# Impact of case-mix adjustment on observed variation in the healing of diabetic foot ulcers at 12 weeks using data from the National Diabetes Foot Care Audit of England and Wales: a cohort study

**Running title: Variation in healing of diabetic foot ulcers: a cohort study**

Arthur C Yelland[1] MA
Claire Meace[1] BA
Peter Knighton[1] MPhys
Naomi Holman[2] PhD
Sarah H Wild[3] PhD
Julie Michalowski[1] MSc
Bob Young[4] MD
William J Jeffcoate[5] MRCP

[1]NHS Digital, Leeds, LS1 6AE, UK
[2]Institute of Cardiovascular and Medical Sciences, University of Glasgow, UK
[3]Usher Institute, University of Edinburgh, UK
[4]National Diabetes Audit, Diabetes UK, London, E1 1FU, UK
[5]Nottingham University Hospitals Trust, Nottingham, NG5 1PB, UK

William J Jeffcoate ORCID Number 0000-0002-1744-7576

Correspondence:
William Jeffcoate, Nottingham University Hospitals Trust, Nottingham UK

william.jeffcoate@gmail.com
+44 7900551823

Word count: 3422
Abstract word count: 239

Tables: 2
Figures: 2
Supplementary Figures: 0
Supplementary Tables: 0

**Key words**
Diabetic foot, foot ulcer, healing, audit variation, case-mix adjustment, care delivery

## Abbreviations

| | |
|---|---|
| BMI | Body mass index |
| DFU | Diabetic foot ulcer |
| FEA | First expert assessment |
| ICD-10 | International Classification of Diseases |
| IHP | Independent health providers |
| NDFA | National Diabetes Foot Care Audit of England and Wales |
| NDA | National Diabetes Audit |
| NHS | National Health Service |
| OPCS-4 | OPCS Classification of interventions and procedures |
| RRT | Renal replacement therapy |
| SINBAD | Ulcer classification based on Site, Ischaemia, Neuropathy, Bacterial infection, Area, Depth |

# ABSTRACT

## Aim

This cohort study investigates the extent to which variation in ulcer healing between services can be explained by demographic and clinical characteristics.

## Methods

The National Diabetes Foot Care Audit (NDFA) collated data on people with diabetic foot ulcers presenting to specialist services in England and Wales between July 2014 and March 2018. Logistic regression models were created to describe associations between risk factors and a person being alive and ulcer-free 12 weeks from presentation, and to investigate whether variation between 120 participating services persisted after risk factor adjustment.

## Results

Of 27,030 people with valid outcome data, 12,925 (47.8%) were alive and ulcer-free at12 weeks, 13,745 (50.9%) had an unhealed ulcer and 360 had died (1.3%). Factors associated with worse outcome were male sex, more severe ulcers, history of cardiac or renal disease and a longer time between first presentation to a non-specialist healthcare professional and first expert assessment. After adjustment for these factors, four services (3.3%) were more than 3SD above and seven services (5.8%) were more than 3SD below the national mean for proportions that were alive and ulcer-free at follow-up.

## Conclusions/interpretations

Variation in the healing of diabetic foot ulcers between specialist services in England and Wales persisted after adjusting for demographic characteristics, ulcer severity, smoking, body mass index and co-morbidities. We conclude that other factors contribute to variation in healing of diabetic foot ulcers and include the time to specialist assessment.

(239 words)

## INTRODUCTION

There is evidence of wide variation between countries, regions and communities in the outcomes of diabetic foot disease. The incidence of major amputation has been reported to be as much as 200 times higher in some countries than in others (1). Within countries, the incidence of major amputation has also been shown to vary 7-10 fold between populations with diabetes in both the USA (2,3) and the UK (4,5). There are many factors which may contribute to such differences including socio-demographic factors (eg ethnicity, social deprivation, age) and clinical risk factors (smoking status, co-morbidities, the presence of peripheral artery disease (PAD) and distal neuropathy) and their interactions. Other potential contributing factors include the structure of health care delivery and the quality of specialist care (6).

Major amputation has limitations as a measure of the outcome of foot disease in diabetes (7) and ulcer healing has been chosen as a preferrable outcome for the National Diabetes Foot Care Audit of England and Wales (NDFA) because it reflects the principal aims of care: return to usual function and limb salvage rather than limb sacrifice. By contrast with amputations, however, there have been relatively few studies of diabetic foot ulcers in which healing has been used as an outcome. Of these, some have compared healing in clinical sub-groups – such as those with and without evidence of PAD (7,8). Others have compared the incidence of healing associated with different degrees of ulcer severity using clinical scores based mainly on the presence of ulcer depth, area and infection and the presence of either neuropathy or PAD (9). One multinational study used multivariate analysis to demonstrate that several patient and ulcer characteristics were independently associated with healing: age, sex, history of heart failure, end stage renal failure, PAD, neuropathy, infection and ulcer area, depth and position on the foot (10).

The NDFA was established in 2014 and its data provide the opportunity to extend knowledge of diabetic foot ulcer outcomes (11,12). The aim of the present study was to describe patient and ulcer characteristics that are associated with healing and assess whether these factors help explain variation in ulcer healing between multi-disciplinary foot care teams.

# METHODS

## Data sources

The NDFA collates data on people with diabetes presenting with a foot ulcer to multi-disciplinary foot care teams in England and Wales. It is part of the National Diabetes Audit (NDA) programme. Data collected comprise the unique NHS number, date of birth, time from first presentation with the ulcer to any health care professional and its first expert assessment (FEA) by a member of a specialist foot care team in either the community or hospital, severity of the index foot ulcer at first expert assessment using the SINBAD classification (12) and whether there is associated Charcot disease. The specialist team also records the following defined healing outcomes: whether the person was both alive and ulcer-free at 12 weeks after first expert assessment (whether or not they had undergone any form of surgery, including amputation), or whether they were alive at 12 weeks but with an unhealed ulcer or surgical wound. As this was a study using data recorded in clinical practice and the status of each ulcer was not determined at exactly 12 weeks from first expert assessment, healing status was defined at any point between 10 and 14 weeks (70-98 days).

Further data on demographic characteristics (sex, ethnicity, social deprivation) and clinical characteristics (type of diabetes, HbA1c, systolic blood pressure, total cholesterol, history of kidney disease) were obtained from the core NDA data (13) The occurrence of major amputation (Classification of Interventions and Procedures (OPCS-4) codes X093-99) within 6 months of first expert assessment, hospital admission for myocardial infarction (ICD-10 codes I21-2), stroke (ICD-10 codes I61, I63, I64, I679) and heart failure (ICD-10 code I50) were obtained from Hospital Episode Statistics for England and Patient Episode Database for Wales, which routinely document hospital activity in England and Wales respectively.

## Ethics statement

The NDA programme is commissioned by NHS England and the Welsh government and managed by the Healthcare Quality Improvement Partnership. The NDFA is delivered by NHS Digital (13) in partnership with Diabetes UK. Initially, the legal basis for the NDFA data collection in both England and Wales was informed patient consent. In May 2017 a new

legal basis for data collection was provided in the form of a Direction from NHS England under Section 254 of the Health and Social Care Act 2012, which meant that patient consent was no longer required in England. In Wales, the legal basis for the collection of data remained patient consent for the duration of this analysis. All patients are provided with standard written information about the NDFA. All counts of people taken from the NDA are rounded to the nearest five to protect confidentiality.

