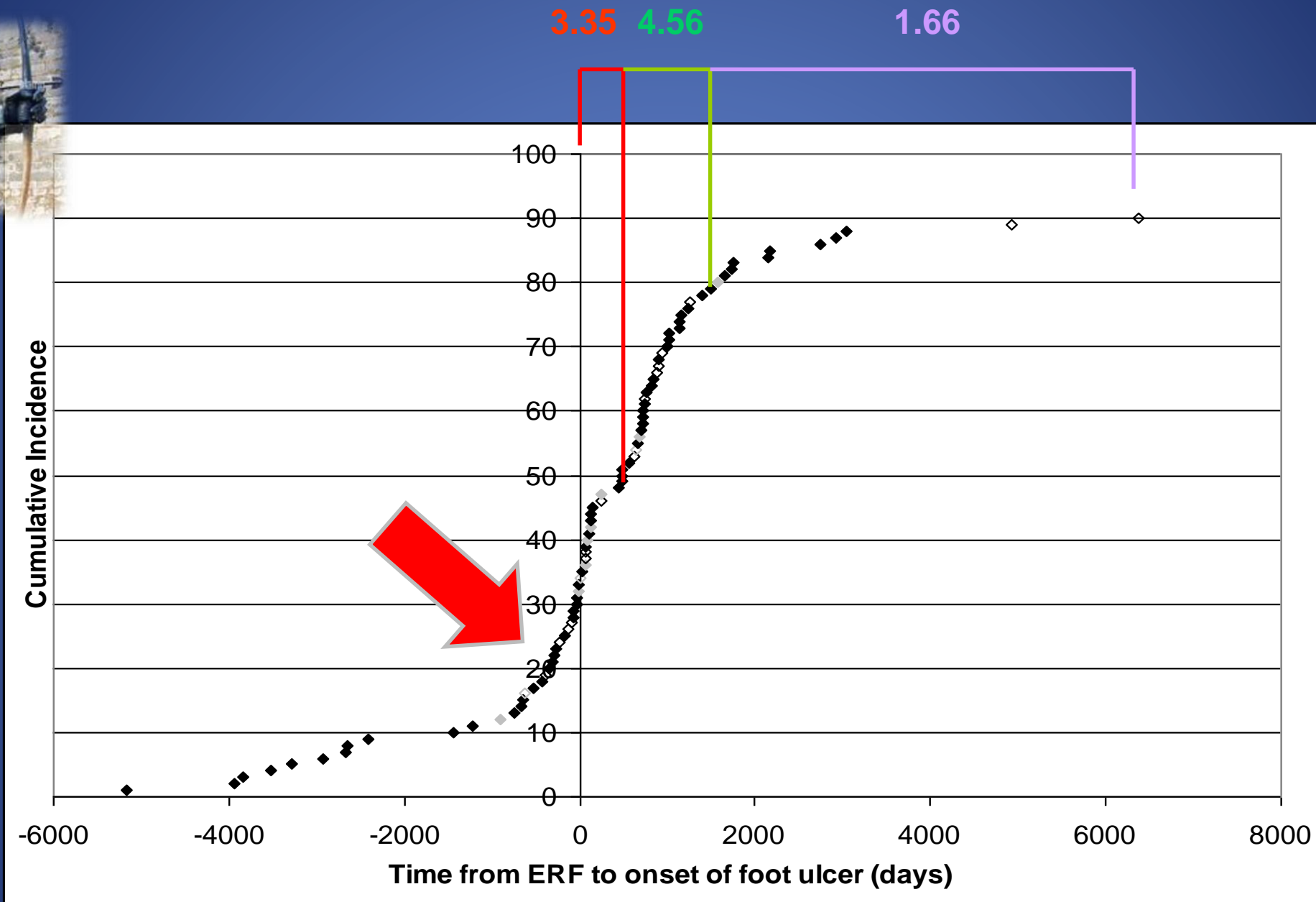
Short Report

Increased risk of renal events in people with diabetic foot disease: A longitudinal observational study[☆]

Fadi Alkhami, Sébastien Rubin, Gauthier Borderie, Ninon Foussard, Alice Larroumet, Laurence Blanco, Marie-Amélie Barbet-Massin, Frédéric Domenge, Kamel Mohammedi, Vincent Rigalleau^{*}

