**Review**

**Assessment, management and prevention of chronic wounds in the Australian context: a scoping review**

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**Abstract**

**Aims** To identify the current research on assessment, management and prevention of chronic wounds in Australia and within the global context.

**Methods** Electronic databases, trial registries and professional organisation websites were searched from 1 January 2010 to 31 May 2022. All original human research studies on chronic wounds conducted in Australia and reviews (systematic reviews (SRs), evidence-based guidelines (EBGs), evidence summaries, consensus documents) conducted worldwide were included. Results were tabulated and synthesised in a narrative review.

**Results** Overall, 365 Australian studies and 569 worldwide reviews were included. The designs of Australian studies were mostly cohort (31%) or cross-sectional (20%), with a few randomised trials (10%). Australian studies were mostly concentrated on wound management (43%) or assessment (40%), and only 17% on prevention; this profile was similar for worldwide reviews. The chronic wound types focused on in Australian studies were 43% pressure injuries (PIs), 27% diabetes-related foot ulcers (DFUs), 16% venous leg ulcers (VLUs), 8% mixed chronic wounds, 6% mixed leg/foot ulcers, <1% fungating wounds.

**Conclusions** This review found Australian chronic wound research focused on PIs and DFUs, with few randomised trials (10%), which is likely related to the lack of national competitive funding and difficulties in infrastructure support for adequately powered trials.

**Introduction** Chronic wounds have protracted progression in healing, often taking months or years to heal, and are typically linked to underlying health conditions¹–³. Any wound may become chronic, however, frequently found chronic wound types include venous leg ulcers (VLU), arterial leg ulcers (ALU), pressure injuries (PI) and diabetes-related foot ulcers (DFU)⁴. It can be anticipated that with an ageing population, chronic...
diseases such as diabetes, venous insufficiency, peripheral arteriadisease and malignant disorders will increase in prevalence, with a corresponding increase in the number of chronic wounds. Thus, there is a significant need for research to identify effective strategies to assess, manage and prevent chronic wounds across all health settings.

In Australia, there is clear evidence that chronic wounds significantly impact healthcare expenditure and health-related quality of life (HRQoL) for persons with wounds. To optimise effective care of chronic wounds, it is important to have a sound understanding of, and access to, available research evidence.

In 2020, the Australian Health Research Alliance Wound Care Initiative was established to develop strategies to optimise wound management in Australia. The Wound Care Initiative was divided into four streams, investigating the cost of wound care, wound care practice standards, education and research. The research stream included reviews of current research evidence for chronic wounds, acute wounds and fundamental wound science, to identify gaps and form the basis for consensus research on priorities for wound research in Australia.

This scoping review aimed to identify the existing research on assessment, management and prevention of chronic wounds to detect gaps in chronic wound research relevant to Australia. The review encompassed two arms: firstly original research studies conducted in Australia (termed Australian studies); and secondly worldwide reviews of research, i.e., systematic reviews (SRs), evidence-based guidelines (EBGs), evidence summaries and consensus documents, which involved review and synthesis of global research led by either Australian and/or international authors (termed worldwide reviews) to provide a global context.

Methods
The reporting of this review was guided by the standards of the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Review (PRISMA-ScR) framework. The full protocol is described in an earlier paper and registered with Open Science Framework Registries Network.

Eligibility criteria
In this scoping review chronic wounds are defined as wounds that “do not to proceed through the normal phases of wound healing in an orderly and timely manner”. A specific timeframe to healing or non-healing was not required for inclusion.

Inclusion criteria:
- Original quantitative or qualitative research focused on prevention, assessment and/or management of chronic wounds conducted in Australia;
- EBGs, evidence summaries, consensus statements and SRs on prevention, assessment and/or management of chronic wounds conducted worldwide (including Australia);
- Published between 1 January 2010 and 31 May 2022;
- Published in English; and
- Human studies.

Exclusion criteria:
- Case studies, case series, case reports, opinions, editorials, conference abstracts, general narrative literature reviews.
- Fundamental science articles related to wound healing, e.g., in vitro laboratory-based studies and animal studies.

Information sources
Information sources included academic databases (Medical Literature Analysis and Retrieval System Online, Excerpta Medica Database (Embase), Cumulative Index to Nursing and Allied Health Literature, Joanna Briggs Institute Library, Cochrane Library, PschINFO), clinical trial registries and professional wound organisation sites. Detailed information is published elsewhere.

Search strategy
We used search strings for each of the databases that included key words of chronic, hard-to-heal, wound, ulcer, leg ulcer, malignant or fungating wound, venous or varicose or stasis, arterial, pressure injury/ulcer/sore, decubitus ulcer, neuropathic, ischaemic, neuro-ischaemic, diabetes-related foot ulcers/diabetic foot ulcer. Three primary search strategies were used (published elsewhere) and refined as needed to identify all eligible articles (see an example search string in Table 1).

Selection of documents
Identified records were uploaded to Covidence. Titles and abstracts were screened and those that met eligibility criteria during screening had their full texts retrieved and were further assessed for eligibility – the process can be seen in Figure 1. All screening and assessments were conducted

Table 1. Search strategy example for Australian original research studies

<table>
<thead>
<tr>
<th>Search ID#</th>
<th>Search terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>(arterial ulcer OR extremity ulcer OR mixed ulcer OR varicose ulcer OR crural ulcer OR hard-to-heal ulcer OR leg ulcer OR foot ulcer OR venous ulcer)</td>
</tr>
<tr>
<td>#2</td>
<td>(chronic wound OR malignant wound OR fungat wound)</td>
</tr>
<tr>
<td>#3</td>
<td>(pressure ulcer OR pressure injury OR pressure injuries OR bedsore OR bed sore)</td>
</tr>
<tr>
<td>#4</td>
<td>Australia OR Australian OR Australians</td>
</tr>
<tr>
<td>#5</td>
<td>#1 OR #2 OR #3</td>
</tr>
<tr>
<td>#6</td>
<td>#5 AND #4</td>
</tr>
</tbody>
</table>
independently by two authors. Any disagreements were resolved by a third author.

Data extraction and charting process

Data were extracted from included papers by one author and were independently checked by a second author. Key items extracted included study design, document type, aims, setting, population, outcomes and the chronic wound type focused on in the study.

Synthesis of results

Results were grouped and reported according to the chronic wound type the study or review focused on, i.e., PIs, DFUs, VLUs, ALUs, studies with leg/foot ulcers of multiple aetiologies, malignant/fungating wounds, mixed chronic wounds (studies including chronic wounds of multiple aetiologies), and ‘other’ rarer wound types (e.g., Buruli ulcers, tophaceous ulcers). A narrative synthesis of findings and study outcomes was then undertaken according to the area of primary investigation – assessment, management or prevention. The topics of research studies were grouped into broad categories based on content.

