Review of Use of Digital Health in Melanoma Post-Treatment Care for Rural and Remote Communities

Abstract

**Background:** The melanoma incidence and mortality rates in rural and remote communities are exponentially higher than in urban areas. Digital health could be used to close the urban/rural gap for melanoma and improve access to post-treatment and support care services.

**Objective:** To understand how digital health is currently used for melanoma post-treatment care and determine its benefits for Australian rural and remote areas.

**Methods:** A systematic search of PubMed, Medline, Google Scholar, Scopus was conducted in March 2018. Findings were clustered per type of intervention and related-direct outcomes.

**Results:** Five studies met the inclusion criteria, but none of them investigated the benefits of digital health for melanoma post-treatment care in rural and remote areas of Australia. A number of empirical studies demonstrated consumers’ acceptance toward digital intervention for post-treatment care. Findings did not take into consideration individual, psychological and socioeconomic factors, even though studies show their significant impacts on melanoma quality of aftercare.

**Conclusions:** Digital interventions may to be used as an adjunct service by clinicians during melanoma post-treatment care, especially in regions that are lower-resourced by practitioners and health infrastructure, such as rural and remote Australia. Technology could be used to reduce the disparity in melanoma incidence, mortality rates and accessibility to post-treatment care management between urban and rural/remote populations.

**Keywords:** Digital health; eHealth; Technology; Melanoma; Post-treatment care; Support care services; Rural areas; Remote communities; Patient centric; Oncology

Introduction

Australia remains a country with one of the highest levels of melanoma. In 2015, the worldwide average age-standardised incidence rate (ASR) for melanoma was 5 cases for 100,000, however the rates for Australia and New Zealand are over ten times that level (Table 1)[1]. Melanoma treatment represents a significant cost for the Australian Healthcare System that has increased dramatically in the past two decades, from approximately AU$30 million in 2001 to AU$201 million in 2017. [2]
Table 1. Worldwide ranking: average age-standardised incidence rate for melanoma

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Age-standardised incidence rate for melanoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New-Zealand</td>
<td>54/100,000 (95% CI 39–73)</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>54/100,000 (95% CI 41–78)</td>
</tr>
<tr>
<td>3</td>
<td>Norway</td>
<td>26/100,000 (95% CI 18–32)</td>
</tr>
<tr>
<td>4</td>
<td>Sweden</td>
<td>26/100,000 (95% CI 20–35)</td>
</tr>
<tr>
<td>5</td>
<td>The Netherlands</td>
<td>25/100,000 (95% CI 17–30)</td>
</tr>
</tbody>
</table>

Cutaneous melanoma (CM) is the fourth most commonly diagnosed cancer in Australia [3] and the most common cancer among young Australians (15-39 years old). Although Melanoma represents only 2% of all skin cancers [4], it often leads to premature death [4] and is responsible for a majority of skin cancer deaths [5]. Compared to metropolitan populations, Australia’s rural and remote communities experience inequities in access to care [6], leading to a higher incidence and mortality within 5 years. The median incidence ASR for Non-Indigenous Australians with CM is 32 per 100,000 across rural and remote areas and 27 per 100,000 in major cities. In comparison, the median worldwide ARS mortality for CM is 5.4 per 100,000 across rural and remote areas and 4.6 per 100,000 in major cities [7].

Melanoma treatment plans depend on (a) prognostic factors which are largely defined by the American Joint Committee on Cancer (AJCC) staging system [8], and (b) individual characteristics which will allow the clinicians to determine the type of Melanoma and the risk for recurrences. For example, patients previously treated for primary CM are at higher risk of recurrences and developing new primary melanomas and skin lesions [9]. However, early-detection can reduce mortality rates, as melanoma can be more effectively cured with simple and cheap treatments in the early stages [10]. In 1996, Berwick and colleagues reported that Total Self Skin-Examination (TSSE) may decrease melanoma mortality by 63% [11] and a 2003 study found that regular Self Skin-Examination (SSE) could significantly reduce the likelihood of a tumour >1 mm thick at diagnosis [12]. It has been suggested that early detection is one factor influencing the disparity between urban-rural survival rates, but other aspects such as access to health services, clinical practices and medical care management need to be taken into consideration to fully evaluate survival rates, especially after an initial diagnosis and treatment for CM [13].

