eHealth in Wound Care

From conception to implementation

A joint document

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United4Health

Healing Wounds Together

AWMA Australian Wound Management Association Inc. National

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Executive summary

Purpose

This document aims to provide wound care clinicians with a rapid and structured overview of the key issues related to use of eHealth applications (telemedicine and telehealth) within wound care. This includes:

- An overview of terminology and available literature
- Guidance on the methodology for evaluation of eHealth solutions
- An introduction to and discussion of the potential benefits of eHealth technologies in wound care, and the possible barriers to their implementation
- Recommendations for ensuring a good implementation process and supporting involvement of wound care professionals in safeguarding that eHealth solutions meet the needs of the patients.

Methodology

The document sections lean on the structure and focus areas of the Model for ASsessment of Telemedicine (MAST) which defines crucial items to evaluate an eHealth application.

The content of the document is developed on the basis of a literature review, identifying available documentation for use of eHealth solutions in wound care. Furthermore, it draws on various key documents recently published on the general development, evaluation and implementation of eHealth solutions. These include valuable up-to-date information relevant for any group of clinicians wishing to follow and influence the way eHealth solutions are integrated into clinical practice.

Findings and conclusions

The literature review revealed that the amount and level of evidence for use of eHealth applications in wound care is still limited. Some MAST domains are not examined in any of the available studies. Thus, more research is required to identify the potential benefits and harms to patients, and the possible challenges related to implementation of eHealth solutions in wound care.

Potential barriers and facilitators for the implementation of eHealth applications into wound care practice are identified in the document, and these may all either enhance or impede the process. However, the available research does demonstrate patient satisfaction, improved access to health services for all client cohorts, and increased job satisfaction for clinicians.

The document recommends that wound management clinicians, considering the use of eHealth applications in their clinical practice, consult widely and conduct regular evaluation of the outcomes to ensure efficient implementation of these services.

To support this approach, steps to ensure a good implementation process within a given organisation have been proposed. These are synthesised into a three circle model.

Abbreviations used in the document

- CHF: Chronic heart failure
- COPD: Chronic obstructive pulmonary disease
- EWMA: European Wound Management Association
- EU: European Union
- HRQoL: Health related quality of life
- ICT: Information and communication technology
- MAST: Model for ASsessment of Telemedicine
- RCT: Randomised clinical trial
- WHO: World Health Organization

Chapter 1: Background and aim of the document

Today, changes in population demographics, an increasing number of individuals with multiple comorbidities[1] and lack of human capital within the health-care setting, represent new challenges for health-care systems. These call for services that provide less expensive and more efficient ways of delivering health interventions.[2] The European Commission encourages the development and implementation of eHealth solutions to solve these challenges throughout the world.[3]

Technology (for example, electronic records, tele-translation and tele-electrocardiograms) has already become an integrated part of health-care system. Today an increasing number of technical solutions and new ideas for using and sharing data are developed in all areas of health care.[4,5] These include, but are not limited to, systematic medical treatment guidance in patients with heart conditions,[6] general aspects of diabetes mellitus care,[7] and management of individuals with COPD.[8]

Within wound care, tele-consultations via video or sharing digital photos support access to expertise in remote areas.[9,10] These have been introduced as a solution to support cross-sector communication and task shifting from hospital-based experts to community care staff.[11,12] A variety of new options for eHealth-supported wound assessment (for example, portable devices for wound evaluations) are already available and under continuous development.

As expected, given the diversity of health-care settings using eHealth solutions, the development, introduction and evaluation of this approach to health-care delivery is not homogenous.[13] This provides challenges for those wishing to embrace the concept of eHealth, as the lack of a uniform approach hinders understanding of the strength of evidence to support the use of eHealth solutions.[14] This challenge is not unique to eHealth, it is reflected in the literature as being a challenge to the wound care world as a whole.[15]

When evaluating eHealth solutions, other aspects of their use, for example, organisational, economical, patient-related perspectives, and especially potential harm, must be evaluated in order to determine the real effect of the implementation of these technologies. The need for a consistent approach to evaluate eHealth solutions led to the development of MAST, which was made public in 2012. This model constitutes an evidence-based framework to evaluate eHealth applications in a structured manner, yielding valuable information for decision-makers.[16]

In light of the challenges facing health-care systems, coupled with the rapid development of new technologies presented as solutions, and the limited amount of high-quality evidence for the use of telemedicine and telehealth in chronic wound management,[17] EWMA has developed this document on eHealth in wound care.

The aim of this document is to provide clinicians who are interested in this subject with concise information about the use of eHealth solutions within a wound care setting. The objectives of this document are therefore to:

- Provide the starting point for a common language about eHealth in the wound-care community
- Support eHealth literacy of clinicians working in wound care
- Serve as a useful tool for clinicians to obtain a rapid and structured overview of the key issues, including the benefits of eHealth technologies and the barriers to their implementation in wound care
- Describe the role of wound-care clinicians in ensuring that eHealth services introduced for use in wound care support the needs of the patients and the clinical practice setting appropriately
- Provide wound-care clinicians with guidance on the evaluation of eHealth solutions
- Provide a simplified overview of terminology including examples of various type of applications and services relevant to wound-care provision

The document is primarily aimed at health professionals working in the field of wound care. However, it will also be of value to those outside the field, who are interested in understanding the value, potential challenges and evaluation methods related to use of eHealth solutions. Policy makers, wider service providers and industry may also find this document valuable as the clarity may provide insights into the use of eHealth solutions more generally.

Chapter 2: Terminology

The terminology used to cover the spectrum of eHealth solutions still lacks standardisation at a local and international level. Furthermore, the terminology employed is often used with different meanings and this makes it difficult to articulate clearly about the use of eHealth.[18]

Among the most widely used terms for health care employed by information and communication technologies (ICT) are:

- eHealth: The EU Commission defines eHealth as:

'The use of ICT in health products, services and processes combined with organisational change in health-care systems and new skills, in order to improve health of citizens, efficiency and productivity in health-care delivery, and the economic and social value of health. eHealth covers the interaction between patients and health-service providers, institution-to-institution transmission of data, or peer-to-peer communication between patients and/or health professionals'.[19]

This definition stresses that eHealth is about changes in the way health care is organised by use of ICT.

- mHealth: This term has been introduced in recent years and is defined as

'Medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices'.[20]

Within wound care examples of mHealth include wound apps offering guidance for wound care experts, private carers and patients, as well as portable devices.

- Telecare: Widely defined as 'a combination of alarms, sensors and other equipment to help people live independently' (primarily aimed at social care needs).[21]

- Telehealth: The use of equipment to monitor people's health in their own home. This term is linked to telecare and primarily used for monitoring of chronic conditions via recording of for example: blood glucose, blood pressure and heart rate.[21]

Within wound care, 'intelligent sheets' and dressings offering automatic monitoring of the wound condition or the patient's risk of pressure ulcer development, constitute examples of telehealth and telecare.

- Telemedicine: Defined as the remote exchange of data between a patient and health-care professional(s) to assist in the diagnosis and management of health-care conditions. WHO defines telemedicine as a solution for providing specialised health care to populations in remote areas.[18] However, today, telemedicine is also widely used to provide expert evaluations to larger groups of patients, thereby possibly saving resources in the health-care provider organisations.

Within wound care, telemedicine often refers to remote wound assessment or teleconsultations (supported by video or photography) supporting communication between community care staff and hospital based wound-care experts. The terminology used in the studies included in this document's review varies. Examples of the terminology include e-consultation, teleconsultation, telemedical visit, telemedical collaboration, store and forward telemedical system, mobile wound care and teleassessment. Most eHealth solutions used specifically within wound care support wound monitoring following a diagnosis made during a face-to-face meeting with the patient.

For the purpose of this document we will use the term eHealth when referring to the overall use of ICT in the health-care sector, and specifically in wound care. This document focus primarily on services that may be defined as telemedicine and telehealth (as described above). However, other eHealth solutions that used in connection with wound care include training of health-care staff by e-learning, internal management systems and electronic patient records. The more specific solutions referred to in the text will be clear from the context in which they are used.

Finally, it should be mentioned that the terminology used in this rapidly developing field is likely to be constantly changing, due to the influence of new technologies and structural changes in health-care delivery.

Chapter 3: The model for assessment of telemedicine (MAST) – evaluation of telemedical solutions

In 2009, a group of researchers were asked to develop a specific model for assessing telemedicine (MethoTelemed) and this led to the development of a multidisciplinary, systematic, unbiased and robust system named MAST.[16] This document describes the three steps in evaluating procedures, focusing on mature eHealth technologies to be introduced in the health-care services, targeting individuals with a variety of diseases. These steps include:

- Preceding considerations
- Multidisciplinary assessment
- Transferability assessment

Within the framework of multidisciplinary assessment, MAST includes seven domains that should be addressed during an evaluation. Fig 1 illustrates the content and structure of MAST.

MAST is based on the EUnetHTA Core Model.[22] The model has been tested in a number of studies, among those two European studies, the Renewing Health project (www.renewinghealth.eu) and the United4Health project (www.united4health.eu).