- 519 patients with Type 2 diabetes hospitalised between 2009 and 2017
- Foot ulcer risk or active foot ulcer
- Outcome new renal events (onset of dialysis, renal transplantation, or a doubling of serum creatinine)

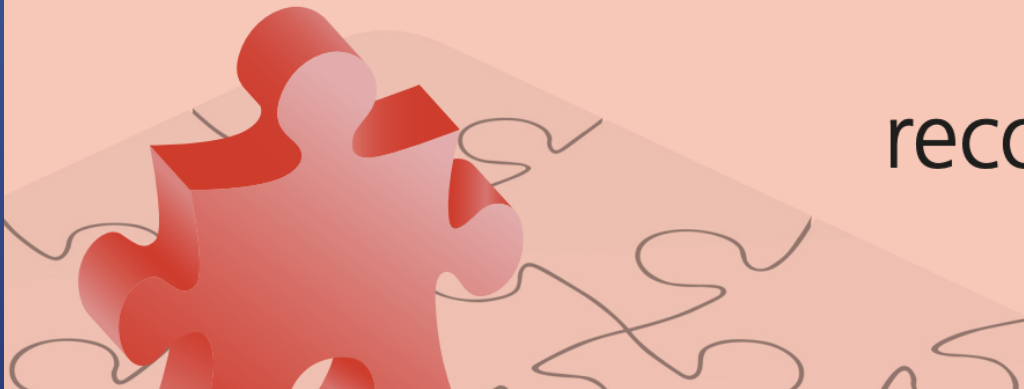




Management of adults with diabetes on dialysis

Summary of recommendations

March 2023



Recommendations For Footcare (Section 5b)

5B.1 We recommend that all people with diabetes on dialysis should be considered high risk of developing foot ulcers and are at high risk of amputation. (Grade 1B)

5B.2 We recommend that all people with diabetes on dialysis should inspect their feet daily and if they are unable to do this because of poor eyesight or frailty their carers should be advised to undertake this for them. (Grade 1C)

5B.3 We recommend that the heels of all people with diabetes on mHDx should be protected with a suitable pressure relieving device during haemodialysis. (Grade 1C)

5B.4 We recommend that all people with diabetes on dialysis should have regular podiatry review. (Grade 1C)

5B.5 We recommend that all people with diabetes on dialysis should have their feet screened monthly using a locally agreed tool and by competent staff on the dialysis unit. (Grade 1C)

5B.6 We recommend that if the individual has an ulcer or there is any other concern the patient should be referred to the diabetic foot team within one working day and each dialysis unit should ensure that there is a clearly defined escalation pathway for these individuals. (Grade 1B)

5B.7 If the individual is on home dialysis, we suggest it is the responsibility of the clinician in charge of their care to ensure that they have an annual foot review and are attending review by the foot protection team. (Grade 2B)

5B.8 We recommend that any individual presenting with a hot swollen foot should be referred to the diabetic foot team within 24 hours. (Grade 1B)

Summary

All people with diabetes on dialysis should have regular review of their feet and rapid access to podiatry services if an acute foot problem develops.

Findings: NDFA Care structures survey results

Results of the 2021 ISS, England and Wales, October 2021

	Question	Responses	Answer %
1	Does your provider have a dedicated multi-disciplinary foot care service (MDFS)?	96	91%
1.1	Is the MDFS well integrated with a community foot care protection service (FPS)?	87	84%
1.2	Is the MDFS integrated with renal services and dialysis units?	87	33%
2	Is there regular training to ensure that people at increased risk of foot ulceration are both identified and have access to appropriate protective surveillance?	96	76%
3	Is there a designated pathway by which a person with any form of diabetic foot disease can get rapid access to specialist (MDFS) assessment?	96	98%
3.1	Is the pathway designed to ensure that all people with diabetes newly presenting with active foot disease can be assessed with appropriate urgency (14 days maximum)?	94	95%
3.2	Is the pathway regularly promoted to both healthcare professionals and to people with diabetes?	94	80%
4	If the person with a foot care emergency has evidence of vascular impairment, is it possible for them to be assessed by a specialist vascular surgeon on the same day?	96	75%
5	Can everyone with a foot care emergency that might require admission be assessed the same or next working day by a member of the MDFS?	96	71%
6	At the time of their first expert assessment, will the patient be provided for the immediate care of their foot problem with medications (e.g. antibiotics) and/or dressings (even if this is a prescription for a local pharmacy) without needing to be seen elsewhere?	96	92%
7	Is there a system in place to coordinate referrals and transfers between different components of the care service – such as between different hospitals and between hospital and community services?	96	85%

