RESEARCH

Determining the actual cost of wound care in Australia

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Abstract

Aim To determine the number and type of wounds and their treatment costs (consumables and labour) in Australian hospitals, residential aged care facilities (RACFs), general practices (GPs) and community, and to provide evidence to inform reimbursement of wound treatment costs for all Australians.

Method Data from 21,189 clients with 49,234 wounds treated by a community care provider in Western Australia, Queensland and South Australia during the financial year 2020/2021 were used to determine the mean and median costs (consumables and labour) to treat wounds. Surveys involving skin inspections and medical record audits were conducted amongst consenting adults over 18 years old in a sample of Australian hospitals, RACFs and GPs. A sample of community clients' data for wounds treated on one day in June 2021 comprised the fourth cohort used in this analysis. The costs to treat all wounds surveyed between 14 December 2020 and 17 October 2021 in the four cohorts were modelled against the community care provider's data for 2020/2021 (49,234 wounds).

Results There were 2,505 individuals with 3,096 wounds. The estimated cost to treat all wounds was A$1,621,768 using the mean costs of the community care provider as a basis, and A$692,144 using the median costs of the community care provider as a basis. Costs for all wound types were determined.

Conclusion The cost of treating wounds in Australia was determined and is anticipated to inform a review of equitable reimbursement of wound treatment costs for Australians with wounds.

Keywords costs, hospitals, aged care, general practice, community care

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Introduction

Chronic wounds, or wounds that have failed to heal, are a serious public health issue[1,2]. In Australia, the economic burden arising from chronic wounds was estimated to be around A$3 billion annually based on 2003–2004 and 2010–2011 datasets[3,4]. It is estimated that some 450,000 Australians live with a chronic wound[4] which impacts on their explicit and implicit costs and their quality of life and wellbeing[1,2,4]. Furthermore, the management of acute and chronic wounds presents a significant workload and fiscal burden for Australian hospitals, primary healthcare settings, residential aged care facilities (RACFs) and community health services[1–5]. Yet actual data, which is important for planning, budgeting and resourcing purposes, and which informs national benchmarking and activity-based funding[6], is limited across all Australian health sectors. More importantly, there is inequitable access to evidence-based wound management services and contemporary treatment consumables for all Australians[1,2,4].

In response to these challenges the Australian Health Research Alliance (AHRA), which is comprised of 10 National Health and Medical Research Centre-accredited research translation centres across Australia developed and implemented a National Wounds Initiative which comprised four projects:

- Project 1. Determining the actual cost of wound care.
- Project 2. An update of the Australian standards for wound prevention and management.
- Project 3. Training and education in wound care: an integrated framework.
- Project 4. A program of wound research.

Collectively, these four projects aimed to promote a nationally consistent and effective approach to wound care. The initiative was co-led for the AHRA by the Western Australian Health Translation Network (WAHTN) and Health Translation Queensland (HTQ).

In developing this National Wounds Initiative, an extensive literature review was undertaken which considered the recommendations and outcomes produced in some key literature such as: the Australian Centre for Health Services Innovation's *Chronic wounds in Australia: an issues paper*[1]; Pacella et al's *Solutions to the chronic wounds problems in Australia: a call to action*[2]; the Australian Government's 2019 *Wounds management pilot grant opportunity*[7]; and the Medicare Benefits Schedule Review Taskforce's *Wound Management Working Group Taskforce findings*[8]. In addition, the AHRA hosted a workshop in Brisbane, Queensland which brought together 32 clinical experts, researchers and representatives from the AHRA and Wounds Australia to determine the wound-related research priorities and strategies.

This paper reports on the methodology and outcomes for Project 1: Determining the actual cost of wound care, which aimed to determine the number and type of wounds and their treatment costs (consumables and labour) in Australian hospitals, RACFs, general practices (GPs) and community providers, and to provide evidence to inform reimbursement of wound treatment costs for all Australians. This would do much to ensure access to best practice treatments and a consistent standard of wound care for all Australians. This project was initiated and led by WAHTN in partnership with HTQ and in collaboration with the Silver Chain Group Inc (Silverchain), a large Australian community care provider.

Methodology

Expressions of interest to participate were sought from the Western Australian (WA) and Queensland (QLD) Health Departments, public hospitals and RACF administrators and GP directors. Unfortunately, the COVID pandemic and associated staffing and access restrictions limited the number of participating facilities and areas. However, two tertiary hospitals (one in WA with 600 beds and the other in QLD with 1,308 beds), one secondary care hospital in WA (290 beds), three WA RACFs (207 beds) and four GPs (two in WA and two in QLD) participated. Approval to conduct the study was obtained from the relevant Human Research Ethics Committees and site-specific Governance Committees.

Data collection

Data recorded in Silver Chain Group's (community care provider hereafter) electronic wound module at the point-of-care in 2020/2021 were analysed. They comprised 21,189 clients with 49,234 wounds treated by nurses from this community care provider in WA, QLD and South Australia (SA). The scope included all wounds treated during 2020/2021 irrespective of whether they were healed or discharged unhealed during the year or had ongoing care beyond 2020/2021. A total of 445,400 client visits for wound treatments were recorded. For each of these visits, the following details were collected: the date, the visit duration, the category and type of wound/s treated, and consumables used excluding Goods and Services Tax. The contemporary wound treatment consumables used (dressing packs, solutions, dressings, devices, instruments, bandages/wraps) were provided at no cost to clients by the community care provider.