**Study population**

31,440 individuals aged 18 years or older were registered by the NDFA after presenting to one of 140 specialist foot care services between 14th July 2014 and 31st March 2018. If an individual had more than one ulcer episode registered by the NDFA, only the first was selected for analysis. 4,410 (14.0%) were excluded from the cohort due to missing follow-up data and this left a study population of 27,030. Entry into the cohort, or index date, was defined as the date of first expert assessment (FEA) by a member of a multi-disciplinary footcare service.

**Follow-up and outcome**

The outcome was that of being alive and ulcer-free at approximately 12 weeks from FEA. To allow for the fact that clinical appointments did not always occur exactly 12 weeks after FEA, outcomes reported between 10 to 14 weeks from FEA were included in the analysis. In the primary analysis people who had undergone an amputation but had a healed surgical wound and no further ulcers were classed as being ulcer-free. A sensitivity analysis re-classifying all people who had undergone an amputation at this time as not being ulcer-free was also undertaken.

**Classification variables**

Age and duration of diabetes derived from the NDA was calculated at the time of presentation to the specialist service. Ethnicity was defined as White, Asian, Black, or other. Deprivation scores were derived from home postcode and defined by the Indices of Multiple Deprivation 2015 (England) and 2014 (Wales). To enable cross-border comparisons, a

combined England and Wales score was created using the Employment and Income domain (14,15). For the purpose of analysis these scores were divided into quintiles.

Ulcer severity was measured using the SINBAD classification (12). A binary outcome was recorded for each of six aspects – site of the ulcer (on the hind foot or elsewhere), evidence of ischaemia, evidence of neuropathy, the presence of bacterial infection, the ulcer being greater than $1cm^2$ in area and reaching to muscle, tendon or deeper. The existence of either active or previous Charcot arthropathy was also noted in this study. The interval between first presentation to any health care professional and FEA was taken from the NDFA and grouped as: self-presenting, ≤2 days, 3-13 days, 14 days-2 months and >2 months.

The latest HbA1c, systolic blood pressure, total cholesterol, body mass index and smoking status recorded in the core NDA within the audit data collection occurring in the same year or one year prior to the initial presentation to the multi-disciplinary team were identified. To account for non-linear associations between these factors and ulcer healing the variables were split into categorical variables which included a category for missing data. Smoking status was defined as current smoker, ex-smoker and never smoked.

Kidney disease was defined as an eGFR of <60 $mL/min/1.73\ m^2$, a hospital admission with an ICD-10 codes of N185, Z490, Z491, Z492, Z992 or evidence of renal transplant or dialysis (OPCS-4 codes M01 or X40). Any history of a hospital admission for myocardial infarction (ICD-10 codes I21-22), stroke (ICD-10 codes I61, I63-4, I679) and heart failure (ICD-10 code I50) in the year prior to or one month after the first expert assessment prior to the first expert assessment of the ulcer was identified.

**Statistical analysis**

Univariable logistic regression models were run for each of the classification variables to establish baseline univariable associations with the outcome. A multivariable logistic regression model was run where all demographic and clinical characteristics were potentially included. Variables were selected for inclusion in the model using an iterative step-wise backward elimination procedure where variables were added in order of the largest p value until all those with an association at 95% significance were included. Using the same approach, a further model was constructed that included time from first presentation of the

ulcer to a healthcare professional to first expert assessment. This information was used to identify factors that may confound the association between service (the key exposure of interest) and outcome.

Two healing ratios were created for each of the 120 (out of 140) services with 20 or more patients included in the study. Firstly, an unadjusted healing ratio was calculated. This was calculated as the proportion of people being treated at that centre who were alive and ulcer-free at 12 weeks, multiplied by the proportion of people alive and ulcer-free in the whole cohort, multiplied by 100. An unadjusted healing ratio of 100 indicates that the proportion of people alive and ulcer-free at 12 weeks treated by that service is exactly the same as the proportion found across the whole of cohort of people included in this analysis. A value below 100 indicates fewer people treated at that service were alive and ulcer-free than in the total cohort across England and Wales whilst a value above 100 shows that a greater proportion of people treated at that service were alive and ulcer-free than the proportion for the whole of England and Wales.

Secondly, in order to take account of the differing patient and ulcer characteristics across services an adjusted healing ratio was calculated. This took the odds of being alive and ulcer-free after adjustment for risk factors from the logistic regression model to calculate the probability of each individual being alive and ulcer-free at 12 weeks based on their demographic and ulcer characteristics. For each service the sum of these probabilities provided the expected number of people who would be alive and ulcer-free at 12 weeks if each individual had the same healing rate as found across the whole cohort in England and Wales for those with the same demographic and ulcer characteristics. The observed, or actual, number of people alive and ulcer-free at 12 weeks for each service was divided by the expected number in each service and was multiplied by 100 to give the standardised healing ratio. An adjusted standardised healing ratio below 100 indicates that after adjustment for patient and ulcer characteristics, fewer people being treated by that centre were alive and ulcer-free at 12 weeks than would be expected based on the outcomes of the whole cohort across England and Wales. Conversely, an adjusted standardised healing ratio greater than 100 indicates that a greater proportion of people treated at that centre were alive and ulcer-free at 12 weeks than would be expected based on the outcomes of the whole cohort across England and Wales. Services with a healing ratio more than three standard deviations above

or below the mean for the whole cohort were considered to have a healing rate outside that which could be reasonably explained by variation in case-mix.

## RESULTS

Between 14th July 2014 and 31st March 2018 31,400 people presented to one of the 140 specialist units providing data to the NDFA with a new active foot ulcer to a specialist team, of whom 27,030 (86.0%) had a valid outcome recorded. After a median of 12 weeks follow up from first expert assessment 12,925 (47.8%) were alive and ulcer-free, 13,745 (50.9%) had an unhealed ulcer whilst 360 had died (1.3%) A total of 1,425 people (5.7%) had one or more major or minor amputations in the 12 week follow up period with 375 (26.2% of these) having a healed surgical wound.

### Univariable models

Univariable logistic regression models showed associations between ulcer-free survival and male sex (OR 0.83 95% CI 0.79-0.88 compared to female), and smoking status: OR 0.82, 95% CI 0.76-0.88 (current smoker) and 0.78, 95% CI 0.66-0.92 (missing smoking status) compared to never smokers.

Having an ulcer on the hind foot (OR 0.62, 95% CI 0.58-0.66), evidence of ischaemia (OR 0.44, 95% CI 0.42-0.46), evidence of neuropathy (OR 0.70, 95% CI 0.66-0.74) or bacterial infection (OR 0.57, 95% CI 0.54-0.60) were associated with reduced odds of being alive and ulcer-free. Ulcers that were 1cm$^2$ or greater in area (OR 0.42 95% CI 0.40-0.45) or that involved the muscle, tendon or were deeper (OR 0.43, 95% CI 0.40-0.46) were also less likely to heal.

Compared to those with a HbA1c of 48-53 mmol/mol those with a HbA1c of 59-74 mmol/mol (OR 0.91, 95% CI 0.84-0.98), 75-85 mmol/mol (OR 0.87, 95% CI 0.79-0.96) and ≥86 mmol/mol (OR 0.88, 95% CI 0.76-0.95) had lower odds of being alive and ulcer-free. Those with a body mass index of less than 20 kg/m$^2$ (OR 0.79, 95% CI 0.67-0.92) and an unknown body mass index (OR 0.73, 95% CI 0.63-0.85) had lower odds of being alive and ulcer-free than people with a body mass index of 25-29.9 kg/m$^2$. A history of renal disease, myocardial infarction, stroke or heart failure were associated with lower odds of being alive and ulcer-free. No association was found between outcome and type of diabetes, ethnicity or deprivation (see Table 2).

