TITLE: Personal Wireless Device Use for Wound Care Consultation: A Review of Safety, Clinical Benefits and Guidelines

DATE: 16 May 2014

CONTEXT AND POLICY ISSUES

Wounds may result from physical, mechanical, or thermal damage, or develop from an underlying medical disorder and include conditions such as pressure ulcers, lacerations, burns, arterial or venous ulcers, and dermatological disorders.[1] Wound care involves accurate assessment and appropriate management strategies and may require specialist consultations which may not always be easily accessible or may be time consuming. Telemedicine offers an alternative option. It is the delivery of health care through telecommunication between the patient with or without the local health care provider and remotely situated specialists.[2] Technology used for telemedicine can range from a simple telephone conversation with the health care provider to complex systems with elaborate consultations with remote specialists at various locations, through live audio or videoconferencing.[2] Telemedicine has been used in various clinical areas such as psychiatry, ophthalmology, and dermatology.[2] Teledermatology consultation has been shown to be reliable and comparable to conventional clinic-based care.[3] Imaging of the wound, uploading images and transferring them to the appropriate location play an important role in wound care involving telemedicine. The advent of high resolution digital cameras, computer technology, and specialized software has revolutionized the process of documentation of wounds.[4] In recent times, personal wireless devices such as mobile phones are increasingly being used as a telemedicine technology. Mobile phones now have in-built cameras and data transfer capabilities and are often referred to as smartphones. The transmission of medical images and other data over mobile phone networks may facilitate remote medical consultations with specialists and enhance wound care management. However the safety and clinical efficacy of this modality of care needs to be assessed before it may be put in to widespread use.

The purpose of this report is to review the available evidence on the clinical benefits and safety of personal wireless devices for wound care consultation and guidelines on the use these devices for wound care consultation.

RESEARCH QUESTIONS

1. What are the clinical benefits and safety issues associated with personal wireless devices for wound care consultation?

2. What are the clinical benefits and safety issues of sending digital images taken with personal wireless devices by email?

3. What are the guidelines associated with the use of personal wireless devices for wound care consultation?

KEY FINDINGS

Non-randomized studies suggest there is agreement in diagnoses and management plans for wound care between face-to-face consultation and remote consultation using smartphone images sent to the specialist's smartphone or to a dedicated account via e-mail. The extent of agreement varies with the type of skin condition. Studies were relatively small (fewer than 100 patients). Hence, results need to be interpreted with caution. Though in most studies the extent of agreement for diagnosis and management of wound care was reported, wound care healing rates or harms were not reported. Therefore, definite conclusions on clinical efficacy or harms are not possible. No evidence based guidelines on the use of mobile phones were identified.

METHODS

Literature Search Strategy

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2014, Issue 3), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. The search was limited to English language documents published between Jan 1, 2009 and Apr 17, 2014.

Selection Criteria and Methods

One reviewer screened the titles and abstracts of the retrieved publications, selected potentially relevant articles for retrieval of full-text publications and evaluated the full-text publications for final selection, according to the criteria listed in Table 1.

Table 1: Selection Criteria

Population	Patients (both pediatric and adult) who have sustained wounds Patients can be located in any health care facility (ER, hospital, long-term care facility) or at home (i.e. diabetics receiving wound dressing changes)
Intervention	Q1 and 3: Personal wireless devices (e.g. smartphones) Q2: Sending digital images (taken with personal wireless device) and sending them by email
Comparator	Face to face consultation or different types of remote consultation
Outcomes	Patient clinical benefits and harms (safety)

	Image quality Guidelines for using personal wireless devices for wound consultation
Study Designs	Health technology assessment (HTA), systematic review (SR) and meta-analysis (MA), randomized controlled trial (RCT), non-randomized study (NRS) and evidence-based guidelines

Exclusion Criteria

Studies were excluded if they did not satisfy the selection criteria in Table 1, if they were published prior to 2009 or duplicate publications of the same study and did not provide additional relevant information.

Critical Appraisal of Individual Studies

Critical appraisal of a study was conducted based on an assessment tool appropriate for the particular study design. The Downs and Black checklist[5] was used for RCTs and NRSs.