Embedded in the electronic wound module was the cost of these wound consumables, which were automatically allocated to each electronic care plan for each wound treatment performed. These records were linked with details about the attending nurse time spent undertaking each procedure, and labour costs were calculated using the actual direct time taken to perform the wound treatments by each attending community nurse and multiplied by their pay rates. Other indirect costs such as travel and organisational overheads were excluded, as these would have differed across the various health settings.

If client visits involved the treatment of multiple wounds, the cost of consumables was ascertained from each care plan for each wound. The labour cost for treating multiple wounds on the same client at the same visit was estimated based on the mean and median time taken to treat the collective different wound types. Since every wound treated had a unique identifier in the wound module database, all the costs of managing a wound across numerous client visits was consolidated into a single total cost to manage each wound treated during 2020/2021.

All of the wounds recorded in the wound module were catalogued into wound *categories* and wound *types*, the latter being subdivisions of each of the former. The wound categories were acute wounds, amputations, foot ulcers, leg ulcers, pressure injuries, skin tears and tumours and other wounds (primarily open dermatological wounds or abrasions). Although skin tears are in effect acute wounds, they were categorised separately, because skin tears comprised a large cohort of wounds in the community provider's data for elderly clients[9].

The client outcomes identified in this same dataset, and reported separately, demonstrated 80% of wounds healed or were discharged to self-care (virtually healed and usually required the client to remove the final protective dressing), during the study period[9].

The cost to treat the hospital, GP and RACF wounds was estimated by using the mean and median costs for the same wound type as identified in the community care provider 2020/2021 dataset. The rationale for this modelling was that it standardised the cost of wounds to treat across the cohorts and it took into account that many hospital patients are discharged prior to complete wound healing. Therefore, the cost for each study wound type was estimated based on the mean and median costs to treat different wound types in the community care provider's dataset 2020/2021 for 21,189 clients with 49,234 wounds. The assumption was that the same wound type across the four cohorts would have had similar treatments and all healthcare providers (primarily nurses) would have taken similar times to perform the treatments, and would have used similar consumables (dressing packs, instruments, solutions, dressings, devices, bandages/wraps).

In order to determine if this modelling was reasonable, a review of wound costing methods literature was conducted using Medline and Onesearch, with three relevant articles identified[10–12]. The project methodological design and data collection methods were reviewed in light of the literature to confirm that:

- The cost collection methodology was sound,
- An appropriate wound care cost that was consistent across each care setting could be determined, and
- The number of Australians requiring community-based wound care could be identified.

Data was then collected during the surveys conducted in WA hospitals, GPs and RACFs on electronic tablets using Qualtrics® software between 14 December 2020 and 20 August 2021. In Queensland, survey data was collected between 19 May 2021 and 15 October 2021 using hospital survey software or Qualtrics® for GPs. A 1-day representative survey sample of data for 30 June 2021 was obtained from the community care provider.

Survey protocols

The following protocol was adopted to carry out the wound surveys in the hospitals and RACFs:

- The WAHTN-HTQ survey coordination team was established, and the survey tool developed.
- Survey procedures, protocols, logistics and risk management were agreed with each site.
- Each site appointed a survey liaison person to work with the coordination team and, where possible, allocated surveyors.
- The WAHTN and HTQ recruited external registered nurses and final year nursing undergraduate surveyors who were referred to as the core team surveyors.
- All surveyors underwent an education program that included the project objectives, methodology and data collection protocol and tools. The wound categories and wound types were defined, and reference resources were provided. The surveyors were able to practise data collection on electronic devices or hard copies provided. They also underwent written interrater reliability testing using wound images for pressure injury staging[13] and skin tear classification using the STAR Classification[14]. An 80% agreement was deemed essential for participation and those who failed to achieve an 80% agreement underwent additional education and re-testing.
- Hospital patients and RACF residents were provided with information and consent forms 24 hours prior to the surveys.
- Surveys were undertaken on an agreed day amongst consenting individuals.
- Core surveyors were partnered with a surveyor appointed by the respective survey site to conduct skin inspections and audit medical records. This pairing of surveyors reduced potential surveyor bias and provided survey skills development opportunities for site staff as well as assisted the core team surveyors to familiarise themselves with site specific locations and practices.
- Data collected included patient/resident demographics (bed number, age, gender); admission date; referral source; wound category (acute, amputation, foot ulcer, leg ulcer, pressure injury, skin tear, tumour, other (primarily open dermatological lesions and abrasions)); wound types (subsets of wound categories); wound aetiology; primary dressing; secondary dressing; fixation used; compression therapy if applicable; and pressure off-loading devices in situ. Medical records were audited to determine if a wound identified on skin inspection was documented and if it was present on admission (required written documentation within 24 hours of admission to be deemed present on admission) or was facility-acquired. The records were also audited to confirm the presence of a completed pressure injury risk assessment, wound assessment and care plan/s.
- All patient and resident data collected was checked at the end of each survey day and was de-identified of any name, patient/resident identifier or bed number prior to final uploading onto the electronic survey platform. For confidentiality reasons, all paper records were returned to the survey liaison person at each site for destruction.