**Multivariable model**

The primary logistic regression model to assess associations with ulcer-free survival included sex, age, deprivation, smoking status, body mass index, duration of diagnosed diabetes, all elements of the SINBAD classification and evidence of Charcot arthropathy. Variables indicating co-morbidity with kidney disease, myocardial infarction and heart failure (but not stroke) were also included in the model (see Table 2). Adding the time from first presentation to a healthcare professional to FEA of the ulcer resulted in age and smoking status no longer being included in the model but ethnicity becoming a statistically significant explanatory variable.

Categorising everyone who underwent an amputation as having an unhealed ulcer irrespective of the state of the surgical wound resulted in a model that did not include age or deprivation as explanatory variables but did include ethnicity (see Table 2).

Across all models the strongest predictors of ulcer non-healing as measured by the beta co-efficient were evidence of ischaemia, having an ulcer of 1cm$^2$ or greater, having an ulcer involving the muscle, tendon or deeper, and being male (see Table 2).

**Variation persisting after risk-adjustment**

Figure 1 shows a funnel plot of the non-standardised healing ratios for the 120 participating care providers with 20 or more cases registered. It highlights the variation in crude rates of being alive and ulcer-free by care provider. There were seven (5.8%) care providers that had ulcer healing rates more than three standard deviations (3SD) above the mean for the whole cohort and 11 (9.2%) more than three standard deviations below the mean for the whole cohort (in contrast to the expected total of 0.3% outside 3 SD either side of the mean for the standard normal distribution) . If the definition of acceptable variation is reduced to two standard deviations from the mean 24 (20.0%) of care providers fell below and 14 (11.7%) were above this limit (in contrast to the expected total of 5% outside 2 SD eitther of the mean for the standard normal distribution). Figure 2 shows the funnel plot for the same 120 participating care providers after standardising the healing ratios. It indicates that even after risk-adjustment there were four (3.3%) care providers with an ulcer healing ratio more than three standard deviations above and seven (5.8%) with an ulcer healing ratio more than three standard deviations below the mean for the whole cohort. For two standard deviation

thresholds the risk-adjusted healing ratios for 18 services (15.0%) were below and 12 services (10.0%) above.

## DISCUSSION

This study of 27,030 people with new diabetic foot ulcers presenting to specialist teams shows that just under half were alive and ulcer-free between 10 and 14 (median 12) weeks following first expert assessment. The strongest associations with ulcer healing were the severity of the ulcer as measured by the SINBAD score, as well as sex and the presence of Charcot arthropathy. Time to the first expert assessment was also a strong predictor of outcome. After adjustment for case-mix the percentage of care providers with a healing ratio outside three standard deviations from the cohort average fell from 15.0% to 9.2%. This suggests that whilst the demographic and clinical characteristics included in the case-mix adjustment explain some of the variation in ulcer healing by care provider, there are factors not included in the analysis that contribute to a greater extent. These are likely to be at service level and potentially include differences in the organisation and delivery of foot care in different settings.

Few other studies of factors associated with better or worse outcome have used ulcer healing as the outcome of interest. A single multinational prospective study exploring factors associated with healing by 12 months reported significant associations between healing and ulcer area, PAD, neuropathy and clinical co-morbidities in 1,088 people with foot ulcers and used them as the basis for calculating a 'risk scoring rule' (16). Other studies exploring factors associated with ulcer healing have nearly all been based on systematic reviews; significant associations were reported between measures of PAD and healing time (17-19). In addition, a single large, retrospective study used data held by the US Wound Registry on 6,440 individuals and reported associations between ulcer healing and multiple factors including wound duration, number of ulcers, infection, patient age, PAD and other co-morbidities from which a 'wound healing index' was devised and reported to be predictive of healing (20).

### Strengths and limitations

One of the strengths of this analysis is the large cohort size drawn from routine practice across specialist care providers throughout England and Wales. Not all care providers

participate in the NDFA and participating services do not necessarily register all newly presenting ulcers. Previous community surveillance has suggested that foot ulcers occur in approximately 2% per year of all people with diabetes in UK (21), of which less than half are likely to be referred for expert assessment in specialist services (22). Using annual caseload estimates provided by NDFA submitters as the denominator, the population coverage of the NDFA for the study period is estimated at 13.3% varying from 8.1% to 23.4% across the regions of England and Wales even though the data presented here are derived from the early years of the audit and participation has increased steadily over time. Those referred to specialist services will have tended to have either more severe ulcers or those which have proved resistant to earlier interventions. On the other hand, it is possible that a percentage of those with more overt PAD may have been referred directly to specialist vascular services.

The binary nature of some ulcer severity variables may have limited the statistical explanatory power of the analysis. For example, the SINBAD scores for ischaemia and neuropathy are not graduated for severity. Nevertheless, this study shows that differences between care providers in England and Wales in healing of diabetic foot ulcers persist after case-mix adjustment. These observations suggest that factors other than those measured in the study are likely to be significant contributors to variation in provider level outcomes. It is noteworthy that repeated studies conducted over the last 25 years have reported that alterations to the structure and process of health care delivery have resulted in very marked improvements, albeit using incidence of major amputation rates as the primary outcome (23-26). It is therefore possible that differences in the structure and delivery of diabetic foot ulcer care are also major contributors to the observed variation in ulcer healing by 12 weeks.

These data confirm that audit is an important part of routine clinical management and can provide evidence of variation in outcome between different specialist services which can be used as the basis of improving quality of care and outcomes. The identification of modifiable factors that contribute to such variation and of effective interventions is also required. The present observations confirm the importance of certain socio-demographic and clinical risk factors but also suggest that a significant contribution might be made by aspects of the delivery of specialist care. Further research is needed into the relationship between the organisation and accessibility of care, staff education and training and outcomes in people with diabetic foot ulcers.

**References**


1. Jeffcoate WJ, van Houtum WH. Amputation as a marker of the quality of care in diabetes. *Diabetologia.*2004;47:2051–2058.
2. Wrobel JS, Mayfield JA, Reiber GE. Geographic variation of lower-extremity major amputation in individuals with and without diabetes in the Medicare population. *Diabetes Care.*2001;24:860–864.
3. Margolis DJ, Hoffstad O, Nafash J, Leonard CE, Freeman CP, Hennessy S *et al*. Location, location, location: geographic clustering of lower-extremity amputation among Medicare beneficiaries. *Diabetes Care.*2011;34:2363–2367.
4. Holman N, Young RJ, Jeffcoate WJ (2011) Variation in the recorded incidence of amputation of the lower limb in England. *Diabetologia.*2011;55:1919–1925.
5. Jeffcoate W, Barron E, Lomas J, Valabhji J, Young B (2017) Using data to tackle the burden of amputation in diabetes. *Lancet.*2017;390:e29-e30 doi 10.1016/SO140-6736(17)32401–32407.
6. Margolis DJ, Jeffcoate W (2013) Epidemiology of foot ulceration and amputation: can global variation be explained ? *Med Clin North Am.*2013;97:791–805.
7. Jeffcoate W, Game F, Morbach S, Narres M, Van Acker K, Icks A. Assessing data on the incidence of lower limb amputation in diabetes. *Diabetologia*.2021;64:1442-1446.
8. Prompers L, Schaper N, Apelqvist J, Edmonds M, Jude E, Mauricio D *et al*. (2008) Prediction of outcome in individuals with diabetic foot ulcers: focus on the differences between individuals with and without peripheral arterial disease. The EURODIALE Study. *Diabetologia.*2008;51:747–755.
9. Meloni M, Izzo V, Giurato L, Martinez J, Uccioli L. Prevalence, clinical aspects and outcomes in a large cohort of persons with diabetic foot disease: comparison between neuropathic and ischemic ulcers. *J Clin Med.* 2020;9:1780doi:10.3390/jcm9061780.
10. Monteiro-Soares M, Russell D, Boyko EJ, Jeffcoate WJ, Mills JL, Morbach S *et al*. Guidelines on the classification of diabetic foot ulcers (IWGDF 2019). *Diabetes Metab Res Rev*. 2020;36 Suppl 1:e3273.doi: 10.1002/dmrr.3273.
11. Pickwell K, Siersma V, Kars M, Holstein P, Schaper N. Diabetic foot disease: impact of ulcer location on ulcer healing. *Diabetes Metab Res Rev.*2013; 29:377–383.
12. Ince P, Abbas, ZG, Lutale JK, Basit A, Ali SM, Chohan F *et al.* Use of the SINBAD classification and score in comparing outcome of foot ulcer management on three continents. *Diabetes Care.* 2004;31:964–967.