Results

Overall selection results

In total, 4,917 records were identified using the search strategy, of which 2,211 unique records remained after removing duplicates, 1,112 remained after title and abstract screening, and 934 remained after full text assessment and were included in this review (Figure 1). In total there were 365 original Australian studies and 569 worldwide reviews. Of the original Australian studies, the most frequently used designs were cohort studies (31%, n=113) and cross-sectional studies (20%, n=73). Specific study designs are displayed in Table 2. Most Australian studies were primarily concentrated on wound management (43%, n=157), with 40% (n=146) on assessment and 17% (n=64) on prevention of wounds.

The largest number of documents overall (of the 934 Australian studies and worldwide reviews) were on DFUs (n=304, 33%) and PIs (n=280, 30%), followed by VLUs (n=155, 17%), mixed chronic wounds, e.g., samples combining VLUs, mixed ALUs/VLUs, PIs, DFUs (n=140, 15%), mixed types of leg/foot ulcers (n=37, 4%), malignant fungating wounds (n=9, 1%), ALUs (n=4, <1%), and ‘others’ (n=5, <1%), which included Buruli ulcers, tophaceous ulcers, ulcers associated with Hansen’s disease, pilonidal sinus and chronic epidermolysis bullosa wounds. Original Australian studies were focused on PIs (43%, n=156), DFUs (27%, n=97) and VLUs (16%, n=60), with fewer studies in populations with mixed types of chronic wounds (8%, n=28), mixed leg/foot ulcers (6%, n=20), only one study on fungating wounds and no studies specifically on ALUs. In contrast, the worldwide reviews focused on DFUs (37%, n=207), PIs (21%, n=122), mixed chronic wounds (19%, n=112), VLUs (17%, n=95), mixed leg/foot ulcers (3%, n=17) and 1% (n=8) on malignant wounds.

The Australian studies (n=365) were mostly conducted in inpatient hospital settings (39%, n=143; 22 of these were in Intensive Care Unit (ICU)), 28% (n=103) in community wound clinics (including hospital outpatient wound clinics, high risk foot clinics, community wound clinics), 12% (n=44) in general community settings (e.g., those receiving in-home services), 4% (n=15) in residential aged care facilities (RACFs), 3% (n=10) in general practice settings, and 10% (n=38) in combined healthcare settings. Most study samples were amongst adults with or at risk of wounds (79%), 9% with healthcare professionals, 5% with residents in RACFs, 3% with healthcare professionals and adults with or at risk of wounds, 2% with ‘older adults’ (defined ages of older adults ranged from 45 years and older to 70 years and older), 1% with neonatal and/or paediatrics and <1% with all ages.

The most frequent topics of investigation by wound type were determined in both the Australian studies (Table 3) and the worldwide reviews (Table 4). An overview, by wound type and primary area of investigation (assessment, management or prevention), is outlined below.

Diabetes-related foot ulcers (DFUs)

A total of 33% (n=304) of documents focussed on DFU, including 97 Australian studies and 207 worldwide reviews. Study designs and topics of research are shown in Tables 2–4.

Assessment

There were 29% (n=89) DFU documents covering assessment, comprised of 46 Australian studies and 43 worldwide reviews (27 SRs, three EBGs and three evidence summaries).
A DFU incidence of 1.2% was reported in community-based adults\textsuperscript{15}, there was a prevalence of 5.4% in adults with diabetes aged 45 years and older\textsuperscript{13,14}, while point prevalence in acute hospital populations was 6.7%\textsuperscript{15,16}. Risk factors for developing DFUs or for complications from DFUs are shown in Table 5.

Studies assessing healing reported that: surface area change per day was superior to wound edge linear advancement\textsuperscript{17}; changes in ulcer area measured by thermal imaging correlated with healing by 12 weeks\textsuperscript{18}; and ulcer surface area, planimetry area and planar volume and curved volume were useful prognostic markers\textsuperscript{19}. Excellent inter-rater agreement was found for the Wound Ischemia foot Infection (WiFi) score, and fair/moderate agreement for SINBAD classification score (site, ischaemia, neuropathy, bacterial infection and depth) and the Wagner and University of Texas Wound Classification System (UTWCS) scales\textsuperscript{20}. There was also good agreement between: a digital program and clinicians\textsuperscript{21}; 3-D cameras\textsuperscript{22,23}; and reproducibility of gait and plantar pressures\textsuperscript{24}. However, inconsistent agreement between visual and objective periwound assessment was determined\textsuperscript{25}. One study found good agreement between a mobile phone application and Visitrak\textsuperscript{2} wound grid and WoundVue\textsuperscript{2} ulcer area measures\textsuperscript{26}. However, another study found mobile phone assessment images had low validity and reliability for remote assessment\textsuperscript{27}.

Four studies on assessing infection found: minimal correlation between the Levine swabbing technique and tissue biopsy and culture\textsuperscript{28}; no correlations between clinical signs of infection and the presence of wound biofilm\textsuperscript{29}; differing microbiomes in cases of severe and mild diabetic foot infections\textsuperscript{30}; and no association between skin
and wound microbiomes and healing. Two studies that investigated pain assessment found observational and non-verbal cues were preferred assessment methods; and formal assessment tools reported higher reported pain scores as compared to a single question (e.g., how much pain do you have on a scale of 0 to 10?).

**Worldwide reviews**

Three EBGs were reviewed and covered the assessment of DFU infection or DFU classification. Two evidence summaries focused on DFU assessment, and one on evidence mapping. Topics and number of SRs are shown in Table 4.

**Management**

There were 196 (64%) DFU documents covering management, comprised of 49 Australian studies and 147 worldwide reviews (123 SRs, 15 EBGs, seven evidence summaries, and two consensus documents).

### Table 3. Topics of investigation by wound type in Australian studies (n=365)

<table>
<thead>
<tr>
<th>Focus topic of study</th>
<th>PIs</th>
<th>DFUs</th>
<th>VLUs</th>
<th>Mixed chronic wounds</th>
<th>Mixed leg/foot ulcers</th>
<th>ALUs</th>
<th>Malignant</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence/incidence</td>
<td>19</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>2</td>
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<td>0</td>
<td>1</td>
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<tr>
<td>Risk factors or tools for wound occurrence, severity, delayed healing or recurrence</td>
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<td>21</td>
<td>8</td>
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<td>3</td>
<td>0</td>
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<tr>
<td>Methods of assessing healing</td>
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<td>0</td>
<td>3</td>
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<tr>
<td>Assessing pain and symptoms</td>
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<tr>
<td>Topical wound/skin treatments/dressings</td>
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<td>1</td>
<td>0</td>
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<tr>
<td>Debridement</td>
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<td>3</td>
<td>0</td>
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<tr>
<td>Adjuvant therapies (NPWT, electrical/laser therapy, HBOT, growth factors, cell therapies)</td>
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<td>3</td>
<td>6</td>
<td>1</td>
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<td>1</td>
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<tr>
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<td>Costs/cost-effectiveness</td>
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</tr>
</tbody>
</table>

PIs: pressure injuries; DFU: diabetes-related foot ulcer; VLU: venous leg ulcer; ALU: arterial leg ulcer; NPWT: negative pressure wound therapy; HBOT: hyperbaric oxygen therapy; PROM: patient-reported outcome measures; QoL: quality of life; EBP: evidence-based practice

A **Australian studies**

Studies on topical wound treatments found: cadexomer iodine and a surfactant gel both reduced microbial load; improved healing from topical propolis; and honey wound gel and alginate were easy to use and patients rated comfort as high. Small trials of ‘spray on skin’ (ReCell®), ultrasonic debridement and topical activated protein C reported improved healing, while a larger randomised controlled trial (RCT) of ReCell® versus standard care found no difference in healing rates. A qualitative study found logistical and communication issues influenced podiatrists’ perceptions of hyperbaric oxygen therapy (HBOT).