Fig 1. The content and structure of MAST (First published in Kidholm et al. 2012)[16]

Preceding considerations
- Purpose of the telemedicine application?
- Relevant alternatives?
- International, national, regional or local level of assessment?
- Maturity of the application?

Multidisciplinary assessment
1. Health problem and characteristics of the application
2. Safety
3. Clinical effectiveness
4. Patient perspectives
5. Economic aspects
6. Organisational aspects
7. Socio-cultural, ethical and legal aspects

Transferability assessment
- Cross border
- Scalability
- Generalisability

Adopting MAST to ensure comparable studies

In most of the available studies of eHealth solutions in wound care, a number of different aspects have been addressed, for example patient satisfaction and technical feasibility. A number of other domains have remained unaddressed.

The MAST methodology

The sections below describe in further details the three levels of MAST: Preceding considerations, multidisciplinary assessment and transferability assessment. These descriptions are based on the MAST introductory article by Kidholm et al. which can also be consulted for further information about the assessment method.[16]

Preceding considerations

First of all, it must be evaluated whether the eHealth application in question can be expected to lead to improvement in health care. The aim of introducing the new technology should be described, including considerations concerning the type of patients targeted and the primary outcome measures. It should also be clear whether the eHealth application will be compared with usual care or a different technology. Finally, it must be clarified whether the assessment concerns implementation on local level or large-scale deployment of the technology on regional, national or international level, as the different levels may introduce different types of challenges and opportunities related to the eHealth service.

When these initial considerations have been made, the model suggests that potential barriers are then addressed. Typical barriers to address include:

- Legal issues related to medical care provision: It must be evaluated whether the eHealth application conflicts with any national or regional legislation.
- Reimbursement structures: Diagnosis Related Groups (DRGs) refers to a reimbursement system adapted by a number of countries. It is common practice that telemedicine-based consultations have not been assigned a DRG tariff, and this may reduce the incentive to perform these services.
- Maturity: The available technology must be sufficiently mature (a tested and stable service) to be evaluated with the objective of ensuring validity and applicability.
- Number of patients: The assessment must include a specified and sufficient number of patients to be able to approximate the estimated costs to the real-life use of the technology.

Multidisciplinary assessment

When the preceding considerations have been made, the multidisciplinary assessment includes seven domains that must be addressed for a full evaluation of the telemedicine application. The seven domains include:

- **Health problem and characteristics of the application**

  This refers to a description of the health problems of the targeted population as well as an introduction to the technological platform and usability measures.
- **Safety includes aspects of risk induced to patients**

  These safety issues should include clinical safety as well as technical safety (technical reliability). Steady reporting of adverse events and an evaluation of patient risks should be carried out throughout the evaluation process.

- **The clinical effectiveness evaluation**

  This should include the effects on mortality, morbidity, quality of life and behavioural outcomes. It is suggested that this assessment be based on well-performed clinical trials using the PICO (patient intervention comparator outcome) criteria to assure that the same process is initiated every time a new technology is applied.
- **The patient perspective**

  The patient perspective refers to matters such as patient satisfaction related to the new technologies – for example, does it provide a realistic alternative for all patients or a certain subgroup, do patients have access to use the technology, and are they able to use the technology in accordance with instructions? Finally, the impact on patient empowerment should be evaluated.
- **The evaluation of economic aspects**

  This should include the development of a business case including expenditures per year, revenue per year, process, structure, culture, management, ethical issues, legal issues and social issues. The evaluation should include a comparison with the resources used in connection with existing (possibly more conventional) disease-handling methods and value for money with respect to clinical cost-effectiveness and QALYs (quality-adjusted life years).
- **The evaluation of organisational aspects**

  This should include a survey of the resources needed in relation to the implementation of the new technology, and the consequences the use of this may have within the organisation. The introduction of a new technology may, for example, reduce the workload of some groups of clinical staff, and increase the work of others, or it may include opportunities to shift tasks between different types of health-care staff or between sectors.
- **Socio-cultural, ethical and legal aspects**

  This refers to considerations regarding the socio-cultural affiliations that the targeted patients have, which may affect their ability to accept and use the new technology, and legal questions that may be relevant to handle in connection with the implementation of the new technology (for example, aspects of privacy, ownership and transfer of registered data), and the existing legal obligations or barriers to implementation.

Transferability assessment

Transferability assessment constitutes the third level of MAST. This is an important aspect to consider with regard to the potential use of the technology within other disease areas and geographical areas (e.g. other regions or countries/socio-cultural settings), as well as the suitability of the system for large-scale deployment (nationally or internationally). This evaluation should also include an assessment of the possible use of the technology in a system with a limited technological infrastructure. This part of the evaluation tests the technology within a broader context of the characteristics of the health-care systems and their ability to integrate and benefit from the eHealth solution in question. It should also be evaluated whether there are challenges or opportunities to be considered with regard to integration with other clinical or administrative systems (interoperability). These aspects may be crucial for the realisation of the potential benefits for patients and health-care institutions.

According to the needs of the product providers, technical solutions should be implemented as fast as possible. However, from the point of view of the health professionals and health-care organisations there is an absolute need for well-designed clinical studies, addressing all relevant aspects, before new technologies are implemented. It should be taken into consideration that study results may not always be applicable in different countries. Within the EU countries the infrastructure varies significantly and a solid technological platform will make a great difference when introducing a new technology, as opposed to low-income countries with limited technological infrastructure.[23]

It is clear that innovative research will provide a large number of new technical solutions for use in health-care systems. It is crucial that these solutions are thoroughly evaluated and that the implementation process is iterative, so that technologies can be adapted after thorough testing in a clinical setting. It is also important that we decide whether we aim to reduce mortality,

increase patient satisfaction, obtain savings in health-care costs or simply use telemedical solutions as another way of communicating within the health-care system or among individuals with comorbidities. To approach the evaluation of eHealth solutions in a standardised way, it is suggested that health professionals adopt MAST as a common model for future clinical studies within this field. The common platform for evaluating eHealth services in different settings will also allow recruitment of patients across borders and generate comparative studies.

Reliability and validity should be applied to every one of the seven domains of the multidisciplinary assessment by considering whether the outcome measures and data-collection methods included in a study will produce valid and reliable measures of the theoretical outcome you want to measure. With regards to the overall validity, the purpose of MAST is to provide information about the outcomes of telemedicine services that decision makers need to determine whether or not to implement the service. Basing MAST on the EUnetHTA core model supports this objective. MAST is based on input from a number of European decision makers. Results from studies on the validity of MAST are not yet available, but the fact that a number of regions in Europe have chosen it as the basis for their investments in telemedicine indicates that these decision makers find the model appropriate.

A number of telemedical solutions have been applied and tested within the field of wound care (Ssee literature review included in this document) but none of the evaluations of these technologies have so far covered all aspects proposed by MAST. Even though the method is cumbersome, it is mandatory that future studies are performed on the basis of this common platform to ensure comparability and transferability.

With regard to the study design, this should be appropriate to answer the research question(s) defined. Recent large-scale studies[24,25] have reported that restrictions on procedures in an RCT may be a challenge, as potentially inefficient procedures defined in the original trial protocol cannot be changed during the course of the trial. These experiences may be taken into consideration, but should not influence the aim, which is to produce evidence of the highest possible quality within this area.

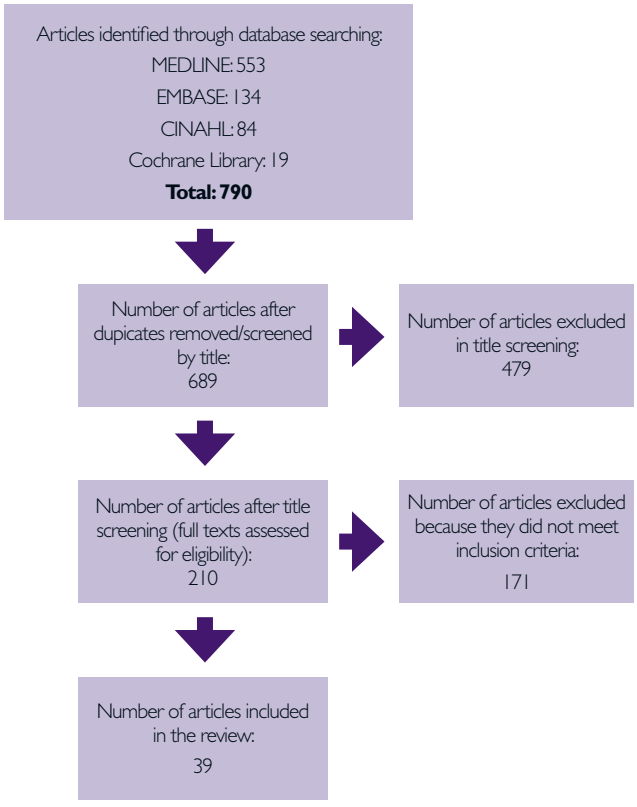
Finally, it should also be stressed that involvement of various types of expertise (economists, technology developers, sociologists etc.) and collaboration between all relevant groups of stakeholders, (health-care staff, management, health-care authorities and providers of eHealth solutions) is crucial for a successful development of sustainable eHealth solutions. To carry out a complete analysis according to MAST, all these types of competencies and perspectives should ideally be included.