For the critical appraisal, a numeric score was not calculated. Instead, the strength and limitations of the study were described.

SUMMARY OF EVIDENCE

Quantity of Research Available

The literature search yielded 575 citations. Upon screening titles and abstracts, 545 articles were excluded and 30 potentially relevant articles were selected for full-text review. No potentially relevant article was identified from the grey literature. Of these 30 articles, 24 did not satisfy the inclusion criteria and were excluded. Six studies were included and comprised one RCT[6] and five NRSs.[7-11] No relevant health technology assessment, systematic review or evidence based guideline were identified. Details of the study selection process are outlined in Appendix 1.

Summary of Study Characteristics

Characteristics of the included RCTs and NRSs are summarized below and details are provided in Appendix 2

Randomized controlled trial

The included RCT[6] was published in 2013 from the United Kingdom (UK). Nursing homes were randomized to either an evaluation group or a control group. The total number of patients in the study was 28. The mean age was 81 years. Percentage of males was 39%. The study compared standard care supported by input from remote expert using a smart phone versus standard care (i.e. care directed by nursing home staff). Images of various types of wound taken by a smartphone were uploaded to a secure server for assessment by a remote nurse consultant. Outcomes reported included wound healing and mortality.

Non-randomized studies

Of the five included prospective non-randomized studies,[7-11] one study[7] was published in 2014 from Korea, two studies[8,9] were published in 2013, one each from Saudi Arabia and Ireland, one study[10] was published in 2010 from USA and one study[11] was published in 2009 from Spain. The total numbers of patients in the four studies[7,8,10,11] varied between 94 and 166, and the percentage of males varied between 58% and 100%. In these four studies, the mean age was 21 years in one study,[7] 28 years in one study,[8] 53 years in one study[11] and one study[10] did not report the mean age but reported that 87% of patients were in the 18 year to 65 year range. In one small study[9] with eight patients, the percentage of males was 88% and the mean age 74 years. Patients had skin lesions in two studies,[7,8] chronic ulcer in one study,[9] lacerations in one study,[10] and surgical wounds in one study.[11] Four studies[7-10] compared assessments based on images and communication by smart phones with assessments based on face-to-face (FTF) consultation. One study[11] compared assessments between three physicians using smart phones.

In two studies[7,8] wound images taken by a smartphone were sent to the smartphones of remote specialists for assessment. In three studies[9-11] wound images taken by a smartphone were sent to a dedicated account for assessment. Of these three studies, two studies[9,11] mentioned that images were viewed on a computer screen and one study[10] did not provide specifics. All studies reported on extent of agreement for diagnosis or management plan for wound care. In addition, sensitivity and specificity were reported in one study,[7] image quality in two studies,[10,11] and patient satisfaction in two studies.[8,11]

Summary of Critical Appraisal

Randomized controlled trial

The included RCT[6] explicitly stated the objective and inclusion/exclusion criteria. Patient characteristics, interventions and outcomes were described. Nursing homes were randomized using a computer to either control or evaluation group. Randomization was stratified according to the number of nursing home beds to ensure even distribution of patients between groups. Individual patient data was provided. However, this type of RCT design with grouping has a disadvantage as there is potential for patients within a group being more similar to each other than to patients in other groups. Sample size calculations were not described. Generalizability may be limited as results pertain to nursing homes in the Bradford and Sheffield area in UK.

Non-randomized studies

Five relevant non-randomized studies[7-11] were identified. All were prospective studies. In all the studies, the objectives were explicitly stated and patient characteristics, interventions and outcomes were described. The inclusion and exclusion criteria were stated in two studies,[7,10] not specifically stated in two studies,[9,11] and one study[8] had no specific inclusion/exclusion criteria. Sample size calculations were not described. In most studies, sample size was small (fewer than 100 patients).Generalizability was limited as the studies pertain to a specific population or region.

Strengths and limitations of individual studies are provided in Appendix 3.