13. National Diabetes Audit — Report 2 Complications and Mortality, 2017-18. *https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-audit/report-2—complications-and-mortality-2017-18* (accessed 9th November 2020)
14. Payne RA, Abel G. UK indices of multiple deprivation – a way to make comparisons across constituent countries easier. *Health Stat Q.*2012;53:22–37.
15. *https://digital.nhs.uk/binaries/content/assets/website-assets/services/ods/user_guide.pdf* (Accessed 4th December 2020)
16. Prompers L. Non-healing in diabetic foot disease is predicted by ulcer size, peripheral arterial disease, polyneuropathy and co-morbidities. The Eurodiale risk score. PhD Dissertation, CAPHRI, Maastricht University, The Netherlands: 63-71.
17. Brownrigg JR, Hinchliffe RJ, Apelqvist J, Boyko EJ, Fitridge R, Mills JL *et al*. Performance of prognostic markers in the prediction of wound healing or amputation among patients with foot ulcers in diabetes: a systematic review. *Diabetes Metab Res Rev* 2016;32 Suppl1:128-135.
18. Wang Z, Hasan R, Firwana B, Elraiyah T, Tsapas A, Prokop L, A systematic review and meta-analysis of tests to predict wound healing in diabetic foot. *J Vasc Surg* 2016;63 (2 Suppl) 29S-36S.
19. Forsyth RO, Apelqvist J, Boyko EJ, Fitridge R, Hong JP, Katsanos K *et al.* Performance of prognostic markers in the prediction of wound healing or amputation among patients with foot ulcers in diabetes: A systematic review. *Diabetes Metab Res Rev* 2020;36 Suppl1:e3278.
20. Fife CE, Horn SD, Smout RJ, Barrett RS, Thomson B. A predictive model for diabetic foot ulcer outcome: the Wound Healing Index. *Adv Wound Care (New Rochelle)*2016; 5:279-287.
21. Abbott CA, Carrington AL, Ashe H, Bath S, Every LC, Griffiths J *et al.* The North-West Diabetes Foot Care Study: Incidence of, and risk factors for, new diabetic foot ulceration in a community-based patient cohort. *Diabet Med.*2002;19:377–384.
22. Guest JF, Fuller GW, Vowden P. Diabetic foot ulcer management in clinical practice in the UK: costs and outcomes. *Int Wound J* (2017);14:43–52.
23. Smith-Strøm H, Iversen MM, Igland J, Østbye T, Graue M, Skeie S *et al.* Severity and duration of diabetic foot ulcer (DFU) before seeking care as predictors of healing time: A retrospective cohort study. *PLoS One.*2017;12(5):e0177176. doi: 10.1371/journal.pone.0177176.eCollection 2017.PMID: 28498862.

24. Canavan RJ, Unwin NC, Kelly WF, Connolly VM. Diabetes- and nondiabetes-related lower extremity amputation incidence before and after the introduction of better organized diabetes foot care: continuous longitudinal monitoring using a standard method. *Diabetes Care.*2008;31:459–463.
25. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in diabetic amputations over 11 years in a defined U.K. population: benefits of multidisciplinary team work and continuous prospective audit. *Diabetes Care* 2008;31:99–101.
26. Paisey RB, Abbott A, Levenson R *et al*. Diabetes-related major lower limb amputation incidence is strongly related to diabetic foot service provision and improves with enhancement of services: peer review of the South-West of England. *Diabet Med* 2018;35:53–62.

## NOVELTY STATEMENT

- The outcome of diabetic foot disease varies widely between centres.
- In order to explore potential causes of variation, it is necessary to adjust data for case-mix using data on the multiple patient-centred factors which may influence the rate of healing.
- This study was prospective and conducted in a very large population of people newly presenting with diabetic foot ulcers in England and Wales.
- The main conclusion of the study is that significant variation in healing was observed between clinical services even after making allowance for case-mix. Residual variation may be explained by aspects of the organisation and delivery of care.

## ACKNOWLEDGEMENTS

The authors are indebted to the many people who have contributed to the conduct of the NDFA since its inception and without whose contribution this work would not have been possible. They thank, in particular, the members of the NDFA Advisory Group as well as the hundreds of clinical staff involved in the collection of the clinical data which form the basis of the analyses.

## FUNDING

This study was funded entirely by NHS England and by Diabetes UK. There was no external funding.

## AUTHOR RELATIONSHIPS

None of the authors has any relationship which could be regarded as a conflict of interest with regard to this work.

## AUTHOR CONTRIBUTIONS

All authors were closely involved in the conduct of this study. WJ is Clinical Lead of the NDFA and BY is the Clinical Lead of the parent National Diabetes Audit. AY, CM, PK, JM, SW and NH conducted all aspects of data handling and analyses. AY, PK, WJ, BY, SW and NH drafted the report. All authors contributed to and approved the final version of the manuscript.

**Table 1: Baseline characteristics of people presenting to specialist services in England and Wales in 2014-2018 with a diabetic foot ulcer by outcome at approximately 12 weeks**