Research on offloading interventions found:

- a cushion-modified total contact cast (TCC) offloaded significantly more pressure than a conventional TCC;
- higher healing rates were associated with TCCs compared to removable non-TCCs.

PIs: pressure injuries; DFU: diabetes-related foot ulcer; VLU: venous leg ulcer; ALU: arterial leg ulcer; NPWT: negative pressure wound therapy; HBOT: hyperbaric oxygen therapy; PROM: patient-reported outcome measures; QoL: quality of life; EBP: evidence-based practice
• evaluation of a DH Pressure Relief Shoe™ found significantly lower peak pressures compared to a control shoe and participants’ standard shoes52;
• treatment with knee-high offloading was associated with faster healings53,54;
• new felt padding offloaded half the pressure of plantar DFUs55; and
• the device side walls of TCCs were found to bear considerable load56.

Infection research indicated: an outpatient antimicrobial therapy service was as effective as inpatient services57; overuse of anti-pseudomonal therapy58; and heterogeneity in antimicrobial treatments59.

One study reported factors influencing pain management32 and one trial found improved healing after a vitamin C supplement60. Three studies investigated self-care, describing emotional isolation61, motivations to perform self-care62 and experience with phone apps to monitor DFUs63.

Research on health services included: a model for rural settings64; evaluation of a multidisciplinary team65; evaluation of an Aboriginal and Torres Strait Islander foot care service66; increased healing rates reported from telehealth67; improved access to services68; general adherences to EBGs with exception of non-removable offloading devices69; and foot care management was a low priority in primary healthcare70.

Significant savings and health benefits were found when

Table 4. Topics of investigation by wound type in worldwide reviews (n=569)

<table>
<thead>
<tr>
<th>Focus topic of review</th>
<th>PIs</th>
<th>DFUs</th>
<th>VLU</th>
<th>Mixed chronic wounds</th>
<th>Mixed leg/foot ulcers</th>
<th>ALUs</th>
<th>Malignant</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence/incidence</td>
<td>11</td>
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<td>1</td>
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<tr>
<td>Methods of assessing healing/wounds</td>
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<td>Tissue characteristics/assessment</td>
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<tr>
<td>Compression therapy</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Adjuvant therapies (e.g., NPWT, electrical/laser therapy, light therapy, shockwave therapy, HBOT, ozone, growth factors, cell therapies)</td>
<td>7</td>
<td>26</td>
<td>8</td>
<td>14</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Multiple/complex interventions</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Pain and symptom management</td>
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<td>0</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Pharmacological treatments</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
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</tr>
<tr>
<td>Nutrition</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Physical activity/exercise</td>
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<td>0</td>
<td>5</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Education/psychological interventions</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Self-management</td>
<td>1</td>
<td>2</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>PROM, QoL</td>
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<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>EBP/implementation studies</td>
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<td>0</td>
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<tr>
<td>Health service management</td>
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<td>0</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Costs/cost-effectiveness</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

PIs: pressure injuries; DFU: diabetes-related foot ulcer; VLU: venous leg ulcer; ALU: arterial leg ulcer; NPWT: negative pressure wound therapy; HBOT: hyperbaric oxygen therapy; PROM: patient-reported outcome measures; QoL: quality of life; EBP: evidence-based practice
implementing EBG care\textsuperscript{71}, and staff resources and regional/remote geography influenced frequency of evidence-based practice (EBP) in debridement\textsuperscript{72}.

**Worldwide reviews**

A total of 15 EBGs discussed DFU management\textsuperscript{34,73–86}. Evidence summary topics included debridement\textsuperscript{87,88}, dressings\textsuperscript{59,90}, offloading\textsuperscript{91}, combined treatments\textsuperscript{37}, and evidence mapping\textsuperscript{39}. Consensus documents focused on DFU management\textsuperscript{92} and topical oxygen therapy\textsuperscript{93}. Topics of SRs are shown in Table 4.

**Prevention**

There were 36 (12\%) DFU documents covering prevention of DFUs, including five Australian studies and 31 worldwide reviews (21 SRs, eight EBGs and two evidence summaries).

**Australian studies**

Studies on offloading reported no benefit from silicone gel sheeting to prevent ulcer recurrence\textsuperscript{94}, and significant differences in plantar pressures between a specialised shoe compared to canvas or participants’ own shoes\textsuperscript{52}. One study found only 45\% of health professionals reported removing shoes and socks of their patients for foot assessment\textsuperscript{95}, and two protocols were registered on preventive interventions\textsuperscript{96,97}.

**Pressure injuries (PIs)**

Overall, 30\% (n=280) of documents focused on PIs, including 156 Australian studies and 124 worldwide reviews. The study designs and topics are shown in Tables 2–4.

**Assessment**

Assessment was addressed in 98 documents, including 58 Australian studies, five EBGs, 29 SRs, four evidence summaries and two consensus documents.

