

**DFA Guides You Through**

# **The estimated burden of diabetes-related foot disease in Australia in 2017**

**Contained in the**

**Australian diabetes-related foot disease strategy 2018-2022**



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## Introduction

The backbone behind any campaign is an estimated burden of the current situation. Only when you know the size of a problem, can you adequately discuss ways to solve the problem. Together with the Australian diabetic foot community, we at Diabetic Foot Australia (DFA) aim to end avoidable amputations in a generation. To reach this goal, we needed to estimate the burden of diabetes-related foot disease (DFD) in Australia. We estimate that on any given day in 2017 Australia has:

- **300,000 people at-risk of developing DFD**
- **50,000 people living with DFD**
- **12,500 people living with a diabetes-related amputation**
- **1,000 people in hospital because of DFD [27,600 hospitalisations each year]**
- **12 people undergoing a diabetes-related amputation [4,400 amputations each year]**
- **4 people dying because of DFD [1,700 deaths each year]**
- **\$4 million spent directly managing DFD [\$1.6billion spent each year] (1)**

As you may have seen, we have used these numbers as the backbone of the *Australian diabetes-related foot disease strategy 2018-2022: The first step towards ending avoidable amputations within a generation*. And as you may have also seen, some of these numbers are currently being widely used by Diabetes Australia and other partners of DFA. So how did we estimate this national burden and which numbers are most accurate? Time for us to “Guide You Through” these statistics we say.

## Our Methods

The burden of a disease is typically determined using the best epidemiology evidence available for the population of people affected. This includes estimating not only the numbers of people affected, but the morbidity, mortality and costs of managing the disease on a population. This is no exception when it comes to *The Australian diabetes-related foot disease strategy 2018-2022*.

To identify the best epidemiological evidence in this case, DFA tapped into researchers involved in performing a systematic review of the DFD literature in this area. Their methodology has been published in full in the journal *Systematic Reviews* (2). In short: they searched various databases using specified keywords, to find publications on the epidemiology of DFD in Australia. Where they could not find publications in some areas they supplemented with other Australian reports (‘grey literature’) or the best available publications from similar nations. They will publish their final results

in 2018. So with that we bring you what we believe is the best available evidence on the burden of diabetic foot disease in Australia to date. We have divided our following findings into 4 parts:

1. Populations
2. Morbidity
3. Mortality &
4. Costs.

Even though we'd like to think we are, we are far from perfect and we welcome any Australian studies that we may have missed that would shed better light on any of our estimates. Please feel free to email us those studies if you think they would help: [nationaloffice@diabeticfootaustralia.org](mailto:nationaloffice@diabeticfootaustralia.org)

## Our Findings

Let's cut to the chase and show you our findings for the estimated burden of DFD in Australia for the nation and per 100,000 people each day. We hear you ask: how on earth did they come up with those statistics? Let us guide you through the research, assumptions and calculations we used to come up with these estimations for the whole Australian population. Please refer to Table 1 below from *The Australian diabetes-related foot disease strategy 2018-2022* as we now guide you through (1). If you love detail you can read more here: <https://www.diabeticfootaustralia.org/researchers/australian-diabetes-related-foot-disease-strategy-2018-2022/>.

**Table 1:** Estimated burden of diabetes-related foot disease in Australia each day

Characteristic	Australia <sup>a</sup>	Per 100,000 <sup>b</sup>
<b>Populations</b>		
People with diagnosed diabetes <sup>c</sup>	1,250,000	5,000
People at-risk of DFD <sup>d</sup>	300,000	1,000
People living with DFD <sup>e</sup>	50,000	200
<b>Morbidity</b>		
People with a previous diabetes-related amputation <sup>f</sup>	12,500	50
People in public hospital because of DFD <sup>g</sup>	1,000	4
People undergoing a diabetes-related amputation <sup>h</sup>	12	1 every 20 days
<b>Mortality</b>		
People dying from DFD <sup>i</sup>	4	1 every 60 days
<b>Costs</b>		
Estimated costs to public hospitals from DFD <sup>j</sup>	\$1million	\$4,000
Estimated costs to all health systems from DFD <sup>k</sup>	\$4.3million	\$18,000

## Part 1: Populations

### People living in Australia

Part 1 of our investigations started with estimating how many people in Australia may be affected. We started with how many people actually live in Australia today. According to the United Nations Australia has 24.5million people living in Australian in 2017 (3).