As the number of patients who visited a GP with a wound on a daily basis was considered to be low, the following process was adopted to facilitate data collection in the GPs:

- Survey procedures, protocols, logistics and risk management were agreed with each site.

- Consent forms were provided to each patient on day of GP appointment.
- One core team surveyor attended each practice for 5 consecutive days and surveyed every patient with a wound in partnership with the attending practice nurse.
- All data was de-identified and electronically uploaded.

A representative sample of 1 day of community clients who had wound care on 30 June 2021 was obtained from the community care provider and underwent the same costing analysis as the other three cohorts. All statistical analysis was conducted using R (version 4.2.1) with descriptive statistics reported as counts or proportions of the total cohort. Chi-squared tests of proportion were used to determine differences between gender proportions between settings.

Results

The characteristics of each individual and each wound recorded in the respective surveys across each of the four cohorts are summarised in Table 1. Overall, there were 2,505

Table 1. Characteristics of the four wound cohorts

Descriptive characteristic n (%) unless stated otherwise	Hospital	RACF	GP	Community	Total
Total patients/residents/clients (n)	**816**	**205**	**137**	**1,347**	**2,505**
Age (years)					
Median (IQR)	64.0 (47.0, 75.0)	82.0 (75.0, 88.0)	67.0 (41.5, 79.5)	69.5 (59.5, 79.5)	69.5 (54, 79.5)
Gender					
Female	305 (37.4%)	99 (48.3%)	81 (59.1%)	572 (42.5%)	1,057 (42.2%)
Male	329 (40.3%)	98 (47.8%)	56 (40.9%)	775 (57.5%)	1,258 (50.2%)
Indeterminate	182 (22.3%)	8 (3.9%)	–	–	190 (7.6%)
Total wounds*	**748**	**99**	**181**	**2,068**	**3,096**
Acute wounds					
Abscess	3 (0.40%)	–	2 (1.10%)	90 (4.35%)	95 (3.07%)
Burns	3 (0.40%)	–	2 (1.10%)	14 (0.68%)	19 (0.61%)
Dehiscence	9 (1.20%)	–	8 (4.42%)	82 (3.97%)	99 (3.20%)
Donor site	1 (0.13%)	–	–	15 (0.73%)	16 (0.52%)
Drain site	80 (10.70%)	–	–	31 (1.50%)	111 (3.59%)
Fistula	1 (0.13%)	–	–	11 (0.53%)	12 (0.39%)
Flap	2 (0.27%)	–	–	9 (0.44%)	11 (0.36%)
Laceration	13 (1.74%)	1 (1.01%)	15 (8.29%)	40 (1.93%)	69 (2.23%)
Open incisional wound	57 (7.62%)	–	23 (12.71%)	126 (6.09%)	206 (6.65%)
Perianal/pilonidal sinus	–	–	–	25 (1.21%)	25 (0.81%)
Peristomal ulcer	11 (1.47%)	–	1 (0.55%)	3 (0.15%)	15 (0.48%)
Suture line (intact)	193 (25.80%)	1 (1.01%)	30 (16.57%)	34 (1.64%)	258 (8.33%)
Pin site	–	–	–	4 (0.19%)	4 (0.13%)
Skin graft	18 (2.41%)	–	1 (0.55%)	50 (2.42%)	69 (2.23%)
Other	34 (4.42%)	2 (2.02%)	8 (4.42%)	–	44 (1.32%)
All acute wounds	***425 (56.82%)***	***4 (4.04%)***	***90 (49.72%)***	***534 (25.82%)***	***1,053 (34.01%)***
Amputations					
Dehiscence	–	–	–	10 (0.48%)	10 (0.32%)
Open incisional	–	–	–	44 (2.13%)	44 (1.42%)
Suture line (intact)	1 (0.13%)	–	–	9 (0.44%)	10 (0.32%)
All amputations	***1 (0.13%)***	***–***	***–***	***63 (3.05%)***	***64 (2.07%)***
Foot ulcers					
Atypical	–	–	4 (2.21%)	43 (2.08%)	47 (1.52%)
Ischaemic	3 (0.40%)	–	1 (0.55%)	46 (2.22%)	50 (1.61%)