In 2017, the Australian Institute of Health and Welfare estimated that 14,000 new melanoma cases would be diagnosed. However, there are only 775 registered dermatologists in Australia (only 260 of which are melanoma specialists), and very few of them are easily accessible to people living in rural and remote areas (Australian College of Dermatologists, 2017). There are several infrastructure, cost and access limitations which impact on the provision of
health services for people. This is further compounded by the lack of training for future dermatologists and GPs in remote areas.

It has been suggested that technology-based training and telehealth could help combat this disparity by bringing health services to rural and remote areas [14]. A number of studies have evaluated the benefits of e-health and the level of acceptance for digital intervention in the early-detection of cutaneous melanoma [15-17]. Benefits of telemedicine and tele-dermatology include increased access to healthcare services, reduced travel and waiting times and cost-effectiveness [16]. A 2006 study reported that patients prefer telemedicine if it can provide quicker access to their physicians. However, a qualitative review found that patients’ attitude toward technology is only positive if the tool is personalised and adapted to the recipients’ needs and characteristics [15]. In addition, available evidence suggests that telemedicine is not only beneficial for patients, but for Healthcare professionals (HCP) too. A prior study reported that General Practitioners (GPs) appreciate using tele-dermatology when they need to refer to dermatologists’ expertise in order to obtain a second opinion [18].

In order to structure post-treatment plans, physicians must refer to the Clinician Guidelines. A recent study showed that clinicians working with rural populations are less likely to properly apply guidelines when it comes to educating patients towards surveillance and supportive care [19]. For example, patients living in rural areas were less likely to be provided with patient education material (86% compared to 89% in urban areas) or encouraged to conduct SSE (86% compared to 81%). There are also concerns that oral educational information provided by clinicians may not be effective, with a recent study finding that only 5% of melanoma patients were able to correctly reproduce all four key characteristics of their tumour [20]. These results suggest a need for better quality and greater consistency in providing information to patients.

An area of post-treatment care that is often neglected across all populations is psychosocial support. Psychological distress, including worry, anxiety and fear for disease recurrences and death, are common for survivors [21-22]. However, only 1% of specialists suggested patients see a psychologist as part of their post-treatment plan, despite an entire chapter of the clinician guidelines being devoted to psychosocial issues related to melanoma.

Although reviews have evaluated the effectiveness of technology for melanoma early detection, no studies have directly highlighted the benefits of e-health on melanoma post-treatment care for rural communities. Qualitatively researchers have examined the different forms of treatment and care between rural and urban populations [23] and the care needs among rural cancer patients [24]. However, these studies did not focus on melanoma post-treatment care.

It is unclear from the published literature the level and utility of technology support available to patients with melanoma living in remote areas. The primary aim this systematic review was to examine how technology is currently used and accepted by physicians and patients with melanoma, and to determine if there has been any implementation of such systems in rural and remote areas of
Australia. With this focus, the researchers seek to identify areas of weakness and bring to light hypotheses on how technology could be used as an adjunct service during post-treatment care of CM, to aid physicians in designing follow-up care plans for patients with CM based on their needs and personal characteristics.

Methods

Databases and Search strategy

The overall aim of this systematic review was to investigate digital health acceptance and its current use among people treated for melanoma. Our primary aim was to better understand digital health benefits among rural and remote populations for CM. However, given the impact of CM across all of Australia’s population, literature around digital health and CM that impacted urban and regional areas was incorporated as well. This was done to ensure broad inclusion of digital health practice for CM post-treatment care. The databases selected were searched using keyword combinations related to digital health and melanoma post-treatment care as outlined in Table 2. For the current systematic literature review, four databases (PubMed, Medline, PsycInfo, Scopus) were searched in March 2018.

