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NHG Health

Enhancing Diabetic Foot Care: Predicting Mortality Using ACE Clinical Guidance (ACG) Risk Stratification in Clinical Practice

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Background:

Diabetes mellitus remains a significant public health challenge in Singapore, with diabetic foot ulcers (DFUs) leading to severe complications, including amputations and increased mortality. Early risk identification is emphasized by both international and local guidelines to improve patient outcomes.[1-2] In Singapore, the Ministry of Health's Agency for Care Effectiveness Clinical Guidance (ACG) recommends routine foot screening to stratify DFU risk and guide management.[1-2] However, the long-term prognostic value of ACG foot risk stratification is not well established. This study aimed to evaluate the association between ACG-defined risk categories and five-year all-cause mortality among patients with diabetes.

Table 1. Baseline Characteristics

Characteristic	N = 1413
Age, mean ± SD, y	62.2 ± 12.5
Male, n (%)	720 (51.0%)
Ethnicity	
Chinese, n (%)	962 (68.1%)
Malay, n (%)	136 (9.6%)
Indian, n (%)	217 (15.4%)
Others, n (%)	98 (6.9%)
Type II Diabetes, n (%)	1371 (97.0%)
ACG risk category	
Low Risk, n (%)	807 (57.1%)
Moderate Risk, n (%)	422 (29.9%)
High Risk, n (%)	184 (13.0%)
Deaths during 5 year follow-up, n (%)	189 (13.4%)

Methods:

A retrospective cohort study of 1,413 patients with diabetes who underwent standardized foot assessments was conducted. See Table 1. Patients were classified into low-, moderate-, or high-risk categories based on ACG criteria, including the presence of neuropathy, peripheral arterial disease, deformity, callus or a history of amputation. Kaplan–Meier survival analysis and Cox proportional hazards regression were performed. Significant predictors in univariate analysis were included in the Cox multivariate model, which assessed the impact of demographic variables and ACG risk category on five-year all-cause mortality.

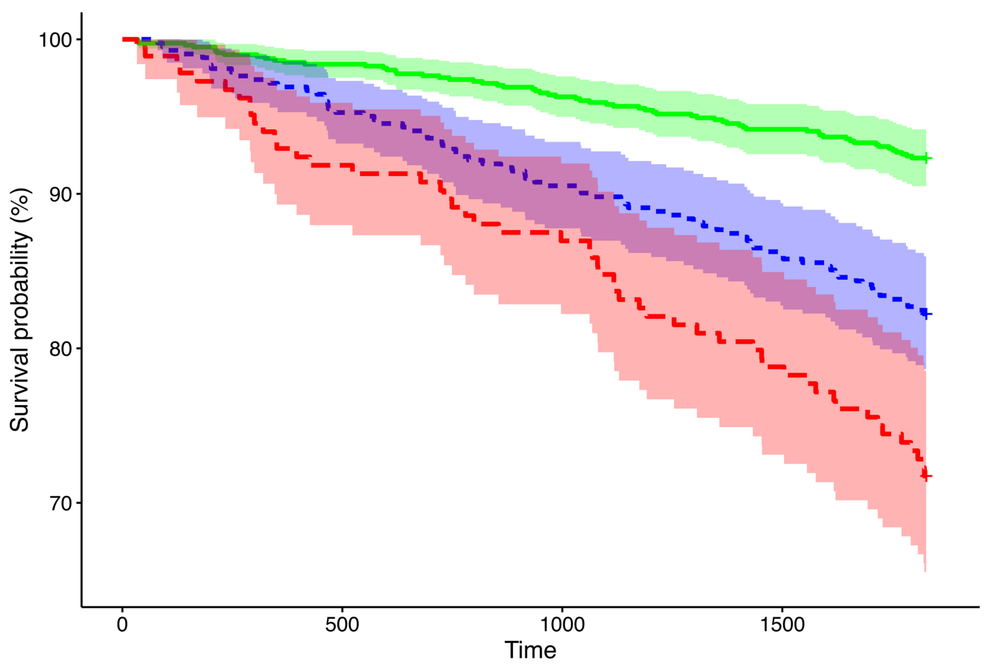

Figure 1. Kaplan-Meier survival analysis for 1413 patients by ACG-risk classification (p<0.001)

Table 2. Multivariate Cox proportional-hazards model for 5-year all-cause mortality