| | All | | Alive and ulcer-free | | With unhealed ulcer | | Died | | Lost to follow up | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % |
| Number | 31,440 | | 12,925 | | 13,745 | | 360 | | 4,410 | |
| Sex | | | | | | | | | | |
| Female | 9,175 | 29.2% | 4,015 | 31.1% | 4,015 | 29.2% | 125 | 34.7% | 1,305 | 29.6 |
| Male | 21,820 | 69.4% | 8,740 | 67.6% | 8,740 | 63.6% | 225 | 62.5% | 3,030 | 68.7 |
| Unknown | 450 | 1.4% | 170 | 1.3% | 170 | 1.2% | 10 | 2.8% | 75 | 1.7 |
| Age | | | | | | | | | | |
| <40 years | 835 | 2.7% | 370 | 2.9% | 305 | 2.2% | - | 0.0% | 155 | 3.5 |
| 40-49 years | 2,370 | 7.5% | 1,005 | 7.8% | 1,030 | 7.5% | 10 | 2.8% | 325 | 7.4 |
| 50-59 years | 5,690 | 18.1% | 2,350 | 18.2% | 2,475 | 18.0% | 20 | 5.6% | 845 | 19.2 |
| 60-69 years | 7,395 | 23.5% | 3,110 | 24.1% | 3,250 | 23.6% | 40 | 11.1% | 995 | 22.6 |
| 70-79 years | 8,160 | 26.0% | 3,365 | 26.0% | 3,625 | 26.4% | 100 | 27.8% | 1,070 | 24.3 |
| 80+ years | 6,970 | 22.2% | 2,715 | 21.0% | 3,045 | 22.2% | 190 | 52.8% | 1,020 | 23.1 |
| Mean (SD) | 67.7 (13.7) | | 67.3 (13.7) | | 67.9 (13.5) | | 78.2 (11.6) | | 67.2 (14.3) | |
| Median (IQR) | | | | | | | | | | |
| Type of diabetes | | | | | | | | | | |
| Type 1 | 3,965 | 12.6% | 1,635 | 12.6% | 1,730 | 12.6% | 35 | 9.7% | 565 | 12.8 |
| Type 2 and other | 26,975 | 85.8% | 11,100 | 85.9% | 11,795 | 85.8% | 315 | 87.5% | 3,760 | 85.3 |
| Unknown | 505 | 1.6% | 190 | 1.5% | 220 | 1.6% | 10 | 2.8% | 85 | 1.9 |
| Duration of diabetes diagnosis | | | | | | | | | | |
| 0-9 years | 9,355 | 29.8% | 3,775 | 29.2% | 4,150 | 30.2% | 80 | 22.2% | 1,350 | 30.6 |
| 10-19 years | 12,825 | 40.8% | 5,620 | 43.5% | 5,260 | 38.3% | 145 | 40.3% | 1,795 | 40.7 |
| 20+ years | 8,505 | 27.1% | 4,005 | 31.0% | 3,235 | 23.5% | 110 | 30.6% | 1,155 | 26.2 |
| Unknown | 755 | 2.4% | 340 | 2.6% | 280 | 2.0% | 20 | 5.6% | 110 | 2.5 |
| Mean (SD) | 15.3 (10.8) | | 15.9 (11) | | 14.7 (10.5) | | 16.7 (10.7) | | 15.2 (10.7) | |
| Median (IQR) | | | | | | | | | | |
| Ethnicity | | | | | | | | | | |
| White | 24,810 | 78.9% | 10,175 | 78.7% | 10,830 | 78.8% | 285 | 79.2% | 3,515 | 79.7 |
| Asian | 1,140 | 3.6% | 480 | 3.7% | 480 | 3.5% | 10 | 2.8% | 175 | 4.0 |
| Black | 785 | 2.5% | 300 | 2.3% | 355 | 2.6% | 5 | 1.4% | 125 | 2.8 |
| Other | 555 | 1.8% | 210 | 1.6% | 260 | 1.9% | 5 | 1.4% | 80 | 1.8 |
| Missing | 4,150 | 13.2% | 1,760 | 13.6% | 1,825 | 13.3% | 55 | 15.3% | 510 | 11.6 |
| Deprivation | | | | | | | | | | |
| Most deprived | 7,975 | 25.4% | 3,235 | 25.0% | 3,455 | 25.1% | 75 | 20.8% | 1,210 | 27.4 |
| 2nd most deprived | 6,600 | 21.0% | 2,635 | 20.4% | 2,930 | 21.3% | 85 | 23.6% | 945 | 21.4 |
| 3rd mort deprived | 6,340 | 20.2% | 2,625 | 20.3% | 2,840 | 20.7% | 60 | 16.7% | 815 | 18.5 |
| 2nd least deprived | 5,450 | 17.3% | 2,285 | 17.7% | 2,360 | 17.2% | 75 | 20.8% | 725 | 16.4 |
| Least deprived | 4,170 | 13.3% | 1,790 | 13.8% | 1,775 | 12.9% | 50 | 13.9% | 560 | 12.7 |
| Unknown | 910 | 2.9% | 355 | 2.7% | 390 | 2.8% | 10 | 2.8% | 155 | 3.5 |
| Smoking | | | | | | | | | | |
| Current smoker | 4,290 | 13.6% | 1,585 | 12.3% | 1,985 | 14.4% | 30 | 8.3% | 690 | 15.6 |
| Ex-smoker | 13,125 | 41.7% | 5,480 | 42.4% | 5,750 | 41.8% | 185 | 51.4% | 1,710 | 38.8 |
| Never smoked | 13,345 | 42.4% | 5,610 | 43.4% | 5,700 | 41.5% | 125 | 34.7% | 1,905 | 43.2 |
| Unknown | 680 | 2.2% | 245 | 1.9% | 310 | 2.3% | 15 | 4.2% | 105 | 2.4 |
| SINBAD score | | | | | | | | | | |
| Site - on hindfoot | 5,580 | 17.7% | 1,825 | 14.1% | 2,835 | 20.6% | 135 | 37.5% | 790 | 17.9 |
| Ischaemia present | 10,920 | 34.7% | 3,270 | 25.3% | 5,925 | 43.1% | 220 | 61.1% | 1,505 | 34.1 |
| Neuropathy present | 25,150 | 80.0% | 10,035 | 77.6% | 11,475 | 83.5% | 275 | 76.4% | 3,365 | 76.3 |
| Bacterial infection present | 13,590 | 43.2% | 4,705 | 36.4% | 6,930 | 50.4% | 140 | 38.9% | 1,820 | 41.3 |
| Area greater than $1cm^2$ | 15,595 | 49.6% | 5,000 | 38.7% | 8,200 | 59.7% | 225 | 62.5% | 2,170 | 49.2 |