Chapter 4: Literature review

Introduction

This review primarily includes studies of those eHealth solutions that have traditionally been used within the wound care domain, such as teleconsultations, which aim to provide remote areas or community care settings with hospital-based wound management expertise. It should, however, be mentioned that many new eHealth technologies for use in wound care have recently been introduced on the market or are being developed for the wound care market. It is therefore likely that new solutions will be implemented into clinical practice within the coming years, if their value for wound-care patients and health-care systems can be documented. These include devices such as intelligent sheets, tools for automatic wound diagnostics tools, risk-assessment tools, and hand held treatment devices, which may support wound-care treatment moving from a hospital setting to a community/home care setting.

Fig 2. Literature search - results



As mentioned in the terminology section, eHealth in wound care constitutes a 'moving target', and for this reason a repetition of this review is likely to be needed within a 2–3 year timeframe, to ensure that an update of the existing eHealth solutions, to provide the needed information for potential implementation of these solutions is available.

Search strategy

The objective of the literature review was to evaluate evidence of telemedicine as a method of delivering wound care as an alternative to face-to-face consultations, using the evaluation criteria defined by MAST.

Papers were included if they appeared in peer-reviewed journals containing original research published between 2000 and 2014. Reports, non-reviewed journals, book chapters, newspapers and websites were not included.

Table 1. Table of included studies.

Ref no	Author	*Year	Type of study	Country	Aim
45	Johnston et al	2000	Quasi-experimental	USA	To evaluate the use of remote video technology in the home health-care setting as well as the quality, patient satisfaction, and cost savings from this technology
33	Demiris et al	2003	Feasibility study	USA	To asssess if technical problems arise that could adversely affect the interaction with the patient during a telemedical visit. To examine the nature of the verbal interaction between the patient and the provider during a telemedical visit
41	Halstead et al	2003	Feasibility study	USA	To ascertain the percentage of agreement for teleassessment versus live responses to four yes/no questions regarding the need to change wound management, satisfaction with assessment, need for referral, and need for additional information
47	Kim et al	2003	Feasibility study	USA	To evaluate the clinical accuracy of a store and forward telemedicine system for assessing the status of different types of ulcers
26	Ameen et al	2004	RCT	UK	To evaluate the impact of expert teleadvice on nurses' knowledge
28	Baer et al	2004	Feasibility study	USA	To assess the agreement between the home care nurses and specialist nurses in the assessment and treatment of wounds
38	Finkelstein et al	2004	RCT	USA	To assess the benefits of using low-cost, standards-based telecommunications and monitoring technologies for health care in the patients home needing skilled home health care
48	Kim et al	2004	Feasibility study	USA	To explore patient attitudes toward a telemedicine system
55	Rintala et al	2004	Feasibility study	USA	To determine the technical acceptability of information available via a customised telerehabilitation system
57	Santamaria et al	2004	RCT	Australia	To examine the effect on clinical outcomes and costs of providing remote expert wound consultation using the Alfred/Medseed Wound Imaging System (AMWIS)
60	Wilbright et al	2004	Feasibility study	USA	To determine if the telemedicine management of foot ulcers is medically equivalent to on-site care provided at a diabetic foot programme

10	Clemensen et al	2005	Feasibility study	Denmark	To investigate the use of telemedicine to enable a visiting nurse (in the patient's home) to coordinate the treatment with experts at the hospital
54	Ratliff and Forch	2005	Feasibility study	USA	To examine the cost and time savings using telehealth for a group of older people with chronic wounds
56	Salmhofer et al	2005	Feasibility study	Austria	(1) To investigate the rate of accordance in the assessment of wound status by a specialist using teledermatology ('e-consultation' or 'e-visits') compared to the assessment by a physician performing face-to-face examination ('live consultation' or 'live visits') (2) To investigate-adverse events such as bacterial infections or allergic contact dermatitis can be confidently diagnosed by e-consultations (3)To investigate if the quality of the electronically transmitted images is sufficiently high to enable the specialist to recommend further therapeutic strategies with confidence
34	Dobke etl al	2006	Feasibility study	USA	To determine the effectiveness of electronic communication for diagnostic and therapeutic plan development purposes
44	Hofmann-Wellenhof et al	2006	Feasibility study	Austria	To examine the feasibility and acceptance of teledermatology for wound management of patients with chronic leg ulcers by home care nurses
49	Larsen et al	2006	Feasibility study	Denmark	To find out whether a universal mobile telephone system was a feasible technology for telemedical collaboration between hospital experts and visiting nurses in connection with the treatment of diabetic foot ulcers
30	Binder et al	2007	Feasibility study	Austria	To examine the feasibility and acceptance of teledermatology for wound management for patients with leg ulcers by home care nurses and evaluate the reduction of costs and the acceptance of teledermatology by patients and home care nurses
42	Hammett et al	2007	Feasibility study	USA	To explore the feasibility and usability of a web-based system for remote wound care consultation in long-term care
61	Wilkins et al	2007	Feasibility study	USA	To evaluate the feasibility of a web-based telemedicine programme for remote wound care team consultations for patients with chronic wounds
27	Assimacopoulos et al	2008	Feasibility study	USA	To investigate the efficacy of telehealth technology in providing timely, efficient, and prudent infectious disease care for rural patients
32	Car et al	2008	Systematic review	N/A	To examine the impact of eHealth on the quality and safety of health care
35	Dobke et al	2008	RCT	USA	To evaluate the impact of the telemedicine consultation on patients with chronic wounds
29	Barrett et al	2009	Feasibility study	Australia	To describe the systemic barriers encountered when implementing a telehealth program in rural Western Australia and provide recommendations for future telehealth initiatives
58	Terry et al	2009	RCT	USA	To evaluate the effectiveness of telemedicine using digital cameras for treating wounds in a home-scare setting

51	Martínez-Ramos et al	2009	Feasibility study	Spain	To analyse the efficacy of the GPRS mobile phone–based telemedicine system used to assess local surgical wound complications during the postoperative course of patients
52	Pirris	2010	Feasibility study	USA	To examine the use of digital pictures taken with patients' cell phones for home wound care
36	Dobke etl al	2011	Feasibility study	USA	To evaluate primary care physicians' attitudes towards telemedicine and determine their satisfaction with telemedicine consultation for patients with problematic wounds
43	Hazenberg et al	2012	Feasibility study	The Netherlands	To assess the feasibility of using a photographic foot imaging device (PFID) as a telemonitoring tool in the home environment of patients with diabetes who were at high-risk of ulceration
9	Summerhayes et al	2012	Feasibility study	UK	To explore the impact that the leg ulcer management tool system had on conventional leg ulcer care
37	Farook et al	2013	Feasibility study	UK	To determine the influence of telemedicine on management of facial lacerations in children
39	Friesen et al	2013	Feasibility study	Canada	To receive feedback on the design and functionality of an mHealth application for pressure ulcer documentation, with the objective to assess the caregivers' experiences in using the wound care app
53	Quinn et al	2014	Feasibility study	Ireland	To examine the feasibility of using mobile phone technology to decentralise care from tertiary centres to the community, improving efficiency and patient satisfaction, while maintaining patient safety.
59	Vowden and Vowden	2013	RCT	UK	To evaluate the effectiveness of a telehealth system, using digital pen-and-paper technology and a modified smartphone, to remotely monitor and support the effectiveness of wound management in nursing home residents
31	Brewster et al	2014	Systematic review	N/A	To investigate factors affecting frontline staff acceptance of telehealth technologies
46	Khalil et al	2014	Feasibility study	Australia	To describe the steps needed for the successful implementation of the Mobile Wound Care system
40	Gagnon et al	2014	Feasibility study	Canada	To document nurses' perceptions regarding the influence of ICT, including telehealth, on their practice and, eventually, on their recruitment and retention in remote or outlying regions
50	Mammas et al	2014	Feasibility study	Greece	To evaluation of feasibility and reliability of Mobile-Telemedicine Systems in the remote prevention of diabetes related complications
17	Nordheim et al	2014	Systematic review	N/A	To assess the effect of telemedicine follow-up care on clinical, behavioural or organisational outcomes among patients with leg and foot ulcers

* official publication year

The review focused on evaluation of wound care provided or monitored by a telemedical solution. The review included all types of clinical studies in the field of telemedical intervention aimed at chronic wound care. The search terms included eHealth related terminology (telemedicine, eHealth, mobile health and text word variations) combined with wound-related terminology (wound, ulcer, diabetic foot ulcer, leg ulcer and pressure ulcer and text word variations). All other types of emergency injuries (for example burns) and studies with teleradiology or other non-wound related assessments were excluded. Information about the search criteria is provided in appendix 1.

After title screening and assessment based on the inclusion and exclusion criteria, 39 papers were included in the review (Fig 2),[9,10,17,26–61] these are shown in Table 1.