Descriptive characteristic n (%) unless stated otherwise	Hospital	RACF	GP	Community	Total
Neuro-ischaemic	3 (0.40%)	–	–	63 (3.05%)	66 (2.13%)
Neuropathic	2 (0.27%)	–	3 (1.66%)	166 (8.03%)	171 (5.52%)
Undiagnosed	4 (0.53%)	2 (2.02%)	–	28 (1.35%)	34 (1.10%)
Other	–	–	1 (0.55%)	–	1 (0.03%)
All foot ulcers	***12 (1.60%)***	***2 (2.02%)***	***9 (4.97%)***	***346 (16.73%)***	***369 (11.92%)***
Leg ulcers					
Arterial	1 (0.13%)	–	–	34 (1.64%)	35 (1.13%)
Atypical	1 (0.13%)	–	9 (4.97%)	35 (1.69%)	45 (1.45%)
Lymphoedema	1 (0.13%)	–	–	39 (1.89%)	40 (1.29%)
Mixed vascular	–	–	4 (2.21%)	125 (6.04%)	129 (4.17%)
Undiagnosed	6 (0.80%)	3 (3.03%)	4 (2.21%)	56 (2.71%)	69 (2.23%)
Venous	6 (0.80%)	–	22 (12.15%)	202 (9.77%)	230 (7.43%)
All leg ulcers	***15 (2.01%)***	***3 (3.03%)***	***39 (21.55%)***	***491 (23.74%)***	***548 (17.70%)***
Pressure injuries[13]					
Stage 1	19 (2.54%)	8 (8.08%)	–	27 (1.31%)	54 (1.74%)
Stage 2	9 (1.20%)	8 (8.08%)	4 (2.21%)	81 (3.92%)	102 (3.29%)
Stage 3	–	–	1 (0.55%)	39 (1.89%)	40 (1.29%)
Stage 4	2 (0.27%)	–	–	23 (1.11%)	25 (0.81%)
Suspected deep tissue injury	5 (0.67%)	8 (8.08%)	1 (0.55%)	9 (0.44%)	23 (0.74%)
Unstageable	29 (3.88%)	–	1 (0.55%)	33 (1.60%)	63 (2.03%)
All pressure injuries	***64 (8.56%)***	***24 (8.08%)***	***7 (3.87%)***	***212 (10.25%)***	***307 (9.92%)***
Skin tears[14]					
Star 1a	22 (2.94%)	4 (4.04%)	1 (0.55%)	8 (0.39%)	35 (1.13%)
Star 1b	18 (2.41%)	7 (7.07%)	1 (0.55%)	14 (0.68%)	40 (1.29%)
Star 2a	8 (1.07%)	3 (3.03%)	5 (2.76%)	9 (0.44%)	25 (0.81%)
Star 2b	12 (1.60%)	2 (2.02%)	8 (4.42%)	28 (1.35%)	50 (1.61%)
Star 3	37 (4.95%)	12 (12.12%)	5 (2.76%)	48 (2.32%)	102 (3.29%)
All skin tears	***97 (12.97%)***	***28 (28.28%)***	***20 (11.05%)***	***107 (5.17%)***	***252 (8.14%)***
Tumours (malignant and benign)					
Benign	7 (0.94%)	2 (2.02%)	–	9 (0.44%)	18 (0.58%)
Malignant	9 (1.20%)	2 (2.02%)	1 (0.55%)	61 (2.95%)	73 (2.36%)
All tumours	***16 (2.14%)***	***4 (4.04%)***	***1 (0.55%)***	***70 (3.38%)***	***91 (2.94%)***
Other wounds					
Abrasion	34 (4.55%)	–	14 (7.73%)	46 (2.22%)	94 (3.04%)
Cellulitic wound	–	–	–	35 (1.69%)	35 (1.13%)
Cellulitis intact	2 (0.27%)	–	1 (0.55%)	5 (0.24%)	8 (0.26%)
Dermatological open lesion	–	–	–	87 (4.21%)	87 (2.81%)
Haematoma	3 (0.40%)	2 (2.02%)	–	13 (0.63%)	18 (0.58%)
No wound – prevention	1 (0.13%)	–	–	30 (1.45%)	31 (1.00%)
Ulceration – not leg or foot	–	–	–	28 (1.35%)	28 (0.90%)
Incontinence-associated dermatitis	11 (1.47%)	11 (11.11%)	–	–	22 (0.71%)
Other	67 (8.95%)	21 (21.21%)	–	–	88 (2.84%)
All other wounds	***118 (15.77%)***	***34 (34.34%)***	***15 (8.29%)***	***244 (11.80%)***	***411 (13.27%)***

* Includes some patients/residents/clients treated for multiple wounds

patients/residents/clients with 3,096 wounds. The relatively low numbers of hospital patients with wounds was influenced by COVID-19 access restrictions in some hospital areas. In addition, written consent was required for hospital patients; a large proportion of these were either too ill or cognitively unable to provide written consent, whilst some declined.

The four cohorts differed in both demographics such as age and also in wound categories and type of wounds. The median age of individuals in the hospitals, RACFs, GPs and community provider cohorts was 64 years, 82 years, 67 years and 69.5 years respectively. However, it is to be noted that no paediatric hospital was surveyed. As expected, the RACFs generally cared for older patients as compared to hospitals and GPs. There was an observed difference in the percentage of males between cohorts ($\chi^2(3)=18.8$, p=0.0003). The GPs treated more females with wounds than males ($\chi^2(1)=4.20$, 95% CI [0.33, 0.50], p=0.040) and the community care provider treated more males with wounds than females ($\chi^2(1)=30.3$, 95% CI [0.55, 0.60], p<0.0001).

Overall, acute wounds were the most common (34.01%), followed by leg ulcers (17.70%), 'other wounds' (13.27%), foot ulcers (11.92%), pressure injuries (9.95%), skin tears (8.14%), and tumours (2.94%). In the hospital cohort, there were 816 patients with 748 wounds, mostly acute wounds (56.82%, including amputations) due to surgical or traumatic aetiologies. The RACF cohort treated 205 residents with 99 wounds, mostly 'other wounds' (34.34%), skin tears (28.28%) and pressure injuries (8.8%). The GP cohort treated 137 patients with 181 wounds, mostly acute wounds (49.72%), leg ulcers (21.55%) and skin tears (11.05%). The community care provider treated 1,347 clients with 2,068 wounds, mostly acute wounds (28.85%, including amputations), leg ulcers (23.74%) and foot ulcers (16.73%).