### Table 5. Risk factors identified for developing DFUs or complications of DFUs

<table>
<thead>
<tr>
<th>DFU event/complication and risk factors identified</th>
<th>DFU occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>• More sedentary activities\textsuperscript{49,450}</td>
<td></td>
</tr>
<tr>
<td>• Higher peak plantar pressures\textsuperscript{451,452}</td>
<td></td>
</tr>
<tr>
<td>• Peripheral neuropathy\textsuperscript{12,453–456}</td>
<td></td>
</tr>
<tr>
<td>• Peripheral arterial disease\textsuperscript{12,453,454,456}</td>
<td></td>
</tr>
<tr>
<td>• Claudication\textsuperscript{12,465}</td>
<td></td>
</tr>
<tr>
<td>• Cardiovascular disease\textsuperscript{450}</td>
<td></td>
</tr>
<tr>
<td>• Previous foot ulcers\textsuperscript{453,454,457}</td>
<td></td>
</tr>
<tr>
<td>• Previous trauma and past surgical treatment\textsuperscript{463,464}</td>
<td></td>
</tr>
<tr>
<td>• Gait abnormalities\textsuperscript{458}</td>
<td></td>
</tr>
<tr>
<td>• Retinopathy, cerebrovascular disease, HbA1c, alcohol consumption, renal impairment\textsuperscript{12}</td>
<td></td>
</tr>
<tr>
<td>• Longer diabetes duration\textsuperscript{450,455,459}</td>
<td></td>
</tr>
<tr>
<td>• Previous hospitalisations for DFU, absent pedal pulse and Aboriginality\textsuperscript{12}</td>
<td></td>
</tr>
<tr>
<td>• Higher rates in males\textsuperscript{455,459}</td>
<td></td>
</tr>
<tr>
<td>• Overweight\textsuperscript{69}</td>
<td></td>
</tr>
<tr>
<td>• Older age\textsuperscript{450,459}</td>
<td></td>
</tr>
<tr>
<td>• Reduced cognitive functioning in comparison to population means\textsuperscript{460}</td>
<td></td>
</tr>
<tr>
<td>• Lower circulating protein C levels\textsuperscript{451}</td>
<td></td>
</tr>
<tr>
<td>• Lower income\textsuperscript{450}</td>
<td></td>
</tr>
<tr>
<td>• Increased foot skin temperature\textsuperscript{462}</td>
<td></td>
</tr>
<tr>
<td>• Three models were validated to predict risk of DFUs or amputation\textsuperscript{463}</td>
<td></td>
</tr>
<tr>
<td><strong>Increased DFU severity</strong></td>
<td></td>
</tr>
<tr>
<td>• Low vitamin C levels\textsuperscript{464}</td>
<td></td>
</tr>
<tr>
<td><strong>Infection</strong></td>
<td></td>
</tr>
<tr>
<td>• Ulcers unhealed after 3 months, deep DFUs, peripheral neuropathy, previous DFUs, foot deformity, female sex\textsuperscript{465}</td>
<td></td>
</tr>
<tr>
<td>• Age\textsuperscript{450,465}</td>
<td></td>
</tr>
<tr>
<td><strong>DFU hospitalisation</strong></td>
<td></td>
</tr>
<tr>
<td>• Duration of diabetes, absence of foot pulse, height, peripheral arterial disease, peripheral sensory neuropathy\textsuperscript{466}</td>
<td></td>
</tr>
<tr>
<td>• Suboptimal glycaemic control\textsuperscript{466}</td>
<td></td>
</tr>
<tr>
<td>• Previous revascularisation\textsuperscript{466}</td>
<td></td>
</tr>
<tr>
<td><strong>Delayed healing of DFUs</strong></td>
<td></td>
</tr>
<tr>
<td>• Congestive heart failure\textsuperscript{467}</td>
<td></td>
</tr>
<tr>
<td>• Younger age, geographical remoteness, peripheral arterial disease, larger ulcers\textsuperscript{53,54}</td>
<td></td>
</tr>
<tr>
<td>• Smoking, neuropathy\textsuperscript{468}</td>
<td></td>
</tr>
<tr>
<td>• Infection\textsuperscript{53,54,469}</td>
<td></td>
</tr>
<tr>
<td><strong>Amputation</strong></td>
<td></td>
</tr>
<tr>
<td>• Low vitamin C, albumin and haemoglobin\textsuperscript{170}</td>
<td></td>
</tr>
<tr>
<td>• Vascular disease, previous amputation\textsuperscript{471}</td>
<td></td>
</tr>
<tr>
<td>• Coronary artery bypass graft (CABG) surgery\textsuperscript{472}</td>
<td></td>
</tr>
<tr>
<td>• Forefoot ulcers of higher severity\textsuperscript{471}</td>
<td></td>
</tr>
<tr>
<td>• Charcot’s arthropathy\textsuperscript{472}</td>
<td></td>
</tr>
<tr>
<td>• Indigenous ethnicity\textsuperscript{471,472}</td>
<td></td>
</tr>
<tr>
<td>• Retinopathy\textsuperscript{472}</td>
<td></td>
</tr>
<tr>
<td>• Decreased toe systolic pressure, distance from a high risk foot service\textsuperscript{473}</td>
<td></td>
</tr>
<tr>
<td>• Wound, ischaemia, foot infection (WIfI) stage\textsuperscript{469}</td>
<td></td>
</tr>
<tr>
<td><strong>Mortality</strong></td>
<td></td>
</tr>
<tr>
<td>• Age\textsuperscript{474,475}</td>
<td></td>
</tr>
<tr>
<td>• Kidney disease, and low plasma albumin\textsuperscript{474}</td>
<td></td>
</tr>
<tr>
<td>• Coronary artery disease\textsuperscript{475}</td>
<td></td>
</tr>
<tr>
<td>• Infection\textsuperscript{469}</td>
<td></td>
</tr>
</tbody>
</table>
Prevalence and incidence research reported varied ranges and there was evidence of inaccurate reporting of hospital-acquired PIs (HAPIs) incidence\(^{103}\). Incidence of 1.33/1000 resident days was reported in RACFs\(^{104}\), with no difference between respite and permanent aged care\(^{105}\). Reported incidences of HAPIs among intensive care unit (ICU) patients varied from 6.8–16.9%\(^{106–108}\), noting that almost 60% of PIs in ICU adults were HAPIs\(^{111}\). The reported incidence of HAPIs in general acute hospital settings was lower than that observed in ICUs, and ranged from 3.3%\(^{109,112}\) to 12.8%\(^{113,114}\). In one study, almost 11% of people aged over 65 years developed a PI in the first 36 hours hospitalised\(^{115}\). Surgically-acquired PI incidence ranged from 0.7%\(^{116}\) to 1.3%\(^{116,117}\). The reported incidence of device-related PIs (DRPIS) ranged from 4.3%\(^{118–120}\) to 27.9%\(^{121}\). The PI incidence rate/1000 patient bed days in patients with contact precautions was 2.9\(^{122}\) and 0.5/1000 patient days in paediatrics\(^{123}\).

Prevalence of PIs varied across settings, from 4–13.7%\(^{124,125}\) in hospitals, 3.6% in a regional hospital\(^{126}\), 5.2% in adults transferred by ambulance\(^{127}\), and 8.9% in community services\(^{128}\). One study reported 137 PIs in 103 people in a district nursing service\(^{129}\), another examined location of heel PIs\(^{130}\), and one examined the costs of auditing PI prevalence\(^{131}\).

Several studies assessed validity and reliability of risk assessment tools, including Waterlow\(^{106,132}\), Ramstadius\(^{106}\), and Norton scores\(^{133}\).