Synthesis

Type and geographical location

Of the 39 studies considered during review, the majority (n=29) were feasibility studies descriptively designed to evaluate a singular eHealth initiative. Of the remainder, there was one quasi-experiment, six RCTs and three papers detailing systematic reviews. In terms of geographical location of the studies, 20 were from North America (USA 18, Canada 2), 13 from Europe (Austria 3, Denmark 2, Greece 1, Ireland 1, Spain 1, The Netherlands 1, UK 4), and 3 from Australia with the 3 systematic reviews being unclassifiable.

Health-care setting

The most common setting and patient population targeted by eHealth studies, perhaps unsurprisingly, was the home care setting (15 studies). This was followed by long-term care settings (5 studies) and outpatients clinic (5 studies), acute care (4 studies), GP care (2 studies), rehabilitation care (1 study) and 4 studies which targeted multiple care settings. It is clear from this that work in this area concentrates on care at home or care in the community in an attempt to use eHealth to keep people with wounds in their own environments.

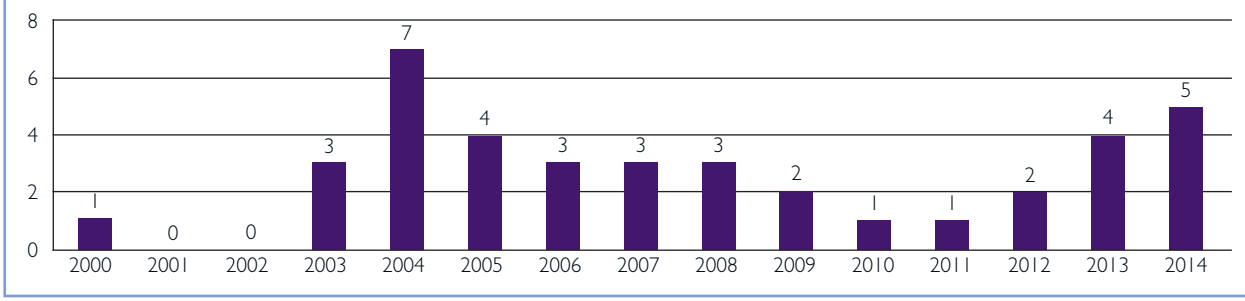
Year of publication

The studies ranged from 2000 to 2014. Fig 3 demonstrates a peak in studies on wound care and eHealth in 2004, and a growing number of studies emerging in the last two years.

Type of wound involved in study

The most common types of wound addressed by eHealth strategies were chronic wounds (n=8), leg ulcers (n=7) and diabetic foot ulcers (n=6). Surgical wounds were the focus of 3 studies and

Fig 3. Number of articles by year of publication



pressure ulcers in 2. The remaining studies (n=13) dealt with different types of wounds and did not specifically state the type of wounds, or the wound was unclassifiable. The high numbers dealing with chronic and often long-term wounds such as leg ulcers and diabetic foot ulcers ties in with the tendency of eHealth strategies being targeted at home care and community care.

Participants and sample sizes

In the majority of cases the target for intervention and measurement of effect were patients (28 studies), while 10 studies targeted health professionals. In terms of health professionals, nurses were the most common target (n= 6). There were 2 studies[33,35] targeting both patients and health professionals. The 3 systematic reviews[17,31,32] were unclassifiable in this regard. Studies targeting health professionals concerned educational interventions or the collection of evaluative feasibility data. Table 2 displays the range of sample sizes and total numbers involved in all studies. This indicates that, to date, well-powered studies have not been carried out in this area.

eHealth solutions

The vast majority of the eHealth interventions described in the reviewed research articles were what could be termed teleconsultations. For the purposes of classification we understand teleconsultation to mean the transmission of images and/or data to enable treatment to be prescribed and monitored. Teleconsultations were further subdivided by being either synchronous or asynchronous, with some studies describing both. A small number of studies described other eHealth solutions (Table 3).

Aims of the reviewed studies

Common themes also emerged in assessing the main aims of the studies. Reflective of the fact that most of the studies involved are feasibility studies, the main aim in many was to ascertain whether or not the systems adopted, worked. Other common aims were to ascertain patient or practitioner acceptance.

Table 2. Sample sizes and total numbers involved in all studies.

	Health professionals (10 studies)	Patients (28 studies)
Participant range	Minimum 5	Minimum 3
	Maximum 38	Maximum 145
Total number	143	1417

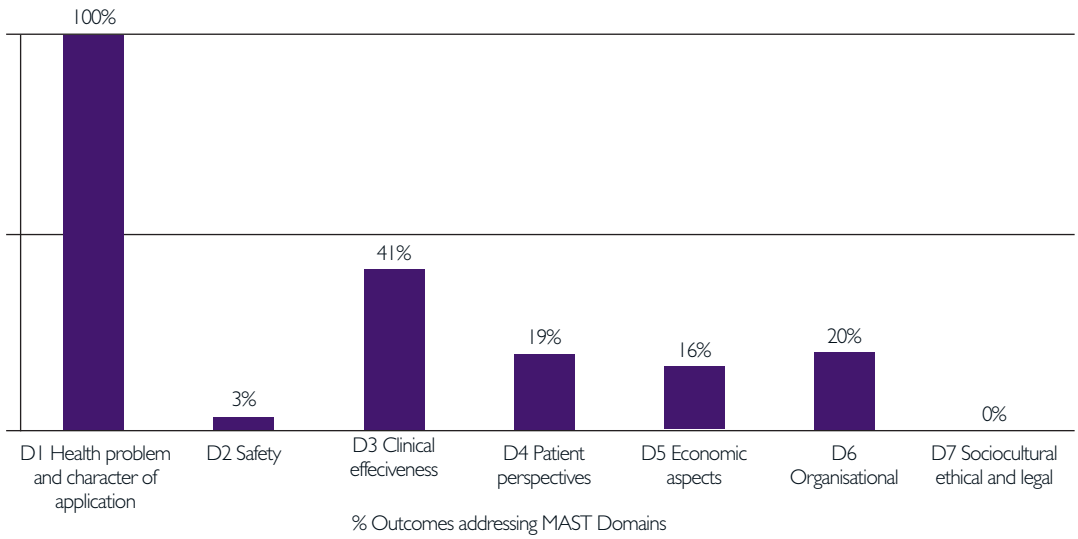
Table 3. eHealth solutions and numbers of studies.

eHealth solutions	No. of studies
Teleconsultation – synchronous Real-time data transfer allowing the patient to take active part in the consultation	15
Teleconsultations – asynchronous Patient data transmission via email or patient record system	12
Teleconsultations – both Email and telephone/video-conference	7
Apps Supporting data transmission	1
Content management system Collection of a range of data about the nature of the wounds	1
Not classified	3

Nature of outcome measures and relationship to MAST

MAST provides a framework to assess the different outcomes and aspects of the specific telemedicine/eHealth applications. The studies reviewed for the purposes of this position paper were subjected to an analysis of their targeted outcomes using MAST in order to gauge whether the various areas of the model are being addressed. Fig 4 demonstrates the results of this analysis. Some papers address more

Fig 4. Nature of outcome measures and percentage relationship to MAST



than one outcome (total: n=68). Fig 4 illustrates the degree of inclusion of the various outcome measures in percentages of the overall numbers of measured outcomes. All of the studies (given the search strategy) fulfil the criteria of addressing a particular health problem or need, and having an eHealth application.

As can be seen from Fig 4, D3 (clinical effectiveness) is a frequently targeted outcome with D4, D5 and D6 attracting small amounts of attention. D2 (safety) is only targeted by one study[32] of those reviewed and D7 (sociocultural, ethical and legal aspects) is not examined.

Actual outcome synthesis

While a range of similar outcomes were measured and reported throughout all the studies reviewed, the methods used to measure and record outcomes were disparate, not allowing direct comparison of the findings. While this heterogeneity hampers comparison it is possible to identify trends that indicate the possible usefulness of eHealth applications used in wound care. These are reported below also under the MAST heading as appropriate.

MAST D1: Health problem and character of application

The outcomes relate in the main to the usability and technical quality of the application. Some other characteristics of applications are also reported in a small number of cases: technical quality was reported on positively in four cases[30,33,41,42], negatively in one case[29] and with no change/mixed in one case.[49] Usability was reported on positively in six cases.[10,39,50,53,55,59]

The literature confirms that the technological solutions needed to provide teleconsultations (as the primary topic of the identified studies) exists and are relevant for use in targeted patient populations. Furthermore, the existing literature base reveals no reason to doubt that eHealth solutions are relevant for use in wound care. In digital photos of wounds and web-based patient

information systems of wound care, eHealth is already omnipresent and is influencing patient pathways in different ways.

MAST D2: Safety

Only one study reported on safety[32] and this did not identify any major safety issues in relation to wound care.