### People diagnosed with diabetes in Australia

We then needed to work out how many people have diabetes in Australian before we could estimate all other DFD numbers. Thanks to the National Diabetes Services Scheme we know that just over 1.25million (~5% of all Australians) have been diagnosed with (a type of) diabetes in 2017 (4). We used this 1.25million figure as a conservative estimate of the number of people with diabetes, as it doesn't include those with undiagnosed diabetes. Many experts suggest there are at least another 0.5million people with undiagnosed diabetes in Australia that we haven't included in our estimates (5). As you can start to see we are already erring on the side of being conservative in our estimates and probably under-estimating our calculations on the burden of DFD.

### People at-risk of diabetes-related foot disease in Australia

Next we needed to work out how many people have risk factors for DFD in a typical average Australian population. We defined risk factors for DFD as people with diagnosed diabetes and diagnosed peripheral neuropathy or peripheral arterial disease, as per most (inter)national guidelines (6). However, it's useful to note we didn't include foot deformity or past DFD history as risk factors in our estimates, even though both are included in the NHMRC Australian guidelines (7). We did this because we thought including foot deformity would over-inflate our estimations as foot deformity has no validated definition in diabetes and is a weak independent predictor of DFD (7). We didn't include past DFD history (past foot ulcer or amputation) as most of that population will have peripheral neuropathy or peripheral arterial disease as a precursor anyway (8).

After all that we identified two robust Australian population-based studies that investigated large populations of people with diabetes and diagnosed risk factors using validated clinical measures (the Freemantle Diabetes Study and Australian Diabetes Obesity and Lifestyle study (AusDiab) (9, 10)). Population-based studies include a population that closely represents the demographics of a typical regional or national population; in these cases the typical Australian diabetes populations (10, 11) .

For people with diagnosed diabetes and diagnosed peripheral neuropathy we found a very wide prevalence range of 13-58% in these studies (9, 10). Because of this wide range, we turned to some good quality studies from the UK with similar populations to determine the trend (12, 13). Additionally, both Australian studies used validated but complex neuropathy disability scores to diagnose loss of protective sensation from peripheral neuropathy, rather than the widely-used 10g monofilament recommended by the NHMRC Australian guidelines (7). The UK studies suggested a range of 21-24% for peripheral neuropathy in people with diabetes as diagnosed by a 10g monofilament (12, 13). Based on the best available evidence, we decided to go with a conservative estimate that 21% of people with diabetes in Australia have diagnosed peripheral neuropathy.

For people with diagnosed diabetes and peripheral arterial disease, we found in these studies a prevalence range of 14-29% (9, 10). Both studies used an Ankle Brachial Index of <0.9 to diagnose peripheral arterial disease (9, 10). With a narrower range and based on the best available evidence we decided to go with a mid-point estimate that 22% of people with diabetes in Australia have diagnosed peripheral arterial disease.

As a last step for this part we needed to combine these two to come up with an overall estimate for those people at risk of DFD. Unfortunately, we can't simply add these two estimates together, as we know that many people with peripheral neuropathy also have peripheral arterial disease. Thankfully, the AusDiab study combined both risk factors into a prevalence of at-risk of DFD category for people with diagnosed diabetes (24%) (10). This aligned nicely with a comprehensive UK paper reporting the same (24%) (12) and the latest international estimates (19-34%) (14, 15). We therefore felt very comfortable reporting a conservative informed estimate that 24% of people with diagnosed diabetes in Australia are at-risk of DFD. This figure combined with the 1.25million people with diabetes leads us to estimate that 300,000 Australians are at at-risk of developing DFD as we write this in 2017.

### **People living with diabetes-related foot disease in Australia**

The following step to working out those at-risk, was working out how many people are living with active DFD in Australia. We defined active DFD as people with a (non-healed) diabetic foot ulcer, diabetic foot infection or diabetic critical limb ischaemia (16, 17). This definition is slightly different to (inter)national guidelines of "infection, ulceration or destruction of tissues of the foot associated with neuropathy and/or peripheral artery disease in the lower extremity of people with diabetes"; however, we felt enough studies have used this new definition, plus validated it for hospitalisation and amputation outcomes, to use this as the most up-to-date definition of DFD (16, 17).

This time we identified only one Australian population-based study (the Freemantle Diabetes Study) (9). This study reported 1.5% of all people with diabetes had an active foot ulcer (9). However, a

recent global meta-analysis of all population-based studies reported a global prevalence of 4.6% (95% Confidence Interval (3.7-5.5%)) and that the 1.5% Australian prevalence was the lowest reported estimate for any nation (18). We therefore concluded after some further investigation that 1.5% is likely to be an under-estimate for the typical Australian population, as it is based on one study of a well-served metropolitan region of Australia using a non-validated method of diagnosis during a general foot inspection in a larger study (9). Therefore, we decided to go with an informed mid-point estimate of 3% of people with diabetes in Australia have an active foot ulcer. Several other Australian studies report nearly all diabetic foot infections originate in diabetic foot ulcers (19, 20) so we assumed all diabetic foot infections were included in the diabetic foot ulcer prevalence.