### Table 6. Risk factors for developing PIs, by population type

<table>
<thead>
<tr>
<th>Population and risk factors for PIs identified</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital inpatients</strong></td>
<td></td>
</tr>
<tr>
<td>• Malnutrition(^{116,477,478})</td>
<td></td>
</tr>
<tr>
<td>• Admissions from residential aged care facilities(^{115})</td>
<td></td>
</tr>
<tr>
<td>• Body shape(^{479})</td>
<td></td>
</tr>
<tr>
<td>• Physical activity/position(^{480,481})</td>
<td></td>
</tr>
<tr>
<td>• Multiple comorbidities(^{115,482})</td>
<td></td>
</tr>
<tr>
<td>• Increased frailty(^{483})</td>
<td></td>
</tr>
<tr>
<td>• Incontinence-associated dermatitis(^{484})</td>
<td></td>
</tr>
<tr>
<td><strong>Critically ill/intensive care inpatients</strong></td>
<td></td>
</tr>
<tr>
<td>• Use of vasoactive agents, extra corporeal membrane oxygenation and mechanical ventilation(^{114})</td>
<td></td>
</tr>
<tr>
<td>• Oxygen tubing behind ears, nasogastric tubes(^{120})</td>
<td></td>
</tr>
<tr>
<td>• Endotracheal tubes(^{120,124,485})</td>
<td></td>
</tr>
<tr>
<td>• Time in a cervical collar and length of ICU stay(^{110})</td>
<td></td>
</tr>
<tr>
<td><strong>Operative theatre</strong></td>
<td></td>
</tr>
<tr>
<td>• Younger age(^{486})</td>
<td></td>
</tr>
<tr>
<td>• Longer operative duration(^{486,487})</td>
<td></td>
</tr>
<tr>
<td>• Operative speciality and hypotension(^{487})</td>
<td></td>
</tr>
<tr>
<td><strong>Residents of aged care facilities</strong></td>
<td></td>
</tr>
<tr>
<td>• Geography and socio-economic status of aged care facilities(^{104})</td>
<td></td>
</tr>
<tr>
<td>• Healthcare factors, equipment and impaired cognition(^{488})</td>
<td></td>
</tr>
</tbody>
</table>

A trial of two dressing types to prevent PIs found no difference in efficacy or product integrity; however, there was a difference in costs\(^{127}\). One study in neonatal intensive care for PIs identified risk factors for developing PIs, by population type.

### Worldwide reviews

Five EBGs covered PI assessment\(^{145–148}\). Evidence summaries focused on PIs in burn patients\(^{149}\) and risk assessment tools\(^{150–152}\). Consensus documents were found on heel PIs\(^{153}\) and medical device-related PIs (MDRPs)\(^{154}\). SR topics are shown in Table 4.

### Management and/or prevention

Management and/or prevention of PIs was addressed in 106 Australian studies, in addition to 76 SRs, seven EBGs, eight evidence summaries and seven consensus documents.

### Australian studies

Studies on pressure-relieving strategies found: repositioning was the most frequent treatment for MDRPs\(^{120}\); increased repositioning frequency halved the incidence of PIs\(^{155}\); 2-hourly repositioning failed to prevent PIs in a third of at-risk residents\(^{156}\); and alternative seating support surfaces decreased interface pressures compared to standard chairs\(^{157}\). Other studies evaluated: a purpose-designed positioning device\(^{158}\); positioning in immobile critically ill patients\(^{159}\); changing device securement type\(^{160}\); and that a fluidised positioning device was found feasible and effective in reducing occipital PIs\(^{161}\). An observational study investigated peak interface pressures and pressure gradients\(^{162}\); a study of interface pressures in the operating theatre found difficulties in using a device to protect all heel/ankle sites\(^{163}\); and the association between positioning and tissue perfusion in ICU patients was investigated\(^{164}\).

Research on dressings found that two foam dressing types were equally effective for negative pressure wound therapy (NPWT) to treat PIs\(^{156}\) and that silicone foam dressings were effective in preventing sacral and/or heel PIs in critically ill patients\(^{166,167}\); high-risk residents in RACFs\(^{168}\) and people in ICU\(^{169,170}\). This dressing type was shown to be cost-effective\(^{171}\). A trial of two dressing types to prevent PIs found no difference in efficacy or product integrity; however, there was a difference in costs\(^{172}\). One study in neonatal intensive care focused on PIs identified risk factors for developing PIs, by population type.

<table>
<thead>
<tr>
<th>Risk factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use of vasoactive agents, extra corporeal membrane oxygenation and mechanical ventilation(^{114})</td>
<td></td>
</tr>
<tr>
<td>• Oxygen tubing behind ears, nasogastric tubes(^{120})</td>
<td></td>
</tr>
<tr>
<td>• Endotracheal tubes(^{120,124,485})</td>
<td></td>
</tr>
<tr>
<td>• Time in a cervical collar and length of ICU stay(^{110})</td>
<td></td>
</tr>
<tr>
<td>• Younger age(^{486})</td>
<td></td>
</tr>
<tr>
<td>• Longer operative duration(^{486,487})</td>
<td></td>
</tr>
<tr>
<td>• Operative speciality and hypotension(^{487})</td>
<td></td>
</tr>
<tr>
<td>• Geography and socio-economic status of aged care facilities(^{104})</td>
<td></td>
</tr>
<tr>
<td>• Healthcare factors, equipment and impaired cognition(^{488})</td>
<td></td>
</tr>
</tbody>
</table>
care found there was a high level of consensus on some skin care practices, e.g., changing body position; however, there was a low level on others such as the risk assessment tool used\textsuperscript{173}.

With respect to nutrition management and prevention/treatment of PIs: arginine supplements were associated with quicker healing\textsuperscript{174–176} and individualised nutrition care may have positive outcomes\textsuperscript{177}; and nutrition guidelines for adults with hip fractures were associated with lower PI incidence\textsuperscript{178}. Four studies found that nutrition interventions are cost-effective\textsuperscript{179–182}.

Studies on patient involvement in PI prevention found that patient educational materials were often not available\textsuperscript{183} and there were barriers in the healthcare environment to patient participation\textsuperscript{184}. However, studies showed there were benefits from education\textsuperscript{185–187} and patients’ understanding of PI prevention enhanced participation\textsuperscript{188}; and a Patient Participation in PI Prevention scale demonstrated acceptable validity\textsuperscript{189}. Good reliability and validity was found of the Pressure Ulcer Quality of Life-Prevention tool\textsuperscript{190} which was more sensitive than the Short Form (SF-12) item survey to differences\textsuperscript{191}.

A number of studies focused on PIs from the perspective of health service delivery, focussing on the practice of health professionals and challenges in delivering PI prevention and management across a range of settings\textsuperscript{192–209}. Cost evaluations were done of: PI management\textsuperscript{210}; non-reimbursed HAPIs\textsuperscript{211}; HAPIs for people with and without dementia\textsuperscript{212}; reduced PI incidence\textsuperscript{213,214}; a PI care bundle\textsuperscript{215}; and use of prophylactic dressings\textsuperscript{216,217}.