| Depth to muscle, tendon | 6,005 | 19.1% | 1,635 | 12.6% | 3,495 | 25.4% | 75 | 20.8% | 805 | 18.3 |
| Charcot | | | | | | | | | | |
| Present | 385 | 1.2% | 150 | 1.2% | 185 | 1.3% | - | 0.0% | 45 | 1.0 |
| Possible | 530 | 1.7% | 205 | 1.6% | 235 | 1.7% | - | 0.0% | 85 | 1.9 |
| Inactive | 1,165 | 3.7% | 430 | 3.3% | 595 | 4.3% | 5 | 1.4% | 135 | 3.1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Not present | 24,685 | 78.5% | 10,310 | 79.8% | 10,740 | 78.1% | 305 | 84.7% | 3,330 | 75.5 |
| | Unknown | 4,680 | 14.9% | 1,830 | 14.2% | 1,990 | 14.5% | 45 | 12.5% | 810 | 18.4 |
| Time to first assessment | | | | | | | | | | | |
| | Self presenting | 7,760 | 24.7% | 3,650 | 28.2% | 3,045 | 22.2% | 70 | 19.4% | 1,000 | 22.7 |
| | <= 2 days | 4,655 | 14.8% | 1,925 | 14.9% | 2,020 | 14.7% | 60 | 16.7% | 655 | 14.9 |
| | 3-13 days | 9,575 | 30.5% | 4,040 | 31.3% | 4,145 | 30.2% | 110 | 30.6% | 1,280 | 29.0 |
| | 14 days - 2 months | 6,545 | 20.8% | 2,475 | 19.1% | 2,995 | 21.8% | 80 | 22.2% | 990 | 22.4 |
| | > 2 months | 2,905 | 9.2% | 835 | 6.5% | 1,540 | 11.2% | 40 | 11.1% | 490 | 11.1 |
| HbA1c (mmol/mol) | | | | | | | | | | | |
| | <48 | 5,615 | 17.9% | 2,375 | 18.4% | 2,370 | 17.2% | 95 | 26.4% | 780 | 17.7 |
| | 48-53 | 4,360 | 13.9% | 1,860 | 14.4% | 1,830 | 13.3% | 40 | 11.1% | 625 | 14.2 |
| | 54-58 | 3,405 | 10.8% | 1,420 | 11.0% | 1,470 | 10.7% | 45 | 12.5% | 470 | 10.7 |
| | 59-74 | 7,890 | 25.1% | 3,225 | 25.0% | 3,495 | 25.4% | 95 | 26.4% | 1,075 | 24.4 |
| | 75-85 | 3,620 | 11.5% | 1,450 | 11.2% | 1,650 | 12.0% | 30 | 8.3% | 495 | 11.2 |
| | 86+ | 5,680 | 18.1% | 2,255 | 17.4% | 2,555 | 18.6% | 40 | 11.1% | 825 | 18.7 |
| | Unknown | 875 | 2.8% | 345 | 2.7% | 375 | 2.7% | 15 | 4.2% | 140 | 3.2 |
| | Mean (SD) | 66.6 (22) | | 66 (21.4) | | 67.2 (22.3) | | 61.4 (20.1) | | 67.3 (23) | |
| | Median (IQR) | | | | | | | | | | |
| Body mass index (kg/m$^2$) | | | | | | | | | | | |
| | <20 | 865 | 2.8% | 405 | 3.1% | 305 | 2.2% | 20 | 5.6% | 140 | 3.2 |
| | 20-249 | 5,195 | 16.5% | 2,300 | 17.8% | 2,060 | 15.0% | 75 | 20.8% | 755 | 17.1 |
| | 25-29.9 | 9,390 | 29.9% | 4,130 | 32.0% | 3,880 | 28.2% | 95 | 26.4% | 1,280 | 29.0 |
| | 30-34.9 | 8,160 | 26.0% | 3,500 | 27.1% | 3,405 | 24.8% | 90 | 25.0% | 1,170 | 26.5 |
| | 35-39.9 | 4,175 | 13.3% | 1,805 | 14.0% | 1,790 | 13.0% | 35 | 9.7% | 545 | 12.4 |
| | 40+ | 2,700 | 8.6% | 1,140 | 8.8% | 1,160 | 8.4% | 20 | 5.6% | 375 | 8.5 |
| | Unknown | 960 | 3.1% | 465 | 3.6% | 325 | 2.4% | 20 | 5.6% | 150 | 3.4 |
| | Mean (SD) | 30.6 (6.8) | | 30.5 (6.8) | | 30.8 (6.7) | | 29.2 (6.7) | | 30.4 (6.8) | |
| | Median (IQR) | | | | | | | | | | |
| Systolic blood pressure (mmHg) | | | | | | | | | | | |
| | <120 | 5,465 | 17.4% | 2,080 | 16.1% | 2,500 | 18.2% | 90 | 25.0% | 785 | 17.8 |
| | 120-129 | 6,330 | 20.1% | 2,610 | 20.2% | 2,715 | 19.8% | 70 | 19.4% | 935 | 21.2 |
| | 130-139 | 8,920 | 28.4% | 3,805 | 29.4% | 3,825 | 27.8% | 80 | 22.2% | 1,210 | 27.4 |
| | 140+ | 9,870 | 31.4% | 4,090 | 31.6% | 4,320 | 31.4% | 105 | 29.2% | 1,350 | 30.6 |
| | Unknown | 860 | 2.7% | 335 | 2.6% | 380 | 2.8% | 15 | 4.2% | 130 | 2.9 |
| | Mean (SD) | 132.6 (17) | | 132.9 | | 132.5 | | 129 (18.9) | | 132.4 (17) | |
| | Median (IQR) | | | | | | | | | | |
| Cholesterol (mol/l) | | | | | | | | | | | |
| | <5 | 23,775 | 75.6% | 9,825 | 76.0% | 10,365 | 75.4% | 280 | 77.8% | 3,305 | 74.9 |
| | 5+ | 6,690 | 21.3% | 2,720 | 21.0% | 2,950 | 21.5% | 65 | 18.1% | 950 | 21.5 |
| | Unknown | 980 | 3.1% | 380 | 2.9% | 430 | 3.1% | 15 | 4.2% | 150 | 3.4 |
| | Mean (SD) | 4.2 (1.2) | | 4.2 (1.2) | | 4.2 (1.2) | | 4 (1.2) | | 4.2 (1.2) | |
| | Median (IQR) | | | | | | | | | | |
| Co-morbidities | | | | | | | | | | | |
| | Kidney disease | 2,115 | 6.7% | 685 | 5.3% | 1,055 | 7.7% | 65 | 18.1% | 310 | 7.0 |
| | MI | 720 | 2.3% | 190 | 1.5% | 400 | 2.9% | 25 | 6.9% | 110 | 2.5 |
| | Stroke | 765 | 2.4% | 265 | 2.1% | 345 | 2.5% | 30 | 8.3% | 130 | 2.9 |
| | Heart failure | 3,190 | 10.1% | 960 | 7.4% | 1,605 | 11.7% | 125 | 34.7% | 500 | 11.3 |