Summary of Findings

The overall findings from the RCT and NRSs are summarized below and details are available in Appendix 4. In most studies extent of agreement for diagnosis or management plan was expressed by kappa value. Higher values of kappa indicate greater agreement. Typically, kappa value of 0 indicates no agreement, up to 0.20 indicates slight agreement, 0.21 to 0.40 indicates fair agreement, 0.41 to 0.60 as moderate agreement, 0.61 to 0.80 as substantial agreement and > 0.81 as almost perfect agreement.[7,10]

What are the clinical benefits and safety issues associated with personal wireless devices for wound care consultation?

Two relevant NRSs[7,8] reported on wound care consultation where wound images taken by a smartphone were sent to the smartphones of remote specialists for assessment.

In one study[7] on skin lesions in patients in military service, the kappa value for diagnostic agreement for FTF consultation versus teledermatology consultation using smartphone ranged from 0.69 to 0.80, and for diagnostic agreement between teledermatologists ranged from 0.62 to 0.77. Diagnostic sensitivity and specificity with teledermatology consultation varied depending on the skin condition. For eczema, viral warts and fungal infection, sensitivity was respectively 78%, 88% and 61% and specificity was respectively 93.1%, 99.6% and 98.1%.

In one study[8] on patients with skin lesions, the kappa values for diagnostic agreement and management plan agreement for FTF consultation versus teledermatology consultation using smartphone were 0.66 and 0.82 respectively. Kappa values for specific types of skin lesions varied between 0.11 and 1.0. Overall patient satisfaction with teledermatology consultation was high.

What are the clinical benefits and safety issues sending digital images taken with personal wireless devices by email?

One relevant RCT[6] and three relevant NRSs[9-11] reported on wound care consultation where wound images taken by a smartphone were sent to a dedicated account for assessment. Of the four studies, two studies[10,11] specifically mentioned that images were e-mailed to a dedicated account, one study[6] mentioned that images were uploaded to a secure server and one study[9] mentioned that images were sent to a secure encrypted computer database.

Randomized controlled trial

The included RCT[6] reported on wound healing and mortality in two groups: evaluation group and control group The control group received standard care and the evaluation group received standard care supported by remote expert consultation using smartphone. Patients with wounds of any etiology or severity were eligible to participate in this study. Wound types comprised pressure ulcer, leg ulcer, foot ulcer, surgical wound and fungating wound. The percentage of wounds healed was 69.6% in the evaluation group and 18.2% in the control group. The death rate was 17.6% in the evaluation group and 11.1% in the control group.

Non-randomized studies

In one study[9] on patients with chronic venous ulcers, the agreement between assessments with smartphone images and FTF clinic consultation was 100% for wound bed, and 80% for peri-wound skin integrity. The image quality was reported as adequate in 80% of cases.
In one study[10] on patients with lacerations, the kappa value for agreement in management plan between consultation with smartphone images and FTF clinic consultation was 0.65. The median value for image quality was 6 on a scale of 10, where higher values indicate better quality.

In one study[11] on patients with surgical wounds, it was stated that there was agreement in assessments based on smartphone images, between the three remote physicians but no numerical data were reported. Patients felt that the telemedicine scheme provided a sense of security during the postoperative recovery period.

What are the guidelines associated with the use of personal wireless devices for wound care consultation?

No evidence-based guideline on the use of personal wireless devices for wound care consultation was identified

Limitations

The majority of included studies were non-randomized studies, hence there is potential for selection bias. There was little detail to ascertain the quality of the studies.

The one included RCT, randomized nursing homes not individual patients. Such study designs have potential disadvantages in that the patients within a nursing home may have more similarity with each than with those from a different nursing home.

Comparison between studies was not possible due to variations in populations, setting, and specific technology and method used. Also not all studies reported all the same outcomes.

Image quality was not always reported and if reported the method of assessment was not always described. Though in most studies the extent of agreement for diagnosis and management of wound care was reported, wound care healing rates or harms were not reported. One RCT that did report on healing rates was a small study (28 patients) and had study design issues. Hence definite conclusions on clinical efficacy or harms are not possible.

Generalizability was limited as the studies were mostly conducted at single centres. None of the studies were conducted in a Canada hence results may not be applicable to a Canadian setting.