Outcomes from evidence implementation studies varied – some studies found uncertain outcomes\textsuperscript{218,219}, others reported significant reduction in PI incidence\textsuperscript{220,221}, documentation\textsuperscript{222}, practice changes and/or decreased PIs\textsuperscript{224}–\textsuperscript{232}. One study found registered nurses reported high compliance with the protocol\textsuperscript{233}, another with nurses reported that workload restricted patient education\textsuperscript{234}, while another found skin inspection and interprofessional communication were important strategies\textsuperscript{235}.

Worldwide reviews
Seven EBGs covered the management and prevention of PIs\textsuperscript{146–148,236–238}. Evidence summaries were available on active support surfaces\textsuperscript{239}, seat cushions\textsuperscript{240}, pressure redistribution mattresses\textsuperscript{241}, preventative dressings\textsuperscript{242}, mobilising and repositioning\textsuperscript{243,244}, prevention strategies during surgery\textsuperscript{245} and heel PIs\textsuperscript{246}. Consensus documents focused on general management of PIs\textsuperscript{247}, MDRPIs\textsuperscript{54}, heel PIs\textsuperscript{153}, nutrition\textsuperscript{248}, preventative dressings\textsuperscript{249,250}, and prevention for critically ill patients\textsuperscript{251}. The SR topics are shown in Table 4.

Venous leg ulcers (VLUs)
The third largest group (17%, n=155) of documents were on VLUs, including 60 Australian studies and 96 worldwide reviews. The study designs and focus topics are shown in Tables 2–4.

Assessment
A total of 28 documents addressed the assessment of VLUs, including 15 Australian studies.

Australian studies
Excellent inter-rater reliability was obtained from a digital planimetry system\textsuperscript{252}, while both the EQ-5D-5L Score and SPVU-5D Score were able to discriminate between healed and unhealed VLUs\textsuperscript{253}. Participants reported that it was useful to include wound care, compression and dressing items to assess QoL\textsuperscript{254}. A study in general practices found vascular assessment is not routinely undertaken, possibly due to a lack of awareness of guidelines, resources or skills\textsuperscript{255}.

Risk factors for delayed healing included larger ulcers, longer duration, higher exudate levels, larger calf circumference\textsuperscript{256,257}; severe pain-depression-fatigue-sleep disturbance symptom cluster group\textsuperscript{258}, dehydration\textsuperscript{259}, living alone, ulcer reduction in 2 weeks, higher ulcer severity score, and not treating with high level compression\textsuperscript{260}. A comparative study found adults receiving home nursing for VLUs were older and had more risk factors for non-healing than those attending wound clinics\textsuperscript{261}. Granulocyte macrophage-colony stimulating factor and matrix metalloprotease-13 were identified as biomarkers predicting healing\textsuperscript{262} and uric levels correlated with wound chronicity\textsuperscript{263}. Validation and reliability testing of a risk assessment tool for delayed healing had good results\textsuperscript{256,260}. One study found thermal imaging was not associated with healing\textsuperscript{264}; however, another found textural analysis of thermal imaging could predict healing\textsuperscript{265}.

Worldwide reviews
There were eight EBGs on assessment of VLUs\textsuperscript{266–273}. SR topics are shown in Table 4.

Management
Management of VLUs was the focus of 121 documents, including 37 Australian studies, nine EBGs, 49 SRs, 12 evidence summaries, and four consensus documents.

Australian studies
Compression therapy studies indicated support for four-layer compression bandaging compared to Class three compression hosiery\textsuperscript{274} and three-layer tubular compression system compared with short stretch compression\textsuperscript{275}. On adherence to compression therapy: funding of compression bandaging did not influence healing or compression use\textsuperscript{276}; and pain, wound size and depth, and age were significant predictors of non-concordance\textsuperscript{277}. Factors influencing adherence to treatment included understanding the management plan, compression-related body image issues, feeling overwhelmed, hot weather and discomfort, cost, ability to wear compression, patience, persistence and remembering self-care instructions\textsuperscript{278}.  

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Studies on wound dressings or topical interventions found NPWT combined with compression had positive results279, while there were no differences in healing from a trial of wool-derived keratin dressings280. Electrical stimulation therapy was mostly acceptable and easier to use than compression281; however, in people with VLUs who did not use high level compression therapy, it was not associated with improved healing rates282. HBOT was associated with a significantly greater reduction in ulcer area, however no difference in overall healing rates282. One study found no difference in time to healing associated with taking 300mg aspirin daily283, while another reported a reduction in matrix metalloprotease-1 in wound fluid associated with high-dose oral doxycycline, however no significant change in ulcer area284.

Research on exercise included evaluation of a self-management home-based exercise program which resulted in improved calf muscle pump function and range of ankle motion285, significant relationships between self-efficacy and outcome expectations related to program adherence, and improved healing rates286,287. A qualitative study concluded that while adults with VLUs were interested in exercise, they faced many obstacles288. One study in adults with VLUs found education was positively associated with physical activity289. Self-management studies found that an education program led to successful self-management290 and differing perspectives and priorities of patients and clinicians on management, with patients’ preferences more closely aligned with EBGs291.

Health service management was investigated in a number of studies, finding: suboptimal knowledge and implementation of EBP in VLU care292,293; similar healing rates between home nursing and wound clinic care294; and a lack of awareness of EBGs and a range of enablers and barriers to EBP in VLU care295,296. Health professionals’ perspectives on EBGs in primary care were also noted296. Cost evaluations found EBG management led to lower costs and improved QoL297 and shorter time to healing298, while the amount participants spent on ulcer care varied according to wound severity298.

Worldwide reviews

Nine EBGs covered the management of VLUs266–273,299. The evidence summaries were on adherence to compression therapy300–302, VLU management303, debridement304,305, protease-modulating matrix interventions306, dressings307,308, electromagnetic therapy309, ultrasound310 and surgical interventions311. There were consensus documents on compression312,313 complexity in VLU management314 and holistic management315. SR topics are shown in Table 4.

Prevention

A total of 30 documents covered the prevention of VLUs, including 10 Australian studies, seven EBGs, 10 SRs, one evidence summary and two consensus documents.

Australian studies

Factors identified for increased risk of VLU recurrence included: male sex316; history of deep vein thrombosis (DVT)316,317; multiple previous ulcers and longer ulcer duration317; and decreased mobility, antidepressant medications and haemosiderosis318. Protective factors included: leg elevation316,317, compression (>20mmHg for at least 6 days/week)318, higher social support316,318, higher self-efficacy316,317 and increased walking317. A qualitative study found participants reported traumatic injury, surgery and failure to replace compression as causes of recurrence319. Although compression was perceived as important, some were unaware of different compression levels and required frequency for replacement319. Two studies investigated the validity of a risk assessment tool for recurrence, both finding good discrimination and goodness of fit320.