Diabetic Foot Disease and Renal disease

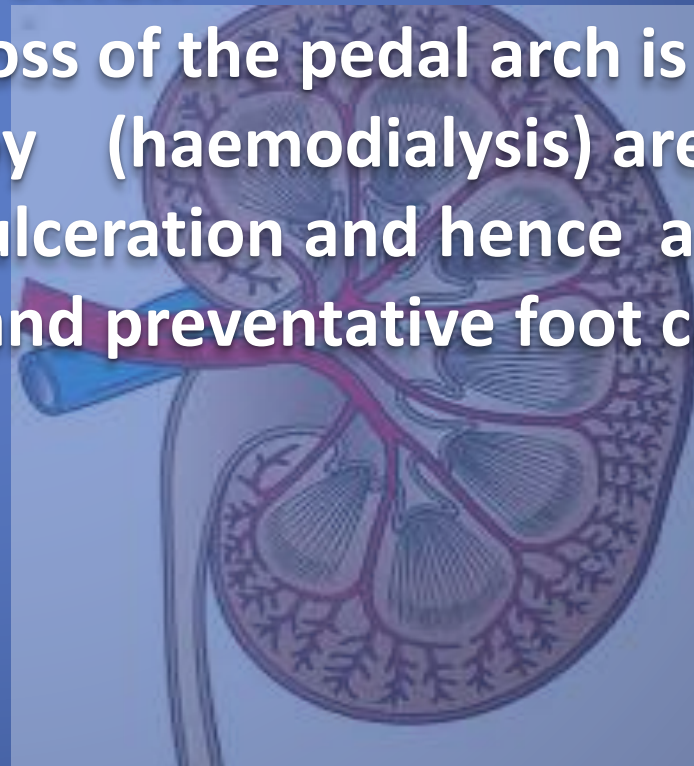
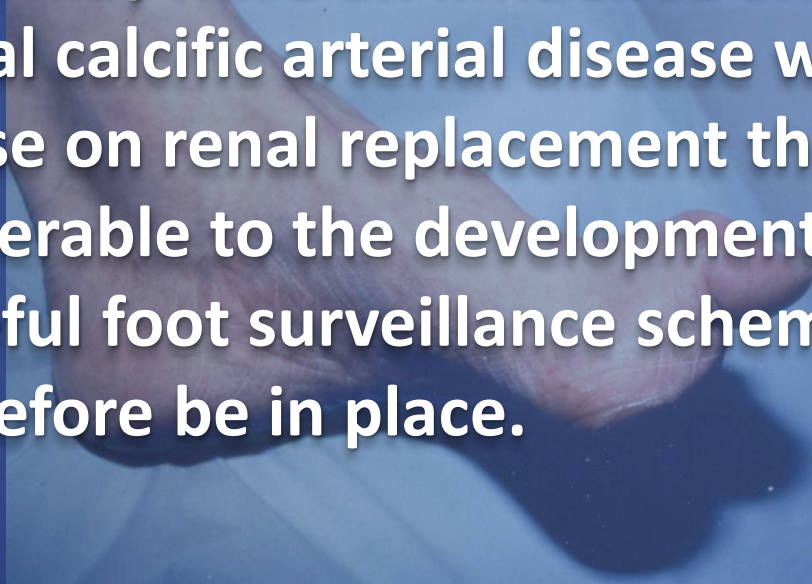
Common underlying pathologies.

Each may have an influence on the other.

Distal calcific arterial disease was loss of the pedal arch is common.

Those on renal replacement therapy (haemodialysis) are particularly vulnerable to the development of ulceration and hence amputation.

Careful foot surveillance schemes and preventative foot care must therefore be in place.



The Diabetic Foot (and renal disease)

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