No guideline on the use of personal wireless devices for wound care consultation was identified
One guideline[1] on wound care, in their criteria for wound photography mentioned that photos should not be taken using a mobile phone. However it was unclear, if the statement was based on evidence.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

Non-randomized studies suggest there is agreement in diagnoses and management plans for wound care between FTF consultation and remote consultation using smartphone images sent to the specialist's smartphone or to a dedicated account via e-mail. The extent of agreement varies with the type of skin condition. Studies were relatively small (fewer than 100 patients). Hence, results need to be viewed with caution. Though in most studies the extent of agreement for diagnosis and management of wound care was reported, wound care healing rates or harms were not reported. Hence definite conclusions on clinical efficacy or harms are not possible. No evidence-based guidelines on the use of mobile phones were identified.

Several factors may need to be considered in implementing use of personal wireless devices such as mobile phones for wound care. Slow data upload speed may be encountered in remote areas and consequently longer image upload times.[9] Mobile phone camera images of wounds may be of variable quality and the quality of the wound image would likely impact the assessment and subsequent management plan for wound care. For electronic image transfer and communication by mobile phones between levels of care, it would be important to consider legal implications, security challenges and confidentiality issues.[4,12] Widespread use of the technology in the absence of guidelines and regulations could be problematic.

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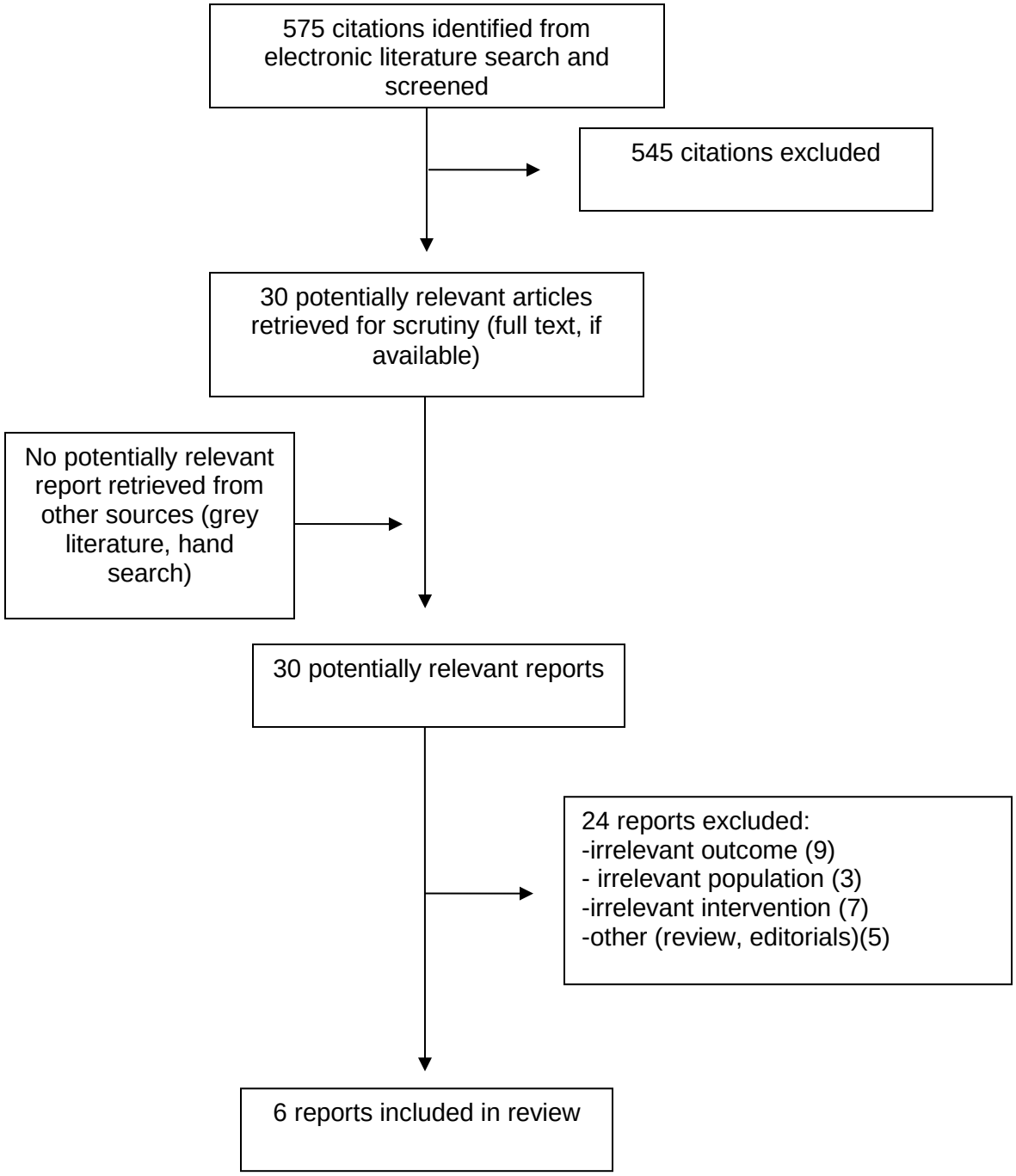
ABBREVIATIONS