**Table 2: Odds ratios for ulcer-free survival at approximately 12 weeks follow-up derived from logistic regression models**

| | Univariable | Multivariable | | | | |
|---|---|---|---|---|---|---|
| | | Main model | | Including time to assessment | | All people who underwent amputation classed as unhealed |
| | OR (95% CI) | OR (95% CI) | ß co-efficient | OR (95% CI) | ß co-efficient | OR (95% CI) | ß co-efficient |
| Sex | | | | | | | |
| Female | 1.00 | 1.00 | - | 1.00 | - | 1.00 | - |
| Male | 0.83 (0.79-0.88) | 0.88 (0.83-0.93) | -0.093 | 0.88 (0.84-0.94) | -0.068 | 0.88 (0.83-0.93) | -0.055 |
| Unknown | 0.80 (0.65-0.98) | 1.35 (0.87-2.11) | 0.064 | 1.18 (0.79-1.77) | 0.040 | 1.07 (0.54-2.10) | 0.023 |
| Age | | | | | | | |
| <40 years | 1.27 (1.08-1.49) | 1.19 (1.00-1.41) | 0.041 | | | | |
| 40-49 years | 1.03 (0.93-1.14) | 0.96 (0.86-1.07) | -0.011 | | | | |
| 50-59 years | 1.00 | 1.00 | - | | | | |
| 60-69 years | 1.00 (0.93-1.08) | 1.03 (0.95-1.11) | 0.010 | Not included in model | | Not included in model | |
| 70-79 years | 0.96 (0.89-1.03) | 0.97 (0.90-1.05) | -0.010 | | | | |
| 80+ years | 0.89 (0.83-0.96) | 0.91 (0.83-0.99) | -0.035 | | | | |
| Unknown | 1.06 (0.42-2.68) | 0.97 (0.36-2.59) | -0.007 | | | | |
| Type of diabetes | | | | | | | |
| Type 1 | 1.12 (0.92-1.35) | | | | | 0.64 (0.32-1.28) | -0.047 |
| Type 2 and other | 1.00 | Not included in model | | Not included in model | | 1.00 | - |
| Unknown | 1.13 (0.92-1.39) | | | | | 0.58 (0.29-1.17) | 0.011 |
| Duration of diabetes diagnosis | | | | | | | |
| 0-9 years | 1.00 | 1.00 | - | 1.00 | - | 1.00 | - |
| 10-19 years | 0.85 (0.80-0.90) | 0.88 (0.82-0.93) | -0.011 | 0.88 (0.82-0.93) | -0.008 | 0.87 (0.82-0.93) | -0.007 |
| 20+ years | 0.73 (0.69-0.78) | 0.81 (0.76-0.87) | -0.043 | 0.81 (0.75-0.87) | -0.041 | 0.79 (0.74-0.85) | -0.049 |
| Unknown | 0.73 (0.62-0.86) | 0.91 (0.70-1.20) | 0.005 | 0.89 (0.68-1.16) | 0.000 | 0.90 (0.68-1.19) | 0.004 |
| Ethnicity | | | | | | | |
| White | 1.00 | | | 1.00 | - | 1.00 | - |
| Asian | 1.08 (0.95-1.23) | | | 1.20 (1.04-1.38) | 0.041 | 1.24 (1.08-1.43) | 0.049 |
| Black | 0.91 (0.78-1.07) | Not included in model | | 1.10 (0.93-1.29) | 0.015 | 1.09 (0.92-1.29) | 0.011 |
| Other | 0.87 (0.73-1.05) | | | 0.88 (0.73-1.07) | -0.040 | 0.90 (0.74-1.09) | -0.038 |
| Unknown | 1.02 (0.95-1.10) | | | 1.02 (0.95-1.11) | -0.005 | 1.02 (0.94-1.11) | -0.009 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Deprivation | | | | | | | |
| Most deprived | 1.00 | 1.00 | - | 1.00 | - | | |
| 2nd most deprived | 0.95 (0.89-1.02) | 0.96 (0.89-1.03) | -0.034 | 0.96 (0.89-1.04) | -0.036 | | |
| 3rd mort deprived | 0.99 (0.92-1.06) | 1.00 (0.92-1.07) | -0.020 | 1.00 (0.93-1.08) | -0.020 | Not included in model | |
| 2nd least deprived | 1.02 (0.95-1.10) | 1.03 (0.95-1.11) | -0.008 | 1.05 (0.97-1.13) | -0.005 | | |
| Least deprived | 1.07 (0.99-1.16) | 1.11 (1.02-1.21) | 0.018 | 1.13 (1.03-1.23) | 0.021 | | |
| Unknown | 0.96 (0.83-1.12) | 1.24 (0.98-1.57) | 0.043 | 1.24 (0.98-1.57) | 0.042 | | |
| Smoking | | | | | | | |
| Current smoker | 0.82 (0.76-0.88) | 0.87 (0.80-0.94) | -0.023 | | | 0.89 (0.82-0.96) | -0.015 |
| Ex-smoker | 0.96 (0.91-1.01) | 1.02 (0.97-1.08) | 0.053 | Not included in model | | 1.04 (0.98-1.10) | 0.062 |
| Never smoked | 1.00 | 1.00 | - | | | 1 | - |
| Unknown | 0.78 (0.66-0.92) | 0.81 (0.58-1.13) | -0.037 | | | 0.78 (0.55-1.11) | -0.049 |
| SINBAD score | | | | | | | |
| Site - on hindfoot | 0.62 (0.66-0.58) | 0.73 (0.68-0.78) | -0.067 | 0.74 (0.69-0.79) | -0.064 | 0.74 (0.69-0.79) | -0.064 |
| Ischaemia present | 0.44 (0.46-0.42) | 0.48 (0.45-0.51) | -0.192 | 0.48 (0.45-0.51) | -0.194 | 0.46 (0.44-0.49) | -0.204 |
| Neuropathy present | 0.70 (0.74-0.66) | 0.77 (0.72-0.82) | -0.057 | 0.77 (0.72-0.82) | -0.057 | 0.76 (0.71-0.81) | -0.060 |
| Bacterial infection present | 0.57 (0.60-0.54) | 0.78 (0.74-0.83) | -0.067 | 0.78 (0.74-0.83) | -0.067 | 0.76 (0.72-0.81) | -0.075 |
| Area greater than 1cm2 | 0.42 (0.45-0.40) | 0.52 (0.49-0.55) | -0.111 | 0.53 (0.50-0.56) | -0.104 | 0.51 (0.48-0.53) | -0.145 |
| Involving muscle, tendon or deeper | 0.43 (0.46-0.40) | 0.60 (0.56-0.64) | -0.180 | 0.62 (0.58-0.67) | -0.177 | 0.51 (0.48-0.55) | -0.189 |
| Charcot | | | | | | | |
| Present | 0.87 (0.70-1.08) | 0.83 (0.66-1.05) | -0.018 | 0.85 (0.68-1.07) | -0.015 | 0.86 (0.68-1.08) | -0.018 |
| Possible | 0.92 (0.76-1.11) | 0.95 (0.78-1.16) | 0.016 | 0.98 (0.80-1.19) | 0.020 | 1.02 (0.83-1.24) | 0.025 |
| Inactive | 0.77 (0.68-0.87) | 0.73 (0.63-0.83) | -0.059 | 0.72 (0.63-0.82) | -0.065 | 0.74 (0.65-0.85) | -0.059 |
| Not present | 1.00 | 1.00 | - | 1.00 | - | 1.00 | - |
| Unknown | 0.96 (0.90-1.03) | 1.00 (0.93-1.07) | 0.042 | 1.00 (0.93-1.08) | 0.041 | 1.01 (0.94-1.09) | 0.038 |
| Time to first assessment | | | | | | | |
| Self presenting | 1.24 (1.16-1.32) | | | 1.09 (1.02-1.17) | -0.015 | | |
| <= 2 days | 0.98 (0.90-1.05) | Not included as potential variable | | 0.98 (0.90-1.06) | 0.020 | Not included as potential variable | |
| 3-13 days | 1.00 | | | 1.00 | - | | |
| 14 days - 2 months | 0.85 (0.79-0.91) | | | 0.87 (0.81-0.93) | -0.065 | | |
| > 2 months | 0.56 (0.51-0.61) | | | 0.62 (0.56-0.69) | 0.041 | | |
| HbA1c (mmol/mol) | | | | | | | |
| <48 | 0.97 (0.89-1.06) | Not included in model | | Not included in model | | Not included in model | |
| 48-53 | 1.00 | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 54-58 | 0.94 (0.86-1.04) | | | | | | |
| 59-74 | 0.91 (0.84-0.98) | | | | | | |
| 75-85 | 0.87 (0.79-0.96) | | | | | | |
| 86+ | 0.88 (0.80-0.95) | | | | | | |
| Unknown | 0.89 (0.76-1.05) | | | | | | |
| Body mass index (kg/m$^2$) | | | | | | | |
| <20 | 0.79 (0.67-0.92) | 0.86 (0.73-1.01) | -0.018 | 0.84 (0.71-0.99) | -0.025 | 0.86 (0.73-1.01) | -0.022 |
| 20-249 | 0.95 (0.88-1.02) | 0.98 (0.91-1.06) | 0.025 | 0.97 (0.89-1.04) | 0.020 | 0.96 (0.89-1.04) | 0.014 |
| 25-29.9 | 1.00 | 1.00 | - | 1.00 | - | 1.00 | - |
| 30-34.9 | 1.03 (0.97-1.10) | 1.01 (0.94-1.08) | 0.040 | 1.02 (0.96-1.10) | 0.046 | 1.03 (0.96-1.10) | 0.042 |
| 35-39.9 | 1.06 (0.98-1.15) | 1.00 (0.92-1.09) | 0.031 | 1.03 (0.95-1.12) | 0.042 | 1.04 (0.96-1.13) | 0.041 |
| 40+ | 1.09 (0.99-1.19) | 0.99 (0.90-1.10) | 0.026 | 1.03 (0.93-1.13) | 0.037 | 1.04 (0.94-1.15) | 0.037 |
| Unknown | 0.73 (0.63-0.85) | 0.64 (0.50-0.81) | -0.101 | 0.61 (0.49-0.77) | -0.113 | 0.64 (0.50-0.81) | -0.104 |
| Systolic blood pressure (mmHg) | | | | | | | |
| <120 | 1.00 | | | | | | |
| 120-129 | 1.17 (1.08-1.26) | | | | | | |
| 130-139 | 1.21 (1.13-1.31) | Not included in model | | Not included in model | | Not included in model | |
| 140+ | 1.15 (1.07-1.24) | | | | | | |
| Unknown | 1.06 (0.91-1.24) | | | | | | |
| Cholesterol (mol/l) | | | | | | | |
| <5 | 1.00 | | | | | | |
| 5+ | 0.98 (0.92-1.04) | Not included in model | | Not included in model | | Not included in model | |
| Unknown | 0.92 (0.80-1.06) | | | | | | |
| Co-morbidities | | | | | | | |
| Kidney disease | 0.63 (0.57-0.69) | 0.87 (0.78-0.98) | -0.036 | 0.86 (0.77-0.97) | -0.039 | 0.85 (0.76-0.96) | -0.040 |
| MI | 0.47 (0.40-0.56) | 0.72 (0.59-0.86) | -0.028 | 0.72 (0.60-0.87) | -0.027 | 0.70 (0.58-0.85) | -0.029 |
| Stroke | 0.77 (0.65-0.90) | Not included in model | | Not included in model | | Not included in model | |
| Heart failure | 0.58 (0.53-0.62) | 0.74 (0.68-0.81) | -0.050 | 0.74 (0.67-0.81) | -0.051 | 0.73 (0.66-0.80) | -0.053 |
| Model fit | | | | | | | |
| c-statistic | | 0.686 | | 0.690 | | 0.698 | |
| Nagelkerke-R2 | | 0.139 | | 0.145 | | 0.158 | |