Good acceptability of compression application devices was reported in one study321; however, non-adherence was higher with higher compression levels and was associated with recurrence322. Adherence to VLU preventive strategies was associated with knowledge, higher self-efficacy and lower depressive symptom scores323. Another study found adherence declined between 6–12 months after healing, with regular follow-up and history of multiple ulcers related to improved adherence, and depressive symptoms and restricted mobility related to decreased adherence324. Research on a multimedia education program found significant improvements in knowledge and self-care behaviours325.

Worldwide reviews

Seven EBGs covered the prevention of VLUs266–270,272,273,326. The evidence summary321 and consensus documents312,313 focused on compression. SR topics are shown in Table 4.

Mixed chronic wounds

Many studies (n=140) were focused on samples of chronic wounds in general, i.e., samples including persons with a chronic wound of any aetiology, such as chronic leg ulcers, non-healing surgical wounds, PIls and pilonidal sinuses, including 28 Australian studies, 27 evidence summaries, three EBGs, 63 SRs, and 19 consensus documents. Study designs and topics are shown in Tables 2–4.

Assessment

A total of 29 documents addressed the assessment of mixed chronic wounds, including 11 Australian studies.

Australian studies

An IT mobile wound care program facilitated data collection326, while a small study found a high prevalence of wounds in adults with dementia living in RACFs, with skin tears the most common wound identified327. A survey on wound pain assessment found it was undertaken at each visit or dressing change by 61% of respondents, with around two-thirds of practitioners using a validated assessment tool328.
High inter-rater reliability was found of a device (SD202) for measuring skin hydration and erythema, and a telemetric sensor system for temperature, moisture and pressure (under compression) was found reliable and repeatable in pilot testing in the lab and on one human volunteer participant. The modified TIME-H tool had moderate support to identify the likelihood of healing.

On infection, a RCT found the Levine wound swab technique had improved outcomes as compared to the Z swabbing technique, and a study identified varied bacterium types in non-healing wounds. Delphi surveys achieved consensus on clinical indicators of wound chronicity, infection, and biofilm, and on prevention, identifying and managing chronic wound infections. A SR of chronic wounds in Australia found costs of healthcare are >A$3.5 billion/year, around 2% of national health expenditure and that EBP improves outcomes. An education and process change intervention led to a significant decrease in wounds and increased nursing knowledge.

**Worldwide reviews**
 Guidelines were available on overall assessment of chronic wounds and on assessment of wound infection. Evidence summaries focused on sampling techniques for culture and assessment of cavity wounds. Consensus documents covered chronic wound assessment, ankle brachial pressure index (ABPI), biofilms and exudate. SR topics are shown in Table 4.

**Management**
 A large number (n=115) of documents addressed the management of mixed chronic wounds, including 20 Australian studies.

**Australian studies**
 Findings from clinical trials included that: a vitronectin; growth factor complex was safe and re-epithelialisation occurred in most participants; there was no difference in wound pain from a trial of low intensity laser therapy; and a standard nutrition supplement led to improved healing compared to a wound-specific supplement. On patient-reported outcomes, a study found sub-optimal HRQoL and significant costs associated with chronic wounds, while in another study participants reported the desire to be independent and improved HRQoL from self-treating. However, one study found an association between self-treating chronic wounds and reduced HRQoL and financial burden. Coping strategies for living with chronic wounds included seeking support, solution-focused problem solving, finding new options to stay healthy, distraction and staying positive.

Health service research reported that: an education and process change intervention led to increased uptake of EBP in RACFs; link clinicians improved the uptake of TIME principles; the documentation of wound care occurred in less than one-third of residents with dementia in RACFs with wounds; the use of an electronic wound management system led to improved communication; an inconsistent approach was found in product utilisation in RACFs; there were improved patient outcomes and/or significant cost savings from specialist wound services; there was high satisfaction and viability of a virtual consultant wound specialist service; and there were positive outcomes from a telephone advisory service.

**Worldwide reviews**
 Three EBGs covered the management of chronic wounds or wound infection. Evidence summaries were found on wound infection, iodophors, debridement, cavity wounds, collagen-based dressings, wet-to-moist dressings, wet-to-dry saline gauze dressings, foam with silver dressings, alginate dressings, pain management, biosynthetic skin substitutes, topical negative pressure (TNP), HBOT and hydrogen peroxide. There were consensus documents on biosignals, 390-392, infection, antimicrobial stewardship, chronic wound management, NWPT, and patient engagement and aseptic technique. SR topics are shown in Table 4.

**Prevention**
 One pre/post study in RACFs found increased uptake of EBP and decreased prevalence of wounds, and two EBGs covered general prevention of wounds.

**Mixed chronic leg and/or foot ulcers**
 A total of 37 documents were identified on assessment, management and/or prevention of mixed types of leg and foot ulcers, including 20 Australian studies, 14 SRs, two evidence summaries and one consensus document. Study designs and topics are shown in Tables 2-4.

**Assessment**
 A total of 11 documents addressed the assessment of mixed leg ulcers, with ten Australian studies and one SR.

**Australian studies**
 Studies on characteristics of populations with foot ulcers reported that: 7.4% of inpatients in acute hospitals had foot conditions as the primary reason for admission; characteristics of non-DFU; and 10% of adults on dialysis had foot ulceration which was associated with a history of amputation, PAD and serum albumin. A later study found additional risk factors of neuropathy and previous ulcers.

Results from studies on infection included no relationship between the clinical assessment of infection versus bacterial burden from wound swabs, however faster healing in wounds with nil or low bacterial growth at baseline over 2 weeks in a nanocrystalline silver group compared to cadexomer iodine treatments. Risk factors for infection in chronic leg and foot ulcers included depression, requiring...
walking aids, a calf-ankle ratio <1.3, larger wound area, and slough. However, not all were validated in a small prospective study. A small study found a significant relationship between transcutaneous oxygen pressure (TcpO₂) assessment and ulcer healing over 4 weeks, and an evidence implementation study found improved EBP in wound assessment in primary healthcare professionals.

**Worldwide reviews**

One SR was found on biomarkers to predict ulceration or recurrence of lower leg ulcers.

**Management**

A total of 26 documents covered the management of mixed types of leg and/or foot ulcers, including 11 Australian studies.

**Australian studies**

Studies on topical treatments reported no differences in healing rates between cadexomer iodine versus nanocrystalline silver, with both dressings rated favourably by participants, and evaluation of an acellular synthetic matrix found 36% healing rate at 12 weeks. Two reports on EMLA topical analgesic cream found no differences in healing rates, however a significant decrease in pain and improved wellbeing in the EMLA group. Two symptom clusters were identified in participants with mixed ALUs/ VLUs which had a significant impact on HRQoL. One study found no impact on healing from antibiotics, anticoagulants, steroids or non-steroidal anti-inflammatory drugs.