This weak level of evidence found in the review is supported by a recent review on safety issues related to telemedical wound assessment published by the Canadian Agency for Drugs and Technologies in Health (2014).[62] A final conclusion on safety threats to the patients can therefore not be made. In the case of teleconsultations in wound care, risk factors are most likely to be linked with a decrease in the quality of the care, for example due to insufficient photo quality, or absence of the opportunity for the expert to smell and physically examine the wound. Potential risks need further evaluation in the case of eHealth applications where automatic monitoring of the wound condition may take place without involvement of health-care staff to assist the patient. In this case, safety issues are linked more directly to the functionality of the device in question. Thus, the question about quality and safety issues (is treatment/monitoring quality as good as in the case of face-to-face contact?) is definitely a crucial area needing further attention.

MAST D3: Clinical effectiveness

A total of 41% of outcomes were designed to measure clinical effectiveness in a number of different guises, for example, amputation rates, wound healing, use of antibiotics, hospitalisation duration, patient satisfaction and HRQoL. The most common measure of clinical effectiveness was the level of agreement between assessors in wound assessment using eHealth applications. These were all reported on positively (14 cases).[28,34,37,38,41,43,44,48,50–53,55,56]

The positive impact on the principle clinical measure, wound healing, was less definitive with three postive reports,[57,59,61] one negative,[58] and two showing no change.[17,60] Clinical outcomes other than healing, such as antibiotic usage and duration of hospitalisation were reported on positively in one case however overall patient survival was not found to be statistically different with or without the use of eHealth. Enhanced patient satisfaction with care delivery was reported in seven studies, however, a further study noted no statistically significant changes in HRQoL.

In conclusion, there is an acceptable amount of evidence available to support the idea that wound assessment using eHealth applications is clinically relevant. It should be stressed that most of the available studies are case-control studies, and that one RCT found prolonged healing time. Other clinical outcome measures (amputations, wound status, death) were reported to a limited degree and only with positive or neutral results. Factors such as an adequate assessment, pain reduction and improved HRQoL are also important markers of clinical effectiveness in wound management. Further documentation of effect on these areas would provide crucial information for defining whether this domain is covered by the applications evaluated for use.

Therefore, there is still a lack of high-quality evidence providing a proper basis for conclusions on the important aspects of clinical effectiveness. However, it should also be mentioned that use of eHealth in clinical practice indirectly supports performing studies. This is due to the fact thatconsistent data collections, made in connection with the registration of all patient data in shared databases by use of eHealth applications, provide a large data set available for study purposes. In the case where shared systems are deployed nationally this may provide valuable data about patient populations and treatments

across the country or even across national borders. These data may be used to plan health-care services and can potentially lead to increased efficiency and resource savings in health-care provision. This does, however, require that the use of the data is considered in the development phase, and that regulatory and data security issues are properly assessed.

MAST D4: Patient perspectives

Patient perspectives were reported on in 19% of outcomes reported. Patient satisfaction is the only reported outcome and is largely positive, with six positive,[10,35,38,47,51,61] and two mixed.[30,49]

In teleconsultations, which involve wound assessment by non-expert health-care staff in the presence of the patient, the equipment meeting the user requirements of the patient group, is not as important as it is in the case of telehealth solutions where the patient takes responsibility for use of the equipment. The level of patient empowerment and increase in health literacy also varies in these two cases. It should be mentioned that new technologies for measurement of various types of wounds and wound conditions are on their way to the market, and under development. It is likely this will lead to an increase in direct involvement of the patient and private care-givers in wound management. The patient perspective will therefore be increasingly relevant to evaluation, and the potential gains for increased patient empowerment are likely to increase.

With regard to the generally positive feedback from patients involved in the reviewed studies, it should be mentioned that the validity of the methods used to evaluate patient satisfaction levels is low level or flawed, as pointed out by previous reviews.[63,64] For example, it is not always clear whether the patients are evaluating the telemedicine solution specifically, or whether they evaluate the complete health-care service delivered.

MAST D5: Economical aspects

A small number of outcomes sought to measure economic aspects of the applications and again these were mainly positive, with six positive,[9,35,45,54,57,59] and one negative.[58] These related to overall cost of care delivery and in two cases the reduction in transportation costs as a result of the eHealth application.

It is, however, not clear whether factors such as a higher disease and/or comorbidity burden in the control groups, compared with the intervention group, may have influenced these results. Recent large-scale studies on use of telemedicine and telehealth solutions, such as the Whole Systems Demonstrator project in the UK[24] and the Pan-European Renewing Health project[25] have not found strong documentation on cost savings generated by use of telemedicine and telehealth within a number of different disease areas (primarily CHF, COPD, and diabetes mellitus). Findings in these studies are generally that treatment costs remain the same after implementation of telemedicine or telehealth solutions. They do, however, point out various reasons for the lack of cost savings. Primary reasons were found to be high costs to purchase of the equipment and that restrictions on procedures in an RCT prevent the staff members involved from changing the predefined procedures according to experiences made during the course of the trial. Thus, inefficient procedures have been continued despite the fact that these would probably have been changed outside the context of the clinical trial.

The relativity simple equipment and off-the-shelf software typically used for remote wound assessment, and the fact that most of the studies included in the review made for this document were not RCTs, could support the positive reporting on economic benefits in these studies. However, given the results from the large-scale trials, the relatively small sample sizes, and

the methodological insecurities of these studies, it can be concluded that the evidence needed to make final conclusions is lacking.

MAST D6: Organisational aspects

The main outcomes addressed with regard to organisational aspects relate to practitioner satisfaction with the eHealth application, with six reporting positively,[30,39,40,44,61] and two mixed.[36,42] Other outcomes related to time and organisational efficiencies (five reported positively,[10,26,41,53,59] and one mixed).[31]

These studies present largely positive reports on the practitioners satisfaction with the eHealth application as well as increased efficiency. However, other studies found major obstacles related to reorganisation of the work force.[29] A primary expectation for the organisational effects of eHealth implementation is that this would liberate staff resources or shift tasks between different groups of health-care staff.[23] In the case of teleconsultations, a primary objective may be to shift tasks from hospital nurses and doctors to nurses in the community care sector, liberating wound care expert resources in the hospitals, and increasing interdisciplinary collaboration and educating non-specialised groups of staff.[40] The review includes positive reports on these organisational effects.[10] It should, however, be stressed that a plan for reorganisation of the staff resources, including a staff training programme,[31] and an adaption of the patient pathway is crucial in ensuring efficient use of the resources liberated. This supports maximisation of the benefits of the use of new technologies. It is crucial that this process is led by clinical staff members with consideration of the patient situation.

MAST D7: Socio-cultural, ethical and legal aspects

No studies included in the review report on these aspects. The relevance of these issues will naturally vary, depending on demographic variation and cultural aspects, such as the level of trust in authorities. This may influence the level of acceptance from patients with regards to the registration and sharing of their health data. The fact that this has not been an outcome of any of the reviewed studies may indicate that it is not understood as a major issue, but it may also constitute one of the reasons for varying success rates for implementation of eHealth solutions.

Conclusion

This document does not include a systematic evaluation of the quality of included studies, and we therefore recommend that conclusions made on the basis of the literature review should be interpreted with this in mind. On the basis of the literature review conducted for this document, we conclude that the available evidence base for use of eHealth in wound care is weak, but that the reports are largely positive with regard to those aspects addressed. Many other relevant aspects remain largely untested, yet are integral components of health-care provision, such as clinical effectiveness and patient safety.

Despite this, remote wound assessment or teleconsultations are already used or evaluated for use in many countries (in some cases due to the need to provide wound care expertise to peripheral regions). This is not unique to eHealth, as many treatment strategies throughout history have been included in daily clinical practice without proper documentation of effect, primarily based on the fact that the strategies met the needs of the health professionals, the patients and the health-care system as a whole. However, the evidence base does of course remain a crucial aspect of ensuring best practice in health care, therefore this is an area that needs further investigations.

eHealth is a developing process that is only partly influenced by patients and health professionals, who are primary stakeholders of the strategies

applied for wound management in health-care systems internationally. Independent technical development and needs of the health-care organisations will have their own impact on the extent to which eHealth will be part of future clinical practice. It is therefore important that wound care clinicians and researchers engage in this field of research and provide the evidence needed to lead the way for implementation of eHealth solutions that take all relevant aspects into consideration. If eHealth solutions are implemented on a large scale without a proper evidence base for selection of appropriate patient groups and clinical objectives for these services, the potential gains may not be reached and patients may receive less than optimal treatment.

The following section of the document will provide an overview and discussion of aspects supporting or working against implementation eHealth applications in different clinical setting and geographical areas.

Chapter 5: Barriers and facilitators for eHealth

When practitioners and service providers look to introduce eHealth technologies they are often confronted by a confusing array of advice; the complexities of the devices, the infrastructure requirements and the best approach to user education. A rapid expansion of technological options and the need to 'future proof' any investment can result in health-care providers taking a conservative approach. This section explores the barriers and facilitators to the use of eHealth in an effort to help provide a framework for judicious decisions for effective implementation. The discussion draws from MAST and focuses on the patients, health practitioners, and services.