Estimates using both the mean and the median costs associated with treating wounds in all four cohorts are shown in Table 2. The distribution of costs was heavily right skewed. While the median is more robust against outliers than the mean, the mean better reflects the real costs expended in clinical practice. There were a significant number of 'other wound' types whose costs could not be estimated because insufficient numbers of these wound types were recorded in the community care provider dataset. Also, some 'other wound' types such as incontinence-associated dermatitis that were identified in the hospital and RACF cohorts were not specifically recorded in the community care provider dataset. Different categorisation schema may also have contributed to low numbers of certain wound types. The wound categories that conveyed the costliest burdens were acute wounds followed by leg ulcers and pressure injuries.

Table 2 summarises the estimated costs of wounds in the four cohorts, including the standard error (SE) in each estimate. Estimates A and B indicate the estimated costs of wound treatment for each wound type based on the *mean* or *median* costs, respectively, as extrapolated from the community care provider's costs in 2020/2021. For example, Estimate A for the consumables cost for treating the 95 abscesses observed during this survey was A$16,841±804, calculated by multiplying 95 by the *mean* cost of consumables incurred by the community care provider in treating abscesses in 2020/2021. Estimate B of the labour cost for the same 95 abscesses was A$17,773±820, calculated by multiplying 95 by the *median* cost. Lastly, estimates of the total treatment cost are the sum of the consumables and labour costs.

Discussion

Evaluation of the data collection methods across each site and cost modelling, which was conducted using a modified bottom-up costing method based on the Independent Hospital and Aged Care Pricing Authority (IHACPA) methodology, proved robust[15]. The results provided valuable insight into the number and type of wounds across a sample of Australian hospitals, RACFs, GPs and a community care provider. Although it was anticipated that hospitals would have a higher number of acute wounds, it was noteworthy that acute wounds also comprised the greater number of wounds managed by GPs and the community care provider. Similar findings were found in a community cross-sectional study conducted in North America[16], as well as in a cross-sectional study conducted amongst 18 GPs in Queensland in 2011, which demonstrated 81.5% of the wounds resulted from surgery or trauma[17].

Skin tears, which are common wounds found amongst the elderly, comprised 28.28% of the RACF wounds[18,19]. They also comprised 12.97% of hospital wounds which was slightly more than the WoundsWest findings obtained from surveys which were conducted across all 86 public hospitals in WA in 2008, 2009, 2011, and which found skin tears to be 11%, 9% and 9.6% respectively[20,21]. Pressure injuries on the other hand were found to range from 4% in GPs, 9% in RACFs and hospitals, and 10% in the community cohort. Nghiem et al[22] reported 12.9% of pressure injuries cost Australian public hospitals A$9.11 billion (95% confidence intervals (CI): 9.02, 9.21) in 2020 and treatment costs attributed to A$3.59 billion (CI: 3.57, 3.60) of these costs. Whilst there appears to be a dearth of data concerning pressure injuries managed by GPs, Wilson et al[23] reported projected costs of A$98,489 to care for 20 residents with 23 pressure injuries. However, these modelled costs included wound treatments, pressure off-loading devices, nutritional supplements and labour, whereas the median cost (consumables and labour) to treat pressure injuries in a community cohort in 2020/2021 was A$150.56 (interquartile range: A$71.85–391.12)[9]. Pressure injuries are costly, and they are considered to be largely preventable wounds; the implementation of preventative strategies is therefore a fundamental tenet of the Australian Commission for Safety and Quality in Health Care Standards[24].

The Australian Medical Association[25] reported challenges in gauging the extent of GP and community wound care costs,

Table 2. Consumables and direct labour costs for wounds across the four cohorts as estimated using the mean (Estimate A) or median (Estimate B) costs identified in the community provider's dataset for 2020/2021*

Wound categories by wound types	n	Consumables $				Labour $				Consumables + labour $			
		Estimate A	SE	Estimate B	SE	Estimate A	SE	Estimate B	SE	Estimate A	SE	Estimate B	SE
Acute wounds													
Abscess	95	16,841	804	5,593	1,007	25,854	654	17,773	820	42,672	1,313	24,926	1,646
Burns	19	2,099	190	641	238	4,434	298	2,093	374	6,524	471	2,839	590
Dehiscence	99	30,362	1,974	7,120	2,474	29,741	1,118	16,534	1,402	59,984	2,884	25,282	3,614
Donor site	16	835	75	281	94	2,116	121	1,255	152	2,947	190	1,505	238
Drain site	111	7,964	512	1,833	641	19,287	664	10,682	832	27,223	1,099	12,878	1,378
Fistula	12	3,901	790	955	991	7,437	930	4,282	1,165	11,333	1,557	5,761	1,951
Flap	11	1,273	194	357	244	2,694	246	1,574	308	3,957	402	1,907	504
Laceration	69	5,092	260	1,401	326	10,365	300	5,714	376	15,452	511	7,345	640
Open incisional wound	206	59,868	3,031	11,081	3,799	60,593	1,455	35,259	1,824	120,424	4,083	49,864	5,117
Perianal/ pilonidal sinus	25	5,722	548	1,900	687	8,825	504	6,115	632	14,542	945	8,539	1,184
Peristomal ulcer	15	3,501	1,046	525	1,311	5,490	1,194	3,020	1,496	8,882	1,945	4,080	2,438
Suture line (intact)	258	12,344	805	3,194	1,009	34,010	919	21,845	1,152	46,343	1,548	26,637	1,940
Wound pin site	4	397	124	96	156	1,022	153	482	192	1,410	224	588	281
Wound skin graft	69	9,842	820	3,048	1,028	19,128	727	11,312	911	28,949	1,467	14,750	1,839
Other	44	–	–	–	–	–	–	–	–	–	–	–	–
All acute wounds	*1,053*	*160,041*	*11,173*	*38,025*	*14,003*	*230,997*	*9,285*	*137,941*	*11,636*	*390,641*	*18,639*	*186,902*	*23,360*
Amputation													
Dehiscence	10	3,645	789	1,344	989	4,432	506	2,596	634	8,053	1,205	4,288	1,510
Open incisional	44	29,759	2,785	11,711	3,490	29,442	1,439	20,853	1,803	59,070	3,861	32,312	4,839
Suture line (intact)	10	1,248	236	411	296	2,849	224	1,884	281	4,097	401	2,538	503
All amputations	*64*	*34,652*	*3,810*	*13,466*	*4,775*	*36,723*	*2,169*	*25,332*	*2,718*	*71,220*	*5,467*	*39,138*	*6,852*