Variable	HR	95% CI	p-value
Age (per year)	1.06	1.05 – 1.08	<0.001
Male gender	1.40	1.05 – 1.88	0.022
ACG risk category			
Low-Risk (ref)	1.00	-	-
Moderate-Risk	2.10	1.50 – 2.94	<0.001
High-Risk	2.73	1.87 – 3.98	<0.001

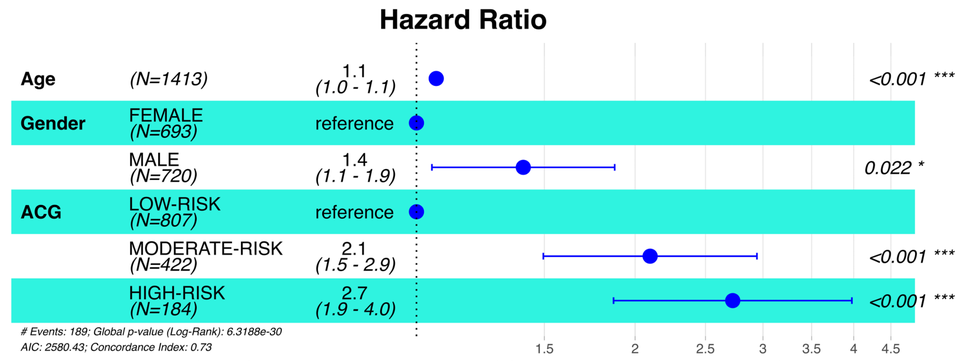

Figure 2. Forest plot of multivariate Cox model for 5-year all-cause mortality

Results:

Of the 1,413 patients, 57.1% were classified as low risk (n=807), 29.9% as moderate risk (n=422), and 13.0% as high risk (n=184). 189 death events were observed within the 5-year period. Older age, male sex, and higher ACG risk categories were significantly associated with increased mortality. Compared to the low-risk group, moderate-risk patients had a hazard ratio (HR) of 2.10 (95%CI:1.50-2.94), while high-risk patients had a HR of 2.73 (95%CI:1.87-3.98). See Figure 1-2 and Table 2. The estimated five-year mortality risk for a 65-year-old male was 18.8% (95%CI:14.2%-23.2%) in the moderate-risk group and 23.7% (95%CI:16.9%-30.0%) in the high-risk group. See Figure 3 and Table 3-4.

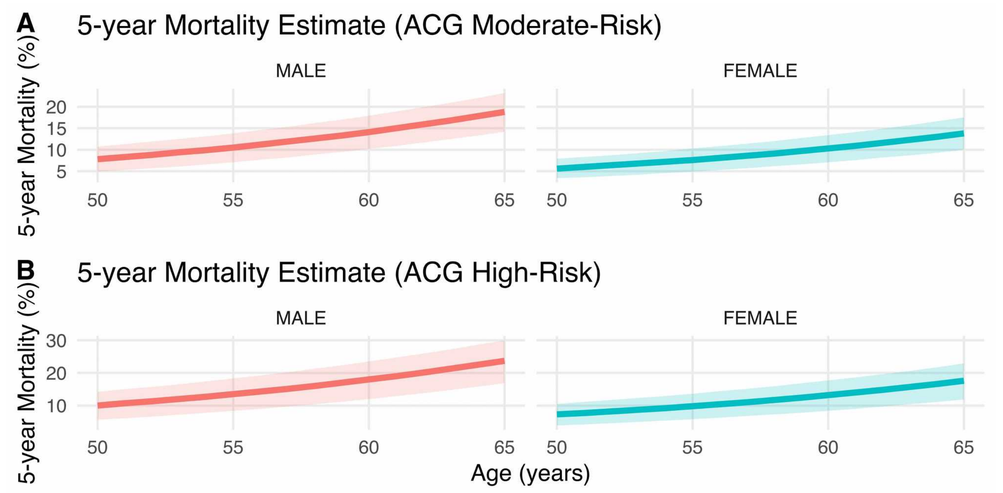

Figure 3. A) ACG Moderate-Risk 5-year Mortality Estimate. **B)** ACG High-Risk 5-year Mortality Estimate