The patients

When examining the implementation of eHealth solutions the focus is often on the device or product. Viewing eHealth through this lens results in 'tail wagging the dog' outcomes. Care delivery systems may be changed to accommodate the needs of technology without demonstrable benefits for the patient. Cartwright et al.[65] found that patients suffering from COPD, diabetes mellitus, or CHF randomly assigned to a telemedicine care option for 12 months demonstrated no improvements in their quality of life or psychological outcomes. As there were no deleterious effects for the patient the authors concluded that these findings support telemedicine as a viable option to current care systems. However, it could be reasonably expected that the additional outlays and effort required to implement a telemedicine service should result in greater benefits to the patients than current systems, even though an alternative objective often is the need to provide more efficient health care.

Replacing face-to-face contact with patients

Designing eHealth systems to address unmet patient needs instead of focusing on technological requirements helps to ensure successful adoption of such systems.[66] For example, in contemporary health-care systems face-to-face encounters between patient and clinician usually require the patient to travel to a relevant clinic or consulting room. For chronic conditions, the frequency of such visits can be numerous. The associated impositions on the time and personal expense of the patient incurred by travel and time off work can be extensive. The use of remote consultations via eHealth technologies has the potential to enhance this system. The face-to-face benefit is retained while travel is not required, time is contained to the consultation only, and infrastructure such as waiting rooms and booking systems are not required. Indeed, teleconsultations provide very viable alternatives to 'therapies of interaction' such as counselling or health education.[67] However, if during the interaction there is a need to examine the patient for example,

via palpation, then eHealth technologies would be insufficient to meet the patient need. In this case, additional technology such as robotics or biosensors would be needed.[68] The current systems facilitate a wound management consultation by clinician–patient interaction and visual inspection of the wound.[69] However, detecting odour, examining the viscosity of wound bed tissue, or assessing the temperature of the periwound could not be performed. The rapid development of wearable and remote sensor technology may provide solutions for future consultation, but are currently outside the scope of most clinical services.[68] Contemporary eHealth services used in wound care rely on a clinician based with the patient to relay examination findings to the expert consultant. While this relies on clinicians with both the time to be with the patient during the consultation and the training in effective use of the technology, it does provide a solution to the contemporary eHealth technology limitations.[70–74]

The attitude of the patients

Another perceived barrier and facilitator towards eHealth services is the attitude of the patients. As the services have been primarily focused on the management of chronic diseases the age profile of the client is most often elderly,[75] and two common contentions are drawn from this fact. Many authors assert that the current cohort of elderly patients have been exposed to less technology throughout their life than younger contemporaries. The second is that because the client has had limited exposure to technology they will be reluctant or fearful to use it as a form of health-care assistance and consultation. Given the pervasive nature of communication technologies the first assertion is hard to support as the exposure of this client cohort can be very varied, limiting any generalisation. The second assertion is not supported by the literature. Most studies that have recruited clients defined as elderly report a high degree of adoption and satisfaction with the technology. A systematic review by Kuijper et al.[76] examined web-based interventions as a mechanism for stimulating patient empowerment. They reported a mean age for participants across the various studies of 60 years (SD 8.5 years) with an age range from 40 to 76 years. Of the 13 studies reviewed, a significant improvement in patient empowerment for the experimental group was found in four studies. An improvement for both control and experimental groups was found in three studies and mixed results in the remaining six studies. While not conclusive, these studies challenge the assertion that clients over 60 years of age will not adapt to eHealth as readily as younger clients. In fact, in some instances, the eHealth interactions are the only social interactions for some clients and therefore viewed very favourably. Furthermore, many of the so-called elderly citizens are already very familiar with use of ICT from their work and private life.

Work by Kim et al.[47] evaluated patients' attitudes towards a 'store and forward' telemedicine sys-tem. Patients with chronic wounds had digital images taken by a nurse in their home, the images were then forwarded onto to a physician who assessed them. Generally patients were satisfied with this form of consultation. However the authors concluded from the results that patients also believed that it was important to have a periodic face-to-face consultation. Indeed, Dobke et al.[35,36] introduced telemedicine before face-to-face consultations for patients with complex wounds and found that patient satisfaction was higher. Patients thought that they were better educated and had a closer connection with their primary care provider. Overall they had a sense that their care was more closely scrutinised.

Another common assertion is that patients with visual or auditory limitations (often age-related) will find the use of the technology challenging. Again, the implementation of large-print screens,

enhanced audio systems and other disability assistance devices make the technology readily available to this client cohort.

Although a great deal more research is required into patient satisfaction and telemedicine, there are trends suggesting that patients are accepting of this form of health-care delivery. However, the provision of eHealth solutions will not negate the need for periodic face-to-face consultations.

Patient data security

Concerns about maintaining the confidentiality and security of patient data is often cited as a patient-generated barrier to the use of eHealth services.[77–79] Preventing such breaches is a major barrier to the implementation of eHealth services. The implementation of, and regular updating of, contemporary encryption codes and firewall protection provide some risk management strategies but data stored in electronic repositories is always at risk of being 'hacked'. However, this risk is also associated with the client's banking, and other private material.

Private data security is, since 2012, a clearly defined focus area of the European Commission (www.ec.europa.eu/justice/data-protection/) with the objective to strengthening online privacy rights by proposing a reform of the EU's 1995 data protection rules.[80,81] The 2012 rules may facilitate cross-border data registration, which is very relevant in the case of eHealth. Furthermore, the EU-financed Momentum project provides guidance on relevant issues to consider with patient data security in its Blueprint.[82]

The patient may be both a barrier and a facilitator of eHealth services. Thus, systems that attempt to reengineer care services around the needs or limitations of the technology in preference to focussing on patient needs, risk unnecessary imposts on the client resulting in an increased dissatisfaction and decreased use of the system. Equally, making assumptions about the client's preparedness to accept, for example, teleconsultations based on aged-related stereotypes runs the risk of excluding client cohorts who may benefit most from the technological interventions.

The health practitioners

The literature describes a number of barriers and facilitators to implementation of eHealth services from the perspective of health-care practitioners. Brewster et al.[31] undertook a review of the literature from 2000 to 2012 and identified a number of considerations involved in staff acceptance of eHealth solutions in clinical practice. Their results demonstrated that the successful implementation of these available and emerging technologies is largely dependent on a number of issues including: staff understanding of the technology, the impact on the change of service delivery, interaction with patients and technical issues.

Clear instructions and training for clinical staff

Mair et al.[83] undertook an RCT of home telecare for the management of patients having acute exacerbation of COPD, and found that a source of dissatisfaction for nurses participating in the study was their role in the initial installation of the equipment. They considered that it would have been more appropriate for a technician, rather than nursing staff, to install the equipment in the patient's home, citing that it was not effective use of their time. In a further study, nursing staff also believed that their workload increased with the implementation of telehealth for patients with COPD.[84] Similar reasons were cited including nursing staff installing and replacing faulty equipment, and the increased time spent preparing the patient for the consultation. In an earlier study, nurses made a number of recommendations to facilitate the ease of use of equipment in an

observational RCT into the implementation of a home telecare service.[85] This included producing step-by-step guides and colour coding the cables.

Adequate and appropriate training was also considered to be critical in a thematic analysis of four health-care services in the UK using telehealth to monitor patients with COPD.[86] Training was required not only in the use of the equipment but also in facilitating identification of suitable patients for teleconsultation. These findings are supported by Brewster et al.[31] and Yellowlees[87] who found that reliable, easy-to-use equipment and appropriate training and support were fundamental to staff acceptance of eHealth initiatives.

Another factor to consider is the involvement of key stakeholders in the preliminary implementation of eHealth services. One of the themes that emerged from research undertaken by MacKenzie et al.[88] into the implementation of a CHF service, was that nursing staff thought that more time spent on prelaunch planning could have improved the implementation.

Role of the champion

Fundamental to the success of telemedicine services is the role of 'local champions' or 'clinical drivers'. These motivated individuals promote the service, motivate the team, forge relationships and take ownership,[72,87,89] ultimately ensuring its success. Ellis[72] examined the role of clinical champions in a wound care project for remote Australia. The role of the champion changed from team leader during the early phase of the project, to health services advocate and coach, and eventually salesperson and academic during the final phase of the project. During the change process it was the clinical champion who inspired the team to overcome difficulties. Wade and Eliott[89] undertook a qualitative analysis of 37 varied telehealth services in Australia. They found that the champion had three main roles: promoting the service, acting as a legitimator and relationship building. However, although the role of a champion was important, it was not the only answer to ensuring sustainability of the service. Nonetheless, in a pilot of telemedicine undertaken linking 11 sites in central and peripheral Scotland,[90] found that of these only one site took on the service. The authors proposed that poor uptake was primarily due to the absence of a champion to drive the service.[90]

Hendy and Barlow[91] found that champions are very effective initially, however some champions were reluctant to share ideas resulting in a lack of spread of the innovation. In the later stages of the implementation of remote care services they advised against limiting knowledge of the service to a few people citing that this potentially could be detrimental to the progress. Although the role of the champion is essential in the initial stages of implementation, it is important that there is 'buy in' from all involved in the programme for it to remain sustainable.