Table 2. Databases search strategy

<table>
<thead>
<tr>
<th>Keywords combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (telehealth OR telemedicine OR teledermatology OR &quot;online services&quot; OR ehealth OR e-health OR eHealth) AND (Melanoma)</td>
</tr>
</tbody>
</table>

Study selection

The search was limited to peer-reviewed papers. Search results identified 451 papers which were exported in a excel document. After duplicates were removed, 271 articles remained.

The search strategy involved two screening phases. Each article was screened based on exclusion criteria to remove irrelevant articles from the initial selection of 271 articles. For the second phase, only studies that were based on empirical evidence and used a patient-centric approach were retained for the final systematic literature review. Figure 1 presents the selection overview based on the PRISMA flowchart.

Figure 1. PRISMA flowchart of the systematic literature review
Data extraction
Data was extracted from the relevant papers using the following classification: (1) Sources (country, year of study intervention), (2) participant characteristics (gender, residential area, mean ages, patient illness conditions, level of education, socioeconomic background), (3) study design, (4) study intervention, and (5) research focus (Multimedia Appendix 1).

Results

Origin
Two of the studies were from Scotland, with the others from The Netherlands, Canada and US. All studies were from before 2015 except for the study from The Netherlands, which was from 2016.

**Participant characteristics**

Four of the studies consisted of patients with melanoma only. The remaining study recruited patients with a history of melanoma and psoriasis, or collateral cancer. A majority of the authors referred to the patient’s illness condition in their sample description. The gender distribution of studies was mostly homogeneous (47% to 60% of males) and the mean age range was 53 to 66 years of age. None of the studies used ‘residential area’ as an independent variable. Two studies used residential area as a patient characteristic, but did not mention it in their findings. Two studies reported socioeconomic criteria in their findings and three featured level of education.

**Study design and intervention**

Before investigation, all published research informed participants of the objectives of the studies. Three of the five studies were qualitative and used semi-structured interviews either face-to-face or over the phone. The interviews were recorded by the researchers, transcribed verbatim, coded and reviewed by one or several co-researchers in order to cluster by themes/concepts of the participants’ answers. The quantitative studies assessed the perception and preferences of dermatology patients about the use of technology for self-monitoring and TSSE [15], a web-based platform (OIN™) to deliver information about melanoma [16], and store-and-forward tele-consultation [25]. The latter used a Willing-To-Pay (WTP) approach in order to investigate dermatology patients’ preferences. One study used both qualitative and quantitative methods to assess the feasibility and acceptability of a digital intervention for self-monitoring and the participants’ attitude to perform TSSE. Another quantitative study used an online questionnaire in order to capture participants’ knowledge of melanoma and TSSE, and their preferences. Figure 2 displays the study design distribution with regards to the research main focus areas.

Figure 2. Distribution of the papers according to the study design and the main focus area
Research focus areas