**Figure 1: Funnel plot of unadjusted ratio of people alive and ulcer-free**

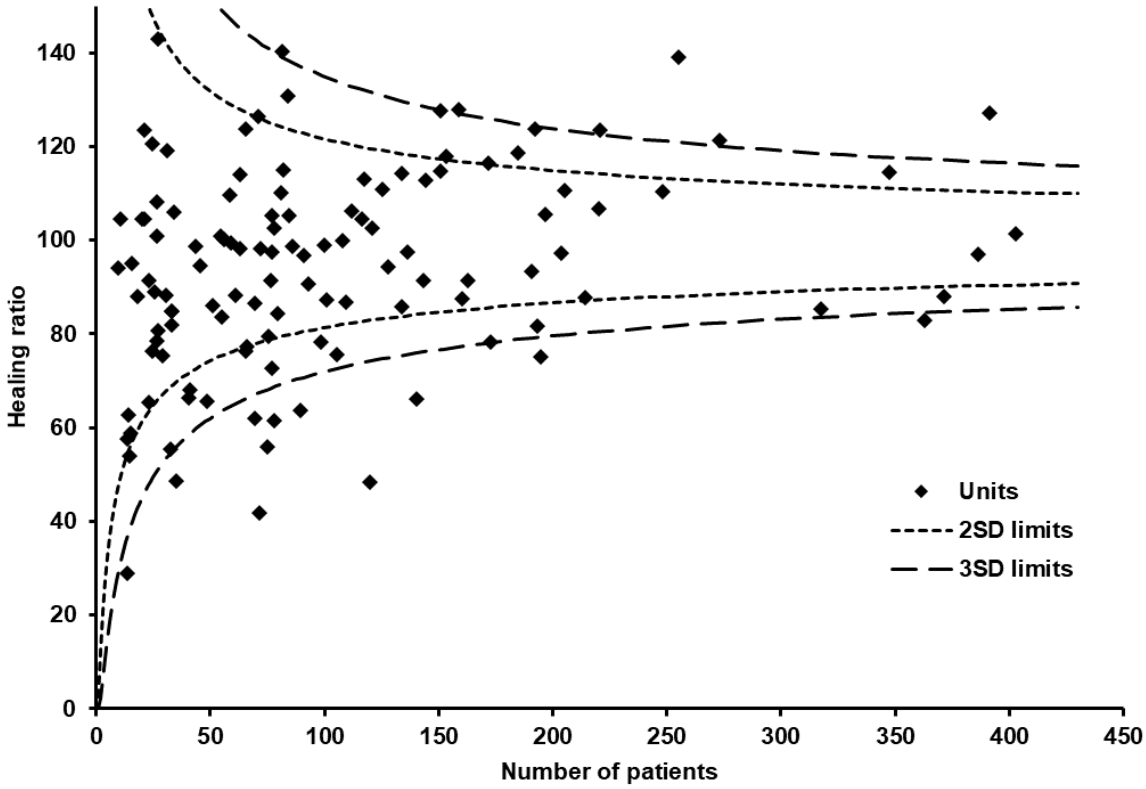
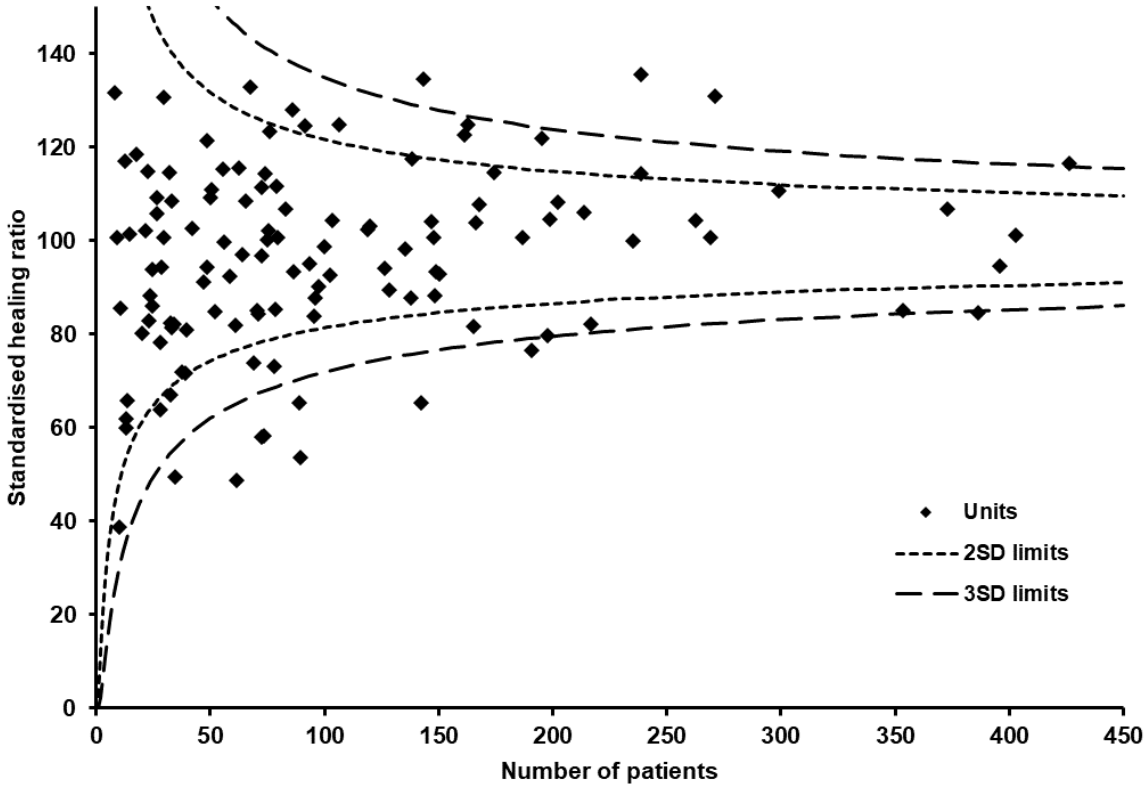


**Figure 2: Funnel plot of standardised ratio people alive and ulcer-free adjusted for case-mix**




Adjusted for sex, age, ethnicity,smoking status, duration of diagnosed diabetes,SINBAD score, presecence of Charcot