In essence the success of the implementation of telemedicine into routine service delivery is dependent on a number of factors including: staff having appropriate education and training on the use of equipment, appropriate technical support for the installation and maintenance of equipment, involving staff in the initial planning phase and having a local champion.

Access to specialised services

The implementation of telemedicine allows for improved access to specialised care, particularly for patients living in remote areas.[57,61,66,92–94]

Another benefit of delivering a telemedicine service in connection with remote area health care is the opportunity for up-skilling of health-care providers who work in rural and remote areas, via formal and informal education, support and

networking.[94] However in one study, a barrier to implementing eHealth in rural and remote Australia was chronic workforce shortages, where there is a high turnover of staff.[29] In this case there is the need for constant training of staff in the use of equipment. This can result in staff under-using resources that are available to assist with the management of chronic wounds. Similar results were also found in other research.[57,95,96] Conversely Moffatt and Eley[94] in their literature review found that there was greater staff satisfaction due to use of eHealth applications. Listed benefits were education and professional development, improved local service and experiential learning by having close contact with specialists. These benefits reduced the perception of health professionals at rural sites being isolated and increased their skills and confidence with information technology. They also suggested that the implementation of telemedicine had a role to play with recruitment and retention of staff.

The use of smartphone applications is also an emerging method of telemedicine. For example, an application was developed to support community nurses managing patients with leg ulcers working in remote Ireland. The overall aim was to try and reduce the number of vascular outpatient appointments, and improve communication, while still providing specialised review and advice.[53] The software allowed either a vascular surgeon or registrar to assess the wounds using a standard proforma. The results demonstrated that this mobile technology was safe and reliable, reducing the number of face-to-face consultations required. However, one of the main barriers was access to wi-fi.

Essentially, telemedicine and telehealth allows for access to specialised services both at rural and remote sites as well as in metropolitan areas. Barriers include high turnover of staff and ease of use of the equipment.

The services

While gaining the confidence of the patient and the clinician are important barriers to be overcome when implementing an eHealth service, it is of equal importance to ensure the necessary infrastructure is 'user friendly', reliable and cost-effective.

User interface

An effective interface between the machine and the human is a critical element of any eHealth service. The recent popularity of various social media services illustrate the point that an easy-to-use, or intuitive, interface helps to ensure larger user uptake.[67,68,97–99] In the past companies would select off-the-shelf software products and then pay for any modifications needed to meet the needs of the business. When it came time for an upgrade of the software the company would buy the newer version and then pay once again for the modifications. Contemporary practice is to buy off-the-shelf software and modify the business to match the software, hence saving costs when it is time to upgrade the software. The eHealth technologies have undergone a similar transition. A decade ago a video consultation required dedicated technology, space and a technician. Now a hand-held mobile or cell phone will achieve the same outcome.[29,68,100–102] Using ready-to-hand technologies reduce costs, is usually familiar to the user and is easily transported. All of this helps to mitigate against the technology being rejected or under used by the patient or the clinician due to a poorly designed interface.

System reliability

While the user interface is important, the reliability of any eHealth technologies is paramount. Consultation 'drop out', poorly defined images, medical record system failure or unauthorised access to confidential patient data will undermine the delivery of any eHealth service. While many authors recommend the types of technology and security for an eHealth system the reality is that

very little in the way of standards exist in this arena. For example if technology is to be used to transmit an X-ray, the monitor must meet a resolution standard. If not a diagnosis cannot be made from the digital image. Such standards are still limited in eHealth. Too often a service is commenced by a keen enthusiast who sets up a technological infrastructure based on their own experiences or advice from 'techies'.

Initiatives to solve these challenges are ongoing, and relevant organisations are currently working to promote certain standards. For example, the nonprofit industry organisation Continua is promoting a set of standards that suppliers and buyers of eHealth technologies can consult to ensure that systems are interoperable with other devices and systems. Due to lack of common standards in the past, the challenges to interoperability will play a significant role in the near future.

Until this happens clinicians wishing to provide an eHealth wound care service are encouraged to consult widely and pay special attention to aspects of product quality, security and interoperability, with regards to current systems and expectations for the future. For further recommendations with regard to selecting eHealth products and systems we can refer to Continua recommendations (www.continuaalliance.org) and best practice examples provided by the Momentum Blueprint.[82]

Cost-effectiveness analysis

There is limited evidence with regard to the cost-effectiveness of providing an eHealth service compared with routine care.[13,103] Cost savings must be made if a consultation can be done at a remote site rather than the patient traveling long distance to the territory centre. A good example of this is Australia where rural patients travel long distances to access specialised tertiary services.[94] For example, this may include travel by air due to the vastness of the continent. Thus, a 30-minute outpatient consultation could actually take three patient days.[92] Consideration must also be given to time away from family, loss of time from work, and hotel and sundry expenses.

The cost of installing and maintaining the equipment must also be taken into account. Mistry,[103] in a review of the literature, found there was inconclusive evidence with regard to the cost-effectiveness of eHealth compared with conventional health care. Wootton[13] found similar results reviewing eHealth in the management of five common chronic diseases (asthma, COPD, diabetes mellitus, CHF, hypertension). Furthermore, it is important to stress that results concerning cost-effectiveness evaluations in different countries cannot be transferred directly to another geographical location or country, due to factors such as size of the region or country, and the number of remote areas to be covered, cross-country internet access, and the cost of staff resources, among others. A comprehensive business case should be developed before any action is taken towards implementation of an eHealth solution.[82] This should also provide a basis for evaluating the resource-saving potential, and the costs related to implementation of the eHealth supported services, including aspects of and costs related to reorganisation of the health-care services.

Summary

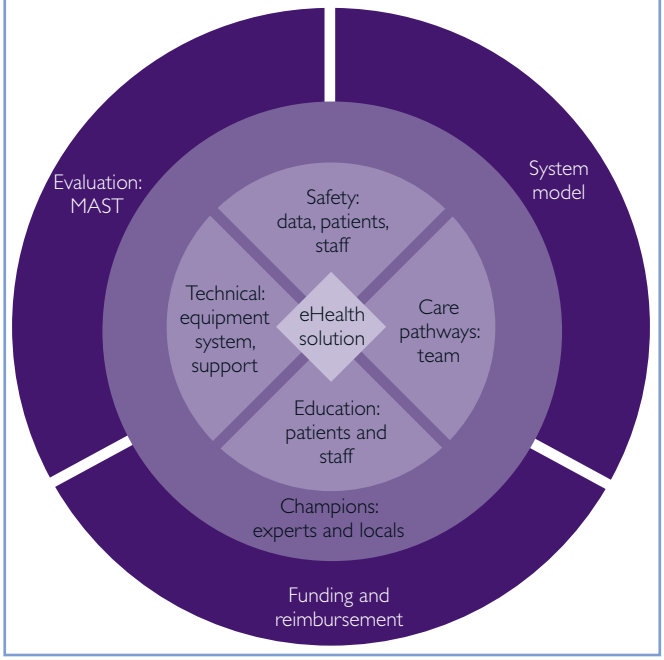
Many barriers and facilitators for the implementation of an eHealth system exist. Patient acceptance, preparation of the clinician and the available infrastructure can all either enhance or impede the implementation process. Clearly, more research is required to help identify cost–benefit outcomes, ensure the reliability and security of the systems and the safety of the patients, develop the required standards/policy, and clarify where eHealth fits into the continuum of care. This

should not stop clinicians and patients from exploring the benefits of eHealth. As illustrated in this section, recent research demonstrates: a high degree of patient satisfaction, improved access to health services for all client cohorts including underprivileged groups, and increased job satisfaction for clinicians. Consulting widely, keeping an open mind and conducting regular evaluation of outcomes will help ensure any wound management clinicians wanting to use eHealth can do so in the most efficient manner currently available.

Chapter 6: Road map for implementation in clinical practice

As described in the previous sections, all steps in the eHealth implementation process must be carefully considered, in order to reduce the risk of major obstacles once the implementation has been initiated

Fig 5. What must be in place during development and implementation of an eHealth solution



In this section we describe proposed steps to ensure a good implementation process within a given organisation (aspects related to large-scale deployment on regional or national level are not described in this section). This process is described in further detail in the Momentum Blueprint,[82] and we refer to this document for a more detailed view on telemedicine deployment.

Fig 5 illustrates three levels (circle 1–3) demanding specific attention in the different phases ranging from initial considerations to actual implementation and use of the system in a clinical practice.

Circle 1: Outer circle

Step 1: System model

As the first step, the type of system (service aim, technology, organisational implications) should be considered and decided on. This should be done with the reasons in mind for integrating this eHealth solution into the current clinical practice. For example which problems/challenges is it intended to solve and why is this type of system believed to solve the problem/challenges? You should also consider all relevant alternatives, to be sure that you are working with the best suited solution. This is an integrated part of the preceding considerations of the MAST evaluation.

Step 2: MAST evaluation

Once you believe you have the right system, you can start performing the total MAST evaluation. MAST provides an established framework for evaluating concrete, mature solutions with a focus on the context in which it is planned to be implemented.