Wound categories by wound types	n	Consumables $				Labour $				Consumables + labour $			
		Estimate A	SE	Estimate B	SE	Estimate A	SE	Estimate B	SE	Estimate A	SE	Estimate B	SE
Foot ulcers													
Atypical	4	10,951	1,253	2,677	1,571	16,273	883	8,298	1,107	27,218	1,977	11,694	2,478
Ischaemic	50	14,107	1,876	3,654	2,352	22,228	1,668	10,496	2,090	36,306	3,390	14,681	4,249
Neuro-ischaemic	66	18,887	1,791	4,419	2,245	30,507	1,681	13,391	2,106	49,380	3,273	18,907	4,102
Neuropathic	171	40,174	2,007	10,705	2,516	69,888	2,398	31,376	3,005	110,012	4,235	43,571	5,307
Undiagnosed	34	7,292	499	2,265	626	12,124	538	6,483	675	19,402	980	9,162	1,228
All foot ulcers	*368*	*91,409*	*7,427*	*23,721*	*9,309*	*151,019*	*7,168*	*70,044*	*8,983*	*242,319*	*13,854*	*98,015*	*17,364*
Leg ulcers													
Arterial	35	14,113	1,445	4,137	1,812	17,687	1,367	8,502	1,713	31,780	2,698	13,713	3,382
Atypical	45	21,129	2,824	3,591	3,539	24,154	2,243	8,269	2,811	44,846	4,731	12,663	5,930
Lymphoedema	40	19,970	1,990	4,768	2,494	20,065	1,328	8,328	1,664	39,977	3,173	14,262	3,976
Mixed	129	62,935	4,343	18,269	5,443	71,728	3,278	30,446	4,108	134,560	7,185	50,959	9,005
Undiagnosed	69	16,623	746	6,082	935	23,939	725	13,513	909	40,519	1,395	20,408	1,749
Venous	230	123,395	5,228	36,414	6,552	135,280	4,216	62,299	5,285	258,520	8,905	101,897	11,160
All leg ulcers	*548*	*258,165*	*16,576*	*73,261*	*20,775*	*292,853*	*13,157*	*131,358*	*16,490*	*550,203*	*28,087*	*213,902*	*35,202*
Pressure injuries													
Stage 1	54	3,329	263	821	330	9,094	423	4,586	530	12,411	652	5,693	817
Stage 2	102	12,294	618	3,002	774	23,751	805	11,653	1,009	36,030	1,335	15,172	1,673
Stage 3	40	13,768	1,312	4,052	1,644	18,294	1,368	9,037	1,714	31,994	2,548	15,236	3,193
Stage 4	25	33,559	5,561	11,179	6,970	27,821	3,186	13,428	3,992	60,550	7,880	26,073	9,876
Suspected deep tissue injury	23	4,958	1,231	850	1,542	6,729	815	2,650	1,022	11,669	1,833	3,607	2,298
Unstageable	63	22,141	2,940	5,242	3,684	26,767	2,645	11,895	3,315	48,851	5,364	18,909	6,723
All pressure injuries	*308*	*90,085*	*11,950*	*25,183*	*14,977*	*112,455*	*9,241*	*53,249*	*11,582*	*201,505*	*19,612*	*84,689*	*24,579*
Skin tears													
Star 1a	35	1,198	91	416	114	3,421	146	1,920	183	4,615	227	2,448	284
Star 1b	40	1,718	176	592	221	4,448	205	2,566	257	6,158	364	3,282	457
Star 2a	25	1,001	72	396	90	2,790	113	1,653	142	3,780	177	2,122	222
Star 2b	50	2,632	105	1,109	131	6,296	178	3,919	224	8,918	272	5,198	340
Star 3	102	5,453	261	1,991	327	12,094	393	6,771	493	17,517	632	9,304	793
All skin tears	*252*	*12,002*	*704*	*4,504*	*883*	*29,048*	*1,035*	*16,829*	*1,298*	*40,988*	*1,672*	*22,352*	*2,096*