ASU	ambulatory surgical unit
CI	confidence interval
ED	emergency department
FTF	face-to-face
h	hour
NR	not reported
NRS	non randomized study
PHN	public health nurse
RCT	randomized controlled trial
SD	standard deviation
UK	United Kingdom
USA	United States of America

APPENDIX 1: Selection of Included Studies



APPENDIX 2: Characteristics of Included Studies

First Author, Publication Year, Country	Study Design[a], Duration	Patient Characteristics, Sample Size (N)	Comparison	Outcomes Measured
Randomized controlled trial				
Vowden,[6] 2013, UK	RCT (Pilot study.Nursing homes were randomized to either evaluation or control group. Randomization was stratified according to bed numbers in the nursing homes.). Wound images were uploaded to a secure server. Duration = NR	Patients with wounds of any aetiology or severity and residing at nursing homes Wound types included: pressure ulcer, leg ulcer, foot ulcer, surgical wound and fungating wound N= 26 with 34 wounds (Eval = 17 with23 wounds, Control = 9 with 11) Age (years), mean (range): 80 (51 – 95) for Eval 83 (66 – 92) for Control, Male = 41% (Eval), 36% (Control)	Standard care supported by input from remote expert using smartphone versus standard care. Standard care was unsupported care directed by nursing home staff	Wound healing, mortality
Non randomized studies				
Shin,[7] 2014, Korea	NRS prospective study at a single centre (Army hospital) Wound images were sent to smartphone. Duration = NR	Patients engaging in military service and visiting a dermatology clinic for their skin lesions. Patients had various skin conditions of which most common were eczema (23%), viral warts (14%), and fungal infections (11%) N = 100 Age in years: Mean (range) = 20.6 (18 to 26)	Teledermatology consultation using Smart phone images versus face-to-face consultation	Diagnostic agreement, sensitivity, specificity

First Author, Publication Year, Country	Study Design[a], Duration	Patient Characteristics, Sample Size (N)	Comparison	Outcomes Measured
		Male = 100%		
Kalyadan,[8] 2013, Saudi Arabia	NRS: prospective study conducted at a single centre (King Faisal University health centre with consecutive patients). Wound images were sent to smartphone. Duration = NR	Patients with skin lesions N = 166 (97 males and 69 females) Age in years: Mean: 28 years. Median (range) = 25 (1 to 67) for males and 24 (1 to 73) for females Male = 58%	Assessments using smartphone images versus face-to-face consultation	Diagnostic agreement, management plan agreement, patient satisfaction
Quinn,[9] 2013, Ireland	NRS: prospective study (pilot study); patients and PHN were from regions 120km from the specialist centre. Wound images sent to a secure computer database Duration = October to December, 2011	Patients with chronic ulcer N = 8 Age in years: Mean (range) = 74.2 (61 to 83) Male = 88%	Assessment using smartphone images versus face-to-face consultation	Assessment concordance
Sikka,[10] 2010, USA	NRS: prospective study at a single centre (urban,academic emergency department). Wound images e-mailed to a dedicated account. Duration = 8 months	Patients with lacerations (hand and head/face) N= 94 Age (years): >18, 10.10%; 18-65, 86.87% >65, 3.03% Male = 65.66%	Decision based on mobile phone generated image versus decision based on in-person evaluation	Image quality (using 10-point Likert scale), decision agreement
Martinez-Ramos,[11] 2009, Spain	NRS: prospective study (pilot study). Wound images e-mailed to a dedicated account Duration = 4 months	Patients with surgical wounds who underwent surgery at the Ambulatory Surgical Unit of a tertiary care teaching hospital. N = 96	Evaluation of images taken by a smart phone by 3 physicians	Assessment agreement, image quality, hospital trips avoided, patient satisfaction