Table 2: Direct outcomes on post-treatment care per type of intervention

<table>
<thead>
<tr>
<th>Direct Outcomes for:</th>
<th>Type of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TSSE – Positive findings</strong></td>
<td></td>
</tr>
<tr>
<td>Provides reassurance to patients [15]</td>
<td>Report sent by phone to clinicians including photographs; Self-monitoring supportive tools</td>
</tr>
<tr>
<td>Convenient: Avoids in-person clinical visit if not necessary [15]</td>
<td>Report sent by phone to clinicians including photographs;</td>
</tr>
<tr>
<td>Reduces the number of people who might forget about TSSE [15]</td>
<td>Reminder sent by text message or email</td>
</tr>
<tr>
<td>Promotes early detection [15]</td>
<td>Report sent by phone to clinicians including photographs;</td>
</tr>
<tr>
<td>Behaviour change: empowers patients’ confidence to perform TSSE [17,25]</td>
<td>Self-monitoring supportive tools; YouTube videos explaining how to perform TSSE</td>
</tr>
<tr>
<td>Reinforces TSSE [17]</td>
<td>Self-monitoring supportive tools</td>
</tr>
<tr>
<td><strong>TSSE - Negative findings</strong></td>
<td></td>
</tr>
<tr>
<td>Topic</td>
<td>Findings</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
</tr>
<tr>
<td>HCPs based their opinion on pictures only [15]</td>
<td>Clinicians’ feedback sent by text message or email</td>
</tr>
<tr>
<td><strong>TELE-CONSULTATION – Positive findings</strong></td>
<td></td>
</tr>
<tr>
<td>Convenient:</td>
<td>Skype or tele-conference, store-and-forward tele-medicine</td>
</tr>
<tr>
<td>- Reduces travel and saves time [15,17]</td>
<td></td>
</tr>
<tr>
<td>- Quick access to Clinicians [15,25]</td>
<td></td>
</tr>
<tr>
<td><strong>TELE-CONSULTATION - Negative findings</strong></td>
<td></td>
</tr>
<tr>
<td>Patients’ desire to discuss F-2-F with clinicians [15]</td>
<td>Skype or tele-conference</td>
</tr>
<tr>
<td>Patients’ skin required to be examined by clinicians [15]</td>
<td>Phone</td>
</tr>
<tr>
<td><strong>CLINICIANS’ SUPPORT AND COORDINATION – Positive findings</strong></td>
<td></td>
</tr>
<tr>
<td>Accuracy in the diagnosis [15]</td>
<td>Three-way consultation via a video or Skype link from the GPs’ room</td>
</tr>
<tr>
<td>Convenient: Time and travel saved [15]</td>
<td>Remote point of contact: nurse specialist’ opinion to be provided via store-and-forward system</td>
</tr>
<tr>
<td><strong>CLINICIANS’ SUPPORT AND COORDINATION – Negative findings</strong></td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>INFORMATIVE AND SUPPORTIVE DISPLAYS – Positive findings</strong></td>
<td></td>
</tr>
<tr>
<td>Promotes early detection [15,16]</td>
<td>Web-based app tailored information delivered about their own conditions; Skin map</td>
</tr>
<tr>
<td>Reduces patients’ stress [16]</td>
<td>Web-based app tailored information delivered about their own conditions; Skin map</td>
</tr>
<tr>
<td>Improves patients’ decision-making in treatment [16]</td>
<td>Web-based app tailored information delivered about their own conditions</td>
</tr>
</tbody>
</table>
**Ease of communication:**
- Content is more adapted to the patients’ level of understanding [16]
- Supporting oral/written information delivered to the patients [20]

| Reduce/control the content load [15,16] | Web-based app tailored information delivered about their own conditions |

### INFORMATIVE AND SUPPORTIVE DISPLAYS – Negative findings

- Don’t want to be associated with other patients. Makes them feel sicker than they are [15]
  - Online peer support (i.e. Forum, group chat)
- Do not replace the oral and written information provided by clinicians [20]
  - YouTube videos explaining how to perform TSSE

### Discussion

**Principal Results**

The primary aim of this review was to identify the different use of digital health for melanoma post-treatment care, including its benefits and weaknesses. Patients perceived digital health as an added value to their post-treatment care [15-17,20,25]. However, a majority of the studies reported the benefits of digital interventions to prevent recurrence and promote early detection [15-16,20]. None of the selected studies investigated the benefits of digital health for melanoma post-treatment care in rural and remote areas. This gap in the digital health literature gives thought to a very specific niche in telemedicine that needs to be explored further, given this is an at-risk population [3]. Thus, it is crucial to understand how digital health could help clinicians to provide better care and quality of life (QOL) for people treated with melanoma, especially in regions where after-care resources are limited or non-existent, such as in rural and remote areas of Australia.