Table 3. Five-year mortality risk in males

Age	Low	Moderate	High
50	3.8 (2.4–5.2)	7.8 (4.9–10.7)	10.0 (5.7–14.2)
51	4.1 (2.6–5.5)	8.3 (5.3–11.3)	10.7 (6.1–15.0)
52	4.3 (2.8–5.8)	8.8 (5.7–11.9)	11.3 (6.6–15.7)
53	4.6 (3.0–6.1)	9.4 (6.1–12.5)	12.0 (7.2–16.5)
54	4.9 (3.2–6.5)	9.9 (6.6–13.1)	12.7 (7.8–17.4)
55	5.2 (3.5–6.8)	10.5 (7.1–13.8)	13.5 (8.4–18.3)
56	5.5 (3.8–7.2)	11.2 (7.7–14.6)	14.3 (9.0–19.2)
57	5.8 (4.0–7.6)	11.9 (8.2–15.3)	15.1 (9.7–20.2)
58	6.2 (4.3–8.0)	12.6 (8.9–16.2)	16.0 (10.4–21.3)
59	6.6 (4.7–8.5)	13.3 (9.5–17.0)	17.0 (11.2–22.3)
60	7.0 (5.0–9.0)	14.1 (10.2–17.9)	18.0 (12.0–23.5)
61	7.4 (5.3–9.5)	15.0 (10.9–18.9)	19.0 (12.9–24.7)
62	7.9 (5.7–10.1)	15.9 (11.7–19.9)	20.1 (13.8–25.9)
63	8.4 (6.1–10.6)	16.8 (12.5–20.9)	21.3 (14.8–27.2)
64	8.9 (6.5–11.3)	17.8 (13.3–22.0)	22.5 (15.8–28.6)
65	9.5 (6.9–11.9)	18.8 (14.2–23.2)	23.7 (16.9–30.0)

Table 4. Five-year mortality risk in females

Age	Low	Moderate	High
50	2.7 (1.7–3.8)	5.6 (3.4–7.9)	7.3 (3.9–10.5)
51	2.9 (1.8–4.0)	6.0 (3.6–8.3)	7.7 (4.2–11.1)
52	3.1 (1.9–4.2)	6.4 (3.9–8.7)	8.2 (4.6–11.7)
53	3.3 (2.1–4.5)	6.8 (4.2–9.2)	8.7 (5.0–12.3)
54	3.5 (2.2–4.7)	7.2 (4.6–9.7)	9.2 (5.4–12.9)
55	3.7 (2.4–5.0)	7.6 (4.9–10.3)	9.8 (5.8–13.6)
56	4.0 (2.6–5.3)	8.1 (5.3–10.8)	10.4 (6.3–14.4)
57	4.2 (2.8–5.6)	8.6 (5.7–11.4)	11.0 (6.8–15.1)
58	4.5 (3.0–5.9)	9.1 (6.2–12.0)	11.7 (7.3–15.9)
59	4.7 (3.2–6.3)	9.7 (6.6–12.7)	12.4 (7.8–16.8)
60	5.0 (3.4–6.6)	10.3 (7.1–13.4)	13.2 (8.4–17.7)
61	5.4 (3.7–7.0)	10.9 (7.6–14.1)	14.0 (9.0–18.6)
62	5.7 (4.0–7.4)	11.6 (8.2–14.9)	14.8 (9.7–19.6)
63	6.1 (4.2–7.9)	12.3 (8.7–15.7)	15.7 (10.4–20.6)
64	6.4 (4.5–8.3)	13.0 (9.3–16.6)	16.6 (11.1–21.7)
65	6.8 (4.8–8.8)	13.8 (10.0–17.5)	17.6 (11.9–22.9)

Discussion & Conclusion:

ACG foot risk stratification independently predicts five-year mortality in patients with diabetes, with moderate- and high-risk patients associated with more than double the mortality risk compared to low-risk patients. These findings extend the utility of the ACG framework beyond ulcer prevention, offering clinicians a practical tool for prognostication and targeted care. By translating categorical risk into individualized mortality estimates, this can potentially improve patient understanding, engagement, and adherence to preventive strategies. Future efforts should focus on refining risk assessment through additional vascular measures, such as the Toe-Brachial Index, and on integrating digital foot-screening data into clinical decision-support systems. Such approaches could facilitate timely, personalized interventions in primary care and strengthen strategies to reduce diabetes-related morbidity and mortality.

References:

1. Agency for Care Effectiveness (ACE). Foot assessment in patients with diabetes mellitus. ACE Clinical Guidance (ACG), Ministry of Health, Singapore. 2024. Available from: go.gov.sg/acg-dfa
2. Schaper NC, Van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, Monteiro-Soares M, Senneville E, IWGDF Editorial Board. Practical guidelines on the prevention and management of diabetes-related foot disease (IWGDF 2023 update). Diabetes/Metabolism Research and Reviews. 2024 Mar;40(3):e3657.