In addition, the Freemantle study also gave us the only estimate we could find for critical ischaemia, defined as 'prior revascularisation' (3%) or 'self-reported intermittent claudication' (9%) (9). We know that many diabetic foot ulcers also have critical ischaemia (20, 21) as a component causing the ulcer so we took a very conservative estimate that ~10% of people with intermittent claudication did not have a diabetic foot ulcer. This equated to 1% of all people with diabetes having ischaemia without a foot ulcer. This 1% critical ischaemia (without ulcer) prevalence was added to the 3% diabetic foot ulcer (with or without infection) to form an estimate of 4% for the prevalence of active diabetic foot disease in Australia at any given time. This figure combined with the 1.25million people diagnosed with diabetes leads us to estimate that 50,000 Australians have active DFD today.

## Part 2: Morbidity

### People with a previous diabetes-related amputation in Australia

Having determined the populations affected, Part 2 of our investigations concerned estimating the collective morbidity resulting from DFD in Australia. This started with the previous diabetes-related amputations. We defined a previous diabetes-related amputation as a person with diagnosed diabetes who had had a previous amputation procedure (minor (below the ankle) or major (above the ankle)) that had healed as per international guidelines (8). We identified two large Australian reports indicating a previous diabetes-related amputation prevalence range of 1-1.7% (1% Freemantle Diabetes Study (11); 1.7% Australian Institute of Health and Welfare (AIHW) (22)). We decided to use the lower 1% estimate, as it was conservative and consistent with international literature (14, 15). Also of interest was that 70% (0.7%) of these were minor amputations and 30% (0.3%) major (11). Overall, though this 1% prevalence figure combined with the 1.25million people diagnosed with diabetes leads us to conservatively estimate that 12,500 Australians are living with a diabetes-related amputation as we write this in 2017.

## People in public hospital because of diabetes-related foot disease in Australia

Another aspect of morbidity we were interested in was people hospitalised because of DFD. Incidence of hospitalisation is often used as a marker of exacerbation of a disease to compare the morbidity of different disease (15, 23). To estimate this, we did two things; we investigated for studies reporting the number of DFD hospitalisations each year and studies reporting the prevalence of all inpatients that were in hospital because of DFD. We defined DFD hospitalisation as 'people admitted overnight into hospital for the principal (or primary) reason of DFD' (17).

A number of studies have retrospectively investigated numbers of hospitalisations caused by DFD using generic hospital admission data codes in Australia (24, 25). One AIHW paper reported 9,900 DFD hospitalisations per year in Australia identified using 2004/05 hospital data codes (24). While another study reported an average of 4,150 DFD hospitalisations per year in Queensland using 2005-2010 hospital data codes (25). As Queensland has been found to represent 20% of the Australian population (residents, diabetes and DFD) we can use this Queensland data to estimate there are 20,750 DFD hospitalisations per year in Australia (25). Apart from the estimates, the major difference between these two studies was that AIHW used one code (for diabetic foot ulcers) to identify their DFD hospitalisation (24), whereas the Queensland study used 32 codes (for diabetes-related peripheral neuropathy, PAD (including ischaemia), foot ulcers, foot infections, Charcot, osteomyelitis and amputation procedures) (25). Nevertheless, another Australian study reported generic hospital admission data codes identified just one-third of the DFD hospitalisations present when compared to more reliable prospective clinical examination (26). This means these two retrospective studies are likely to be a significant underestimate and we needed studies using prospective clinical examinations for DFD hospitalisation.

We identified one large population-based study that has used prospective validated clinical examinations to identify DFD hospitalisation (Foot Disease in Inpatients Study (17, 20)). This multi-site study identified that 2% of a representative sample of all Australian inpatients (diabetes and non-diabetes) on one day were in hospital for the primary reason of managing DFD (17). In addition, it found a further 2.5% of all inpatients had DFD present, but had not been admitted because of DFD (20). This combined 4.5% figure (17) was very similar to a global meta-analysis finding that 4.7% of all inpatients have DFD at any given time (27). Therefore, we were confident that 2% of all inpatients in hospital at any given time in Australia are in hospital because of DFD.