**Patients’ individual characteristics**

The current review found some evidence for the efficacy of digital interventions for melanoma post-treatment care. Key findings identified that clinicians need to take into consideration patients’ individual characteristics in order to provide personalised follow-up plans, tailored information and quality of care [15,25]. It is clear that IT capabilities, patient age, illness condition, level of incomes and residential areas influence clinician and patient decision-making in the post-treatment plan. One study by Hall and Murchie found that participants who were familiar with technology and not living close to hospitals, were more likely to
have a positive attitude toward telemedicine for self-monitoring and performing TSSE [15]. Querish and colleagues also reported that 73% of the participants are more willing to pay when telemedicine was giving them faster access to the clinicians. Among this sample, 55% had an income inferior, or equal to US$50,000 p/a [25]. Other studies that investigated consumers’ perception toward tele-medicine found that people with ‘technology anxiety’ were less likely to use technology for specific care [26]. In contrast, young populations may be more inclined to trust digital health interventions, as they are more familiar with technology [27].

**Patients’ acceptance**

In order to efficiently use personal consumer technology in melanoma post-treatment care, it is crucial to understand patients’ acceptance toward digital intervention. Several of the studies reviewed illustrated a shift from ‘passive’ recipients to ‘active’ patients for their own care [16], which led to proactive health behaviour change and positive attitudes toward early-detection. Simple measures such as receiving a reminder to perform TSSE by text message or email, having access to informative videos, or using smartphone apps for self-monitoring, reduced anxiety and reinforced TSSE [15,17,20]. These technologies could also be used to address the need for better quality and greater consistency in information provided to melanoma patients [20].

The study by Quereshi and colleagues reported that patients’ attitude toward telemedicine was generally positive if it showed convenience (58% well willing to pay up to US$125P), but almost universally positive if it gave a quicker access to their clinicians (95% of the patients were willing to pay up to US$500) [25]. The study by Horsham and colleagues emphasised that survivors showed positive attitude towards a digital health application that allowed them to monitor quality of life and provided tailored information and advice [27].

While these findings demonstrated that patients were generally receptive toward digital health for melanoma post-treatment care, no studies to date have focused on rural and remote communities’ views. Nevertheless, a few studies have already highlighted people’s acceptance toward telemedicine in Australian rural and remote communities for cancer more broadly. In their studies, Sebesan and colleagues reported the benefits of tele-oncology in rural and remote areas for cancer care [28-29]. The main benefits of this telehealth system included travel time saved and better access to specialist care. In addition, studies have shown that telehealth may lead to financial benefits and improved quality of care in distant communities [29-30].

**Patients’ psychological and social needs**

In this systematic review, there was a lack of empirical evidence with regards to the benefits of digital health for support and psychological care services, in order to provide better QOL. These studies mainly focused on early-detection, including self-monitoring and TSSE. However, a previous systematic review suggested that 30% of patients with melanoma reported psychological distress [31], which interfered with QOL, medical cost, risk of recurrence and mortality rates [32-33].
Likewise, Oliveria and colleagues found that patients treated with melanoma showed direct psychosocial concerns related to conducting skin self-examination; anxiety associated with new recurrence and sun exposure; familial concerns; financial constraints and maintenance of health insurance benefits [34]. Emotional support and reassurance is considered a key component of care [31-37], with psychological intervention associated with superior survival and recurrence rates, and decrease of distress [36]. Clinicians should therefore take into consideration the psychosocial impact on patient outcomes when designing post-treatment plans.

**The economic burden of melanoma treatment in Australia**

Melanoma early detection reduces mortality rate and results in simple treatments for lower cost [38]. A 2017 study [2], estimated the mean cost to the Australian health system for melanoma treatment to be AU$10,716 per patient. However, treatment cost for advanced melanoma may be 21% to 70% more expensive than for early stages (in-situ, stage I & stage II). Doran and colleagues compared the direct and indirect costs of melanoma and non-melanoma skin cancer (NMSC) in 2010 [39]. The direct costs related to the management of the disease, including diagnosis and treatment to follow-up, and indirect costs included productivity losses associated with morbidity and premature mortality. Estimates of direct lifetime cost per case were AU$10,230 for melanoma and AU$2,336 for NMSC; and total indirect cost per case AU$34,567 for melanoma and $123 for NMSC.