Wound categories by wound types	n	Consumables $				Labour $				Consumables + labour $			
		Estimate A	SE	Estimate B	SE	Estimate A	SE	Estimate B	SE	Estimate A	SE	Estimate B	SE
Tumours													
Benign	18	1,557	565	438	708	3,381	639	1,743	801	4,917	1,115	2,363	1,397
Malignant	73	3,835	2,452	834	3,072	6,703	2,849	3,047	3,571	10,473	5,115	4,040	6,410
All tumours	*91*	*5,393*	*3,017*	*1,272*	*3,781*	*10,084*	*3,488*	*4,791*	*4,371*	*15,389*	*6,230*	*6,404*	*7,808*
Other wounds													
Abrasion	94	6,857	450	1,444	564	13,977	554	6,589	695	20,829	967	8,302	1,212
Open cellulitic wound	35	8,461	1,140	1,550	1,429	10,936	575	5,639	721	19,378	1,583	7,471	1,985
Cellulitis intact	8	1,333	332	131	416	2,295	343	877	429	3,626	650	1,167	815
Dermatological open lesion	87	15,005	1,236	2,670	1,549	22,801	1,092	9,501	1,368	37,783	2,170	12,691	2,720
Haematoma	18	2,114	232	490	291	3,893	257	2,019	322	5,998	455	2,638	570
No wound – prevention	31	2,465	250	464	313	5,905	353	2,522	442	8,359	568	3,208	712
Ulceration-not leg or foot	28	4,449	516	1,184	646	9,117	856	3,750	1,072	13,530	1,297	5,266	1,626
Other†	111	–	–	–	–	–	–	–	–	–	–	–	–
All other wounds	*412*	*40,684*	*4,155*	*7,933*	*5,207*	*68,924*	*4,029*	*30,897*	*5,050*	*109,503*	*7,691*	*40,742*	*9,639*
Total all wound categories	**3,096**	**692,432**	**58,813**	**187,364**	**73,710**	**932,103**	**49,571**	**470,441**	**62,128**	**1,621,768**	**101,252**	**692,144**	**126,899**

* Four care settings combined: residential aged care, hospital, general practice, and community. Excluded any indirect costs such as organisational overheads, management, administration, travel, systems, training that were additional to direct client contact, and business overheads such as rent, utilities, insurances, vehicles, maintenance and repairs. Consumable costs excluded the goods and services tax.

† These wounds were excluded from cost analysis since there were no comparator wounds in the community care provider dataset.

although a study in the UK found 81% of total wound care costs to the National Health Scheme were incurred in the community sector[26]. Access to rigorous data from diverse community healthcare providers in Australia is complicated by the number and variety of community healthcare providers and the potential for duplication of services. An Australian study conducted in Queensland found patients with leg ulcers reported a median of three (range two to seven) healthcare provider organisations involved in their care[27]. Fortunately, the community care provider whose data was used to determine costs in this study has an enviable and rigorous electronic system for recording wound data at point of care and a commitment to monitoring data entry[9].

Adherence to the principle that wound care should be provided at the lowest appropriate cost without compromising best practice[28] is challenged by inequitable access to contemporary wound consumables across Australia[1,2]. Furthermore, some researchers have employed a top-down costing model using hospital estimated costs[4], or in other settings modelled costs for inclusion of adjuvant therapies such as nutritional supplements or pressure off-loading devices[5]. Although the IHACPA approach uses a bottom-up model for costing direct labour time and therapeutic goods specific to the patient and the diagnosis, they also include additional cost buckets for recurrent costs such as hotel costs, procedure and imaging costs, staff salaries with on-costs and depreciation[15].

However, the researchers involved in this study chose to report only actual costs for treatment consumables and direct labour costs to perform the wound treatments in order to provide a more transparent insight into the direct costs of wound care. It was acknowledged that many other costs associated with the delivery of care are covered within alternative funding arrangements of the treating organisation. Nor did the researchers explore additional costs that may have been placed on patients/residents/clients, although these additional costs should be investigated by subsequent research.

As outlined, a strength of this study was the use of actual costs made possible by the fact that contemporary treatment consumables were provided at no cost to the community care provider's clients, and it was these data that were used to model the costs of wound treatments across the four study cohorts. However, treatment costs varied significantly between and within the study wound types due to the variations between the estimates for each wound type (Table 2). This variation emphasises that a standardised average reimbursement price for wound care across all wound types is not feasible. However, determining the cost of reimbursement other than for labour and consumables for each wound type was outside the scope of this study.

The wound types associated with highest estimated costs in this study were suture lines, open incisional wounds and venous leg ulcers. The findings for incisional wounds were similar to a review of 2014 data from US Medicare beneficiaries which found surgical wounds and infections were the costliest items, noting that the highest costs were incurred in outpatient settings[29]. In an earlier study, Fife et al[30] reported a mean cost to heal per wound of US$3,927, and also noted wide variation in costs for complex wounds such as flaps or grafts which had a mean cost to heal of US$9,358. Guest et al[31] examined a sample of 2,000 patients which comprised 40% acute wounds, 48% chronic wounds and 12% an unknown diagnosis in the United Kingdom (UK) National Health Service (NHS) and calculated costs of £698–3,998 for healed wounds, and £1,719–5,976 for unhealed wounds. The wide variations in costs were again similar to those found in this study.