To determine how many people this finding equates to we needed to identify how many people in the Australian population are in hospital on any given night. AIHW reports show there are ~50,000 overnight public hospital beds available in Australia with an occupancy rate of >90% (28). We assumed that this figure was 100%, and therefore, 50,000 Australians are in a public hospital each night of the year. The 2% prevalence figure, combined with the 50,000 Australian inpatients in hospital each night for any reason, leads us to estimate that 1,000 Australians are in a public hospital

tonight because of DFD (29). Please note this estimation does not include DFD hospitalisations in private hospitals and is likely a significant under-estimate of all DFD hospitalisations in Australia.

A recent PhD thesis used this figure (of 1,000 each night) from validated clinical examinations to more accurately estimate the number of Australian DFD hospitalisations that occur each year (29). The thesis estimated ~360,000 hospital bed days were used for DFD hospitalisations in Australian each year (29). It then assumed the average length of stay for DFD hospitalisations to be a more conservative 13 days as per AIHW reports (24) rather than the 10 days reported in the Queensland study (25, 29). Finally, it combined the total hospital bed days and average length of stay to make arguable the most informed estimate for annual DFD hospitalisations in Australia to date of 27,600 (29). Of further interest to the diabetes community in Australia was that the study compared these 27,600 DFD hospitalisations to the number of hospitalisations cause by all other leading causes of public hospitalisation in Australia as reported by AIHW (28). This comparison identified that DFD hospitalisation was comfortably a top 20 cause of all overnight public hospitalisation in Australia and the leading cause of diabetes-related hospitalisation (29); to put this in context it was higher than all admissions for atrial fibrillation (26,800), appendicitis (25,900) and knee arthritis (15,600) (28).

### **People undergoing a diabetes-related amputation in Australia**

The final and most obvious aspect of morbidity we were interested in when it comes to DFD were the number of new diabetes-related amputations in Australian each year. We defined this as a new amputation procedure (minor (below the ankle) or major (above the ankle)) occurring during hospitalisation. The two most recent reports reporting the number of diabetes-related amputations in Australia were from the Australian Commission on Safety and Quality in Health Care (ACSQHC) (30) and another study investigating all causes of amputations (31). Both studies used hospital admission data codes to identify new amputation procedures and both only recorded the highest amputation procedure if multiple occurred in one hospitalisation (30, 31). Unlike DFD hospitalisation, the accuracy of identification of amputations using generic hospital data codes is a little more robust and is commonly used for this purpose across the world. The ACSQHC reported 4,400 diabetes-related amputation hospitalisations in 2012-13. Whereas the other study reported an average of 6,600 amputation hospitalisations in Australia of which an average 3,600 were diabetes-related each year between 2007-2012 (31). Interestingly, this study also reported 72% of all amputations were minor and the rest major (31). However, we are unsure why there is a discrepancy in the overall diabetes-related numbers between studies as both used very similar data codes for very similar periods; however, the ACSQHC report investigated amputations in all hospital admissions (public and private) and we were unable to determine if this were the case in the other study and this may be one reason for the difference. Interestingly both studies showed diabetes-related amputation rates varied from region to region by up to 11-fold (30, 31). Based on these

studies we suggest the ACSQHC is most likely the more accurate as it included all hospitals and specifically investigated for diabetes-related amputations as the primary focus unlike the other study. This leads us to estimate that 4,400 diabetes-related amputations occur in people with diabetes each year. If we average out this figure over the whole year this equates to 12 diabetes-related amputations occurring each day in Australia.

## Part 3: Mortality

### People dying from diabetes-related foot disease in Australia

Having determined the populations and morbidity, Part 3 of our investigations concerned estimating the collective morbidity resulting from DFD in Australia. Mortality concerns people dying from DFD. Whilst we know globally that people with DFD have 5-year mortality rates of 40-50% which are worse than many cancers (32, 33), there is limited data on DFD mortality in Australia. The only Australian findings that we were able to identify were from an AIHW report using 2005 data from the National Mortality Database (24). This report found of all diabetes-related deaths (where diabetes or a diabetes-related complication was reported as the underlying (main) cause of death) 1,001 had foot ulcers, 678 had PAD and 26 peripheral neuropathy recorded as a cause of death (24). An Australian review used this data to report that 1,705 people had died in Australia due to DFD (34). Although this is old data this 1,705 figure is the best available estimate we could identify for people dying from DFD in Australia each year (34). If we average out this figure over the whole year this equates to 4.7 people each day dying from DFD of which we have conservatively rounded down to 4 people each day.