Moreover, additional studies have reported an urban-rural disparity in term of accessing health care and mortality rate [13,23]. Yu and colleagues reported that socioeconomic factors may impact people’s decision-making in selecting their healthcare provider [23]. The study showed a difference in provider performance based on patients’ income. Rural populations with lower-income received poorer care from HCPs, compared to patients living in urban areas.

The comparatively lower cost of delivering support care services via digital health initiatives, in addition to reduced treatment costs associated with promoting early detection [14-16] would go some way to improving access to health care and reduce urban/rural inequity.

**Limitations**

This systematic literature review presents several limitations. First, most of the studies used small samples (n≥20). It is evident that digital health research regarding melanoma post-care treatment is still in its early stages of investigation. Second, few studies were identified as focusing on the psychosocial and health economic side of post-care treatment, as melanoma studies are primarily focused on early-detection, and those that did used retrospective measurement of consumer attitudes towards telemedicine. Third, melanoma treatment plans depend on individual characteristics, including the disease staging. Only one of the studies used staging as a participant characteristic. Finally, although the authors were primarily interested is rural and remote areas of Australia, the lack of studies conducted in these areas meant that studies for this review were drawn from across the world, and their conclusions may not necessarily generalise to the Australian rural and remote context.
Overall, the current systematic review provides findings about patients’ perceptions toward telemedicine and digital interventions already used by clinicians and patients. However, in order to have a complete review of digital health benefits for melanoma post-treatment care, it would have been necessary to look at HCP’s acceptance toward such technological interventions.

Conclusion
The study of digital health has become an area of focus in primary health care, as it can help clinicians in their practice and support patients in improving and monitoring their quality of life. While there is research interest in using digital health in early detection of melanoma, there is an urgent need to explore the potential for benefits of digital health in melanoma post-treatment care for specific needs and intervention, particularly for rural and remote populations who are lagging behind in terms of post-care treatment quality and availability. This current literature review also highlights the importance of considering individual, psychosocial and socioeconomic characteristics in future developments in this area.

Although our findings showed positive outcomes with regards to using technology during post-treatment care, there were also some limitations in using digital health. Patients believe that technology can’t replace clinician provided written and oral information, follow-up visits, or clinical interventions [20]. To summarise, digital health shows potential to be used as an adjunct service by clinicians during melanoma post-treatment care, especially in regions that are lower-resourced by practitioners and health infrastructure, such as regional and remote Australia.

Implication for further research
Future research needs to explore the potential for digital health within rural and remote areas for melanoma post-treatment care in order to reduce the mortality rate disparity in between urban and rural population. In addition, it will be interesting to consider how digital health implementation may transform the patients’ ecosystem, and the cost-effectiveness of this solution for both patients and the healthcare industry.

Interdisciplinary studies in behavioural psychology and health economy can add new insights to the healthcare industry in term of benefits and services that digital health can bring to melanoma patients care in rural and remote areas.

Acknowledgements
We would like to thanks Dr. John Turner for advising on research methodology.

Conflicts of Interest
N/A

Abbreviations
ACD: Australian College of Dermatologists
AJCC: American Joint Committee on Cancer
Appendix 1: The consumer-technology relationship and digital interventions for melanoma post-treatment care.

References


22. Bird J, Coleman P, Danson S. Coping with melanoma-related worry: a qualitative study of the experiences and support needs of patients with malignant melanoma. Journal of Clinical Nursing 2015 Feb; 24(7-8): 937-


35. Fischbeck S, Imruck BH, Blettner M, Weyer V et al. Psychosocial care