Phillips et al[32] reported that leg and foot ulcers, pressure injuries and postoperative wounds accounted for most of the wound care costs in GP in Wales in 2012/2013, with average costs of £1,727 per patients (for up to 6 months follow-up). Costs were associated with GP visits, district nurse home visits, outpatient and inpatient care[32]. Potentially some of these associated costs would have been covered by other NHS funding arrangements, and conglomerate healthcare costs make for difficult comparisons of actual wound treatment costs (consumables and labour). Furthermore, they can negatively influence the argument for national reimbursement of wound consumables.

Notwithstanding, it is difficult to compare costs across studies as there is inconsistency in methods of cost evaluation, that is discrepancies in use of direct and indirect costs, duration of data collection and outcomes measured. Romanelli et al[33] reported standard care direct costs were US$2,540 for venous leg ulcers during an 8-week trial in an outpatient setting. While Urwin et al[34] reported an average 2-week cost per person of £166.39 (95% CI: 157.78–175.00), with an estimated annual cost per person of £4,585.70 using data from a survey of nine UK NHS community health services in 2015/2016. More recently, venous leg ulcers were demonstrated to be a common wound in an Australian community cohort, with a median cost to treat (consumables and direct labour) of A$495 (range A$198–1,162)[9].

Considering venous leg ulcers are estimated to affect over 300,000 mainly older Australians, and with anticipated increases in the ageing population[35] and reports of lengthy healing times and recurrence rates of up to 78%[35,36], it would appear feasible and prove cost-effective to fund preventive treatments. Compression therapy in the form of bandages, hosiery or wraps is considered the 'gold' standard treatment for venous leg ulcers[34–36]. However, there is currently no Australian reimbursement scheme for dressings or compression therapies for all Australians. Cheng et al[35] determined reimbursement of compression therapy for the treatment of venous leg ulcers would cost the Australian health system an additional A$270 million over 5 years, which they proposed would be substantially offset by anticipated A$1.4 billion in cost savings.

In accordance with the results from this study, the researchers debated three options for an Australian Health System reimbursement of wound treatment (product, labour) services and products:

- Full cost recovery specific to each of the 45 wound types identified in this study, including cost of consumables, labour and on-costs (staff leave and superannuation, administration, transportation, training, insurances and overheads).
- Specific cost recovery for the mean or median cost to treat *all* wound *categories* (labour and consumables), but not on-costs.
- Specific cost recovery for the mean or median cost to treat *each* wound *type* (labour and consumables), but not other costs.

The researchers would recommend the last option as it is considered to be more feasible for ensuring equitable access to wound care services and products for all Australians.

Strengths and limitations

As previously highlighted, a strength of this study was the use of data for actual wound treatment consumables and direct labour costs for performing the wound dressing procedures. The fact that the consumables were supplied at no charge to clients with wounds recorded in the community care provider dataset, and these data were used to model the costs across the four cohorts, allowed for standardised comparisons.

A limitation relates to the fact that the community care provider has the capacity to bulk purchase consumables yet these associated cost benefits may not be available to smaller providers. Furthermore, these costs reflect 2020/2021 costs for labour and consumables, and variations in exchange rates and procurement may lead to associated cost increases over time. The community provider labour costs were determined based on nurse salary levels; it could be assumed that health professionals other than nurses may perform the wound dressing procedures in other health settings and therefore this may lead to associated cost differences. Additional limitations were access restrictions associated with the management of the COVID-19 pandemic which limited the capacity to survey all wards in the tertiary hospitals and conduct surveys in more health settings, particularly regional hospitals, remote communities and a more diverse range of GPs across all Australian states and territories.

Conclusion

This study sought to determine the number and type of wounds and their treatment costs (consumables and labour) in a sample of Australian hospitals, RACFs, GPs and community care providers and provide evidence to inform reimbursement of wound treatment costs for all Australians. Ultimately, every Australian with a wound should expect the same standard of care regardless of their geographic location, type of wound and healthcare provider. The researchers are strongly convinced that best practice wound prevention and management would lead to optimal healing outcomes if services and practitioners who adhere to this thesis and implemented national standards were reimbursed the mean cost of wound treatments and, if not covered by other funding arrangements, the mean cost of direct labour for performing the treatment procedures.

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Author contribution

Jo Wilkie was involved in the conception, design, acquisition, analysis and interpretation of the data, as well as final approval of the version of the paper to be published. Keryln Carville was involved in the design, acquisition, analysis and interpretation of the data, drafting of the paper, as well as final approval of the version of the paper to be published. Rhonda Kerr was involved in the analysis and interpretation of the data, as well as drafting of the paper. Shih Ching Fu was involved in the analysis and interpretation of the data, as well as drafting of the paper. Kathleen Finlayson was involved in the design, acquisition, analysis and interpretation of the data, drafting and revision of the paper. Jason Lenzo was involved in the drafting and critical revision of the paper. Tanya Tuffrey was involved in the design, acquisition of the data, drafting and revising of the paper. Gary Geelhoed was involved in the conception and design of the project.

Conflict of interest

The authors declare no conflict of interest.

Ethics statement

An ethics statement is not applicable.

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