## Part 4: Costs

### Estimated direct costs to public hospitals diabetes-related foot disease in Australia

The final part of our investigations concerned estimating the direct costs caused by DFD in Australia. Costs of care for a disease in a population can be attributed as direct costs (such as hospital management of that disease) or indirect costs (such as lost productivity of an employee off sick). We identified two Australian studies that have estimated the direct costs of public hospital care from DFD (29, 35). Both studies applied a similar standard occupied hospital bed day cost to the estimated hospital bed days used for people in hospital because of DFD (29, 35). Interestingly both studies when adjusted to \$AU (2015) reported very similar estimates of ~\$AU350million per year (\$349million (35); and \$348million (29)) for DFD hospitalisation in public hospitals (29). Therefore,

our best estimate of the direct costs of DFD hospitalisation in public hospitals in Australia each year is \$350million. If we average out this figure over the whole year this equates to ~\$1million per day that Australia directly spends on the care of people hospitalised because of DFD. Please note this estimate doesn't factor in any surgical procedures (such as amputations or revascularisation), care of inpatients with DFD that weren't hospitalised for the primary reason of DFD or indirect costs (29).

### **Estimated direct costs to all health systems from diabetes-related foot disease in Australia**

The above studies estimated only the direct costs of managing DFD in public hospitals. They did not take into account any estimated direct costs to the health system outside of public hospitals nor any indirect costs. We identified only one Australian study that did attempt to estimate the cost of DFD to the whole Australian health system each year (29). This study used the above estimated direct costs of DFD hospitalisation in the public hospital system of Australia with a series of assumptions to estimate the direct costs the whole Australian health system (29). The first assumption it made was that the 2% DFD hospitalisation prevalence in public hospitals would be the same in private hospitals so as to calculate an estimate of DFD hospitalisation across all Australian hospitals (public or private) (29). The second assumption was that the average overnight hospital bed cost in a private hospital would be the same cost as a public hospital (\$AU 971(36)) (29). The final assumption it made was the general formula used by AIHW reports for calculating total recurrent health system expenditure using total hospital expenditure (37) would be the same for DFD expenditure (29). After all those assumptions, this study estimated the annual direct costs to the Australian health system from DFD to be ~\$AU1.57billion (29). If we averaged this figure over the whole year this equates to ~\$4.3million per day that Australia directly spends on managing DFD. Without other more recent or robust studies these estimated direct costs findings are the best available evidence we have and do not include any indirect costs.

## **Conclusions**

In this "DFA Guides You Through" document we have described the best available estimates that we are aware of on the burden of DFD in Australia. This included using the best available evidence from Australian and international studies to estimate the: population affected, morbidity, mortality, and the overall direct costs imposed by DFD in Australia each day and each year. We have attempted to be conservative with our estimates throughout so as not to not over-state the DFD burden.

For clinicians, we hope this document gives you a greater insight into the size of the burden of DFD in Australia and your local region and perhaps some evidence that you can take to your managers to illustrate the burdens of DFD you/we face each and every day.

For researchers, we hope this document initially enables you easy access to references on the burden of Australian DFD, perhaps encourages you to undertake more robust epidemiology studies to fine tune and monitor the estimated burden of DFD in Australia, and inspires you to investigate innovative future solutions to bring us closer to ending avoidable amputations in a generation.

For policy makers, we hope this document facilitates a much improved evidence-based understanding of the seemingly silent yet enormous burden that DFD imposes on our nation and regions. We also hope you use these informed estimates to compare the burden of DFD to other well-known disease burdens and we are sure you will be shocked by what you find.

What we haven't told you yet is we have also calculated the averages of these national estimates per every 100,000 people in Australia for all these outcomes (See Table 1). We did this because we want you to be able to quickly estimate the burden of DFD in your local region using the best available evidence when you need too. For example, if you were in Albury (~50,000 population; you would multiple the per 100,000 estimates by 0.5), Geelong (~190,000 population, multiple by 1.9) or Perth (~2million population; multiple by 20). However, please cautiously note that such estimates will only be a guide and that the local demographics, social deprivation, ethnicity, diabetes population and service profiles of your region will also impact on the accuracy of estimate for any local burden.

In conclusion, for everyone, we hope you enjoyed your guide through the estimated burden of diabetes-related foot disease in Australia for 2017. For those who cannot wait until our next "DFA Guides You Through" overview, remember that we publish various "latest research" posts every month on our website (<https://www.diabeticfootaustralia.org/for-researchers/latest-research/>). Keep a sharp eye out on our social media to read when a new one is posted online.

We continually look forward to working with each and every one of you as we progress towards our national goal of ending avoidable amputations in a generation.

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