Step 3: Funding and reimbursement aspects

When the type of system has been selected, analysed in the proper context, and found suitable for providing the needed service, the opportunities to gain the funding for implementing the system, and the surrounding reimbursement system must be evaluated. The Momentum Blueprint[82] underlines the importance of developing a good business plan including a cost–benefit analysis, and taking into account an appropriate reimbursement scheme that supports the actions of the involved clinicians and organisations. Guidance on developing the business plan can be found in this report.

Circle 2: Middle circle

Step 4: Champions: experts and local

Once the framework for implementing the eHealth solution and the type of solution have been analysed and approved for implementation, focus should change to the key factors needed to ensure a consistent progress in the change management phase. This phase demands a group of dedicated champions with sufficient power to influence key players and decision makers in the organisation. The local champion may be a clinical staff member who makes sure that the telemedicine application meets the demands of the patients and professionals using it,[86] while the involved experts should provide the organisation with the knowledge support needed to make the right decisions. Expert knowledge may be provided by regional/national health authorities and by the technology provider (depending on their role and financial interests). Both local and expert champions must be supported by the relevant management levels, and management levels must be involved throughout to ensure progress.

Circle 3: Inner circle

The inner circle focuses on four specific aspects of the actual implementation and use of the system. These are aspects that need thorough consideration and planning to ensure a functional system that is properly founded in the services and situation of the involved organisations.

Step 5: Technical aspects

A technical solution that is easy to use and has a high degree of stability is an important basis for

ensuring that the system is accepted by the primary users (patients and clinicians). It is therefore important to make sure that the equipment and system are properly connected and that you have technical support at hand to solve the start-up problems that are likely to occur during the implementation phase and the future use of the system. If an internal IT department has the responsibility for the day-to-day running of the system, you should make sure that this is closely involved in the implementation phase. Avoid an implementation phase only supported by an external system provider. Finally, it is important to make sure that you have a plan available for regular testing and future proofing of the selected system.

Step 6: Safety aspects

The safety aspects are naturally a crucial part of all health management planning. These include data security, safety for patients and a clear description of the potential problems regarding definitions of staff responsibility when using eHealth services. These should be clearly addressed to avoid cases of litigation. Data security aspects (who has access to data, how are data transferred etc.) are usually defined via national and international legislation, and providers responsible for the system should be asked to account for the system's accordance with these. See Momentum Blueprint[82] for further information.

Step 7: Adjustments according to care pathways

The patient care pathway must be a central part of planning how the eHealth solution should be integrated into the current clinical practice (or adapted versions of this). Within wound care, the care teams constitute an important aspect of providing optimal care for the patient, as many types of expertise are needed to ensure proper care with a starting point in the specific needs of each patient.[104] Thus, it is crucial that the system supports involvement of and communication between all members of the wound care team. Also that a clear plan for the telemedicine-supported patient pathway is in place, including a clear definition of the responsibilities of the team member profiles. In the planning and implementation phase, wound care team members (representatives of the various groups in all involved sectors) should meet regularly to ensure that all points of views are taken into consideration.

Step 8: Education

Finally, it is important to develop an educational programme for all staff members using the system, as well as for the patients, if they are responsible for using the service without involvement of a clinical staff member. The education should be adapted to the background and needs of the different groups of staff and patients. In cases where the eHealth services supports involvement of groups of health-care staff with no clinical expertise in the disease area in question, the education may include clinically relevant training that is not directly linked to the use of the eHealth solution, but provides a basis for involvement of non-professional carers in the care team.

Part of this education may be as e-learning, to enable education of groups based in more remote areas, or those not likely to invest in more time-consuming educational activities, for example general practitioners with limited involvement.

Chapter 7: Conclusion

The rapidly increasing complexity in health care epidemiology, coupled with a growing demand for greater cost-effectiveness and efficiency, has seen a proliferation in the use of eHealth across the health-care spectrum, including in the field of wound care. As with other health-care delivery modalities, the development and use of eHealth in wound care has not been standardised, resulting in a diverse application of the technology. This poses challenges for those wishing to gain a clear insight into the potential impact of eHealth to prevent and control morbidity and mortality, and its subsequent impact on the cost of care. In order to provide some guidance on the most appropriate variables to include in evaluating of eHealth solutions, the MAST model was developed, outlining three key aspects to consider: the preceding considerations, a multidisciplinary assessment and finally a transferability assessment.

Within the field of wound care there are mixed outcomes arising from the evaluation of eHealth solutions as demonstrated by the literature reviewed here using the MAST model headings. The outcomes are largely positive in the available studies, in those aspects which were addressed such as patient perspectives and organisational considerations. However, many other relevant aspects remain largely untested, yet are integral components of health-care provision, such as clinical effectiveness and patient safety. Despite this, there is a keen interest among practitioners involved in wound care to consider the use of eHealth solutions.

We have identified that there are barriers and facilitators to consider when planning to adopt an eHealth solution in wound care, such as patient acceptance, the preparation of the clinician and the available infrastructure, all of which can either enhance or impede the implementation process. To overcome these obstacles we have identified some proposed steps to ensure a good implementation process within a given organisation. These are synthesised into a three-circle model, with the outer circle addressing issues such as the system itself, the evaluation process, and funding and reimbursement. The middle circle outlines the importance of having champions including both experts in eHealth solutions and local practitioners. Finally the inner circle addresses issues pertaining to the actual implementation and use of the system.

We believe that eHealth solutions provide a real opportunity for enhancing the provision of wound care in a more connected fashion both nationally and internationally. From a EWMA perspective we have been advocating strongly for the implementation of knowledge into practice, with the ultimate aim of enhancing patient outcomes. It is evident from the literature reviewed here that eHealth offers one such opportunity. However, in keeping with the guidance from MAST, any implementation process should embrace the wider considerations outlined within this document, to ensure greater generalisability of outcomes achieved.

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Appendix 1: literature review – search strategy and literature overview

Search methods for identification of studies

All searches were conducted on 1 September 2014. The review considered only English language publications. Relevant Journal literature were identified by use of: The Cochrane Library, MEDLINE, CINAHL, EMBASE. Table 4 outlines the search terms employed.

Search strategies

MEDLINE search strategy: The search strategy uses MeSH terms

A, AND B, AND C (narrowed by set of terms to retrieve trials between 2000 and 2014).

CINAHL search strategy: The strategy uses CINAHL thesaurus terms

A, AND B, AND C AND (narrowed by set of terms to retrieve trials between 2000 and 2014.)

Data collection results and analysis

The articles were reviewed blindly by two reviewers and selected on the basis of the defined inclusion and exclusion criteria.

After title screening all relevant articles were imported to endnote X7.1 (210 articles). These studies were reviewed using the criteria for the review set out in the method section of this article.

All relevant articles were defined with regards to format, intervention and aim/outcome, and evaluated for inclusion of the MAST domains. If a study reported outcomes in more than one outcome or domain, the article was presented in all of the relevant domains.

Table 4. sample sizes and total numbers involved in all studies.

Set A terms: (Combined by OR):	Set B terms: (Combined by OR):	Set C terms: (Combined by NOT (limit)):
Telemedicine (and text word variations)	Wound (and text word variations)	Radiology (and text word variations)
eHealth (and text word variations)	Ulcer (and text word variations)	Burn (and text word variations)
Mobile health (and text word variations)	Diabetic foot ulcer (and text word variations)	Emergency (and text word variations)
Health, mobile (and text word variations)	Leg ulcer (and text word variations)	
	Pressure ulcer (and text word variations)	

Notes

The European Wound Management Association (EWMA)

EWMA is a European umbrella organisation, linking wound management organisations, individuals and groups with interest in wound care.

EWMA works continuously to improve European wound patients' quality of life. We pursue identifying and advocating the highest quality of treatment available and its cost effectiveness from a multidisciplinary point of view. We work to reach our objectives by being an educational resource, contributing to international projects, organising conferences, and actively supporting the implementation of existing knowledge.

Thus, EWMA strives to be the organisation that citizens, patients, professionals, Governments, Health Services and educational institutes come to for advice about and expertise in wound management in Europe.

www.ewma.org

The Australian Wound Management Association (AWMA)

AWMA is a multidisciplinary, non-profit association consisting of people who are committed to developing and improving wound management for all individuals through education, research, communication and networks.

The Association acts as a parent body to the autonomous State/Territory wound management associations in New South Wales, Queensland, South Australia, Tasmania, Victoria, Australian Capital Territory and Western Australia. There are approximately 3,000 members from the disciplines of nursing, medicine, pharmacy, podiatry, industry and the sciences.

www.awma.com.au

The United4Health Project

This document is published in connection with the United4Health project. EWMA's role in the United4Health consortium is to support the engagement of health-care professionals in the development and deployment of eHealth services.

The core ambition of United4Health is to share the understanding that in order for eHealth solutions to work it is essential that health-care providers adopt innovative health and care service models.

United4Health's philosophy is that eHealth solutions provide value for citizens, health-care providers and payers by improving access to services (locally or in the home), reducing costs (reduced home visits, fewer emergency admissions to hospital), and increasing quality; more personalised tailored care with easier involvement of family and carers.

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www.united4health.eu