Looking at models of care, one study compared health service models found significant differences in EBP and healing outcomes, and two studies investigated models to increase EBP, with a positive change in EBP in wound assessment and management in primary healthcare professionals. A survey of specialist providers for chronic leg ulcers found about one-third used HBOT, while the remainder did not believe it had a role or did not have access to HBOT.

**Worldwide reviews**

Evidence summaries were available on maggot debridement and NPWT for mixed leg ulcers. A consensus document covered antimicrobial prescribing for leg ulcer infection. SR topics are shown in Table 4.

**Prevention**

One quasi-experimental study evaluated an intervention to facilitate uptake of EBP in assessment, management and prevention of wounds. Results were inconclusive due to a small sample size.

**Malignant fungating wounds**

Nine articles addressed malignant fungating wounds, one Australian study and eight SRs.

**Assessment**

A qualitative study investigated the experience of living with malignant wounds with patients, caregivers and nurses, finding malodour was one of the worst aspects.

**Management**

There were five SRs on symptom management (to manage odour and/or exudate), one on topical agents and dressings, one on management of bleeding from malignant wounds, and one on microbiome species in malignant wounds.

**Arterial leg ulcers (ALUs)**

Two EBGs and two SRs focused on ALUs. There were no Australian studies. The EBGs both covered the assessment and management of ALUs, with one also providing recommendations for prevention. The SRs focused on wound dressings and autologous bone marrow cell therapy.

**Other chronic wound types**

A small number of studies (n=5) were found on wound types not addressed in the main categories, encompassing Buruli ulcers, chronic epidermolysis bullosa wounds, pilonidal sinuses, tophaceous ulcers and ulcers resulting from Hansen’s disease.

**Australian studies**

Australian studies reported that: Australian Buruli ulcers were mostly located on upper and lower limbs; wounds healed faster after receiving intralesional allogenic cultured fibroblasts in matched wounds in adults with recessive dystrophic epidermolysis bullosa; and a registered trial aimed to evaluate metronidazole ointment for pilonidal sinuses.

**Worldwide reviews**

Two SRs were found on treatments for ulcers associated with tophaceous gout and interventions for ulceration caused by Hansen’s disease.

**Discussion**

Over the 12-year period scanned in this review, 365 Australian research studies on chronic wounds were identified. In general, the number of studies steadily increased each year, from 17 in 2010, up to 42 in 2020, followed by a drop in 2021 (34), possibly due to research restrictions during the COVID-19 pandemic. Over two-thirds of these studies (70%) focused on PIs and DFUs. Information on prevalence of wound types in Australia is scarce; however, a recent Australian study surveyed all (acute and chronic) wound types in hospital, RACFs and community settings, reporting that while 9.9% of the wounds were PIs and 11.9% were foot ulcers, 17.7% were leg ulcers, the latter being an area which may need increased focus in Australian research. Only one Australian study was found on malignant wounds, a qualitative study with patients, carers and nurses.
representing 0.3% of Australian studies. In comparison, the large Australian survey of wound types above reported malignant wounds represented 2.4% of wounds.

Most studies in this review focused on wound management or assessment, and a smaller proportion (17%) on prevention, although there is significant potential for prevention of these wound types which are predominantly caused by underlying chronic conditions. There were relatively few Australian studies using RCT designs (10%) compared to observational study designs, such as cohort (31%) and cross-sectional (20%) studies, despite recommendations from previous authors who identified a gap in high quality evidence from well-designed trials. A 2019 scoping review of recommendations, guidelines and standards for chronic wound research identified a lack of RCTs and well-designed, prospective studies. The lack of these studies subsequently limits the ability to compare and combine data in meta-analyses and SRs.

The largest proportion (43%) of original Australian studies were on PIIs – these were mostly cohort or cross-sectional studies. The increased focus placed on prevention of PIIs in health systems, including financial penalties and monitoring of prevalence as a quality indicator, may be a reason for the higher proportion of PI research found in Australia (43%) compared to worldwide reviews (22%).

The second largest proportion (27%) of Australian studies were on DFUs, although lower than the proportion of worldwide reviews (36%), with the largest group of reviews being SRs, most related to efficacy of topical wound applications and dressings (18%). Although the overall research output for DFU research was diverse, the majority concentrated on assessment (29%) and management (64%). Only five Australian studies were on prevention (2%), highlighting the need for greater work in this critical area. Further, Australian DFU studies reported a comparatively low proportion of RCTs (6%) compared to all Australian chronic wound studies (10%), with the vast majority of DFU research utilising observational methodologies. Thus, with a comparatively low focus on DFU studies in Australia compared with worldwide reviews, and an especially low proportion of RCTs, this suggests there may be a comparatively low level of focus and funding available at a national level for DFUs. With DFUs a top 10 leading cause of national and global hospitalisation and disability burden, it is recommended the focus and funding on Australian DFU research needs to improve.

The third largest group of Australian original studies were on VLUs. The most frequent designs were observational studies and randomised trials, conducted primarily in community settings. Nearly two-thirds (62%) of the studies focused on VLU management, in particular health service management, with results reflecting the well-known gaps in access to EBP for this population, despite studies showing that EBP results in significantly improved outcomes.

Studies which combined mixed types of chronic wounds included samples with non-healing wounds of multiple aetiologies. Similar to the other wound groups, most studies focused on assessment or management, with only one study including prevention strategies. A small number of intervention studies were identified; however, most studies were observational in design, with limited high quality evidence.

There is a paucity of good quality research conducted on mixed leg ulcers, with only 20 Australian studies addressing assessment or management, and only one study addressing prevention. Prevalence rates, risk factors for poor outcomes, and evaluations of models of care provide important information; however, some studies indicated non-significant results, concluding that larger sample sizes and more research is needed. Further research is imperative to drive EBP for an increasing number of leg ulcers that are of mixed aetiology.

Overall, topics of Australian research studies were disproportionately focused on either prevalence or risk factors for poor wound outcomes, or implementation of EBP (particularly for PIIs), with only half the number of studies on clinical interventions to heal, manage or prevent wounds.

Limitation

These scoping review results have some limitations. Firstly, the level of detail of the findings reported in this scoping review is necessarily brief due to the size of the review. In addition, despite best intentions, the search strategies may have failed to identify all eligible studies.

Conclusions

This review maps the wound research landscape in Australia which demonstrates great variety and diversity of output. Results highlight strengths in areas of risk assessment and implementation research, and a number of gaps – the lack of national evidence being generated on wound prevention, the lack of studies on leg ulcers of mixed or arterial aetiology, and the lack of high quality clinical trials, which is likely related to the lack of national competitive funding in this area of research.

Ethics statement

An ethics statement is not applicable.

Conflict of interest

CP owns shares in a company that manufactures amniotic membrane allografts for wound applications. Other authors have no conflicts of interest to disclose.

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Author contribution
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