First Author, Publication Year, Country	Study Design[a], Duration	Patient Characteristics, Sample Size (N)	Comparison	Outcomes Measured
		Age in years; Mean (range) = 52.6 (21-54) Male = 58%		

Eval = evaluation group; NR = not reported; NRS = non randomized study; RCT = randomized controlled trial
[a]Details of the study method are described in the table below.

Details of study method

First Author, Publication Year, Country	Study Method
Randomized controlled trial	
Vowden,[6] 2013, UK	Patients with wound of any etiology and severity and residing in nursing homes in Bradford and Sheffield in UK were eligible for the study. Nursing homes were randomized to evaluation or control groups. Randomization was stratified by nursing home capacity (i.e. number of beds). Evaluation group: The nursing home staff made the wound diagnosis and recorded information on state of the wound and treatments. Wound images were taken by a smartphone. The wound images and information were uploaded to a secure server for assessment by a remote nurse consultant. Control group: The same wound care information was recorded as for the evaluation group. Control group patients were referred to the tissue viability nurses when the nursing home staff felt it to be necessary (standard care).
Non randomized studies	
Shin,[7] 2014, Korea	Patients in military service with skin lesions were enrolled. A paramedic with no dermatology specific knowledge or experience, obtained skin lesion images using a Smartphone. The images and patient information were then sent to three remote dermatologists (at Seoul National University Hospital). The dermatologists had previous experience with teledermatology. They magnified the image on their smartphone display and made a diagnosis. After the paramedic had sent the images and associated information to the remote dermatologists, the patients were sent to the clinic dermatologist (at the Armed Forces Yangju Hospital) for a face-to-face (FTF) consultation and diagnosis. All the patients were seen by the same dermatologist.
Kalyadan,[8] 2013, Saudi Arabia	Consecutive patients with skin lesions, attending a dermatology out-patient department at a university health centre were enrolled. Using a smartphone (Samsung, Galaxy S3) photographs of the skin lesions were taken by the on-site dermatologist and sent to a remote dermatologist along with associated patient information. The remote dermatologist viewed the images on a similar smartphone (Samsung, Galaxy S3)
Quinn,[9] 2013, Ireland	Eight patients with chronic ulcers who were attending a vascular clinic at a University teaching hospital were enrolled for the study. Five PHNs participated in the study. Patients had images of their ulcer taken in the community by their public health nurse (PHN) using a smartphone (iPhone 4). If required, more than one view of the ulcer was taken. The images along with associated patient information were sent by the PHN to a secure encrypted computer database containing the patient's medical history located at a tertiary hospital. The ulcer images were viewed on a computer screen and assessed by a consultant surgeon or registrar (minimum postgraduate year 4). The ulcer was also assessed by a consultant or registrar at a FTF consultation when the patients came for their usual clinic visit. Assessments using images and assessments at FTF consultations were within one week apart.

First Author, Publication Year, Country	Study Method
Sikka,[10] 2010, USA	Patients with lacerations in the ED were enrolled by research assistants who were available 12h/day on weekdays (convenience sampling). Patients or family members obtained four images of the laceration with their mobile phone and then e-mailed or text-messaged them to a dedicated account. Photographs were taken while the patient was in a triage room or examination room. The healthcare professional evaluated the image quality using a 10-point Likert scale (1 =poorest and 10 = best) and documented a diagnosis and management strategy. The same healthcare professional documented a diagnosis and management strategy following in-person examination.
Martinez-Ramos,[11] 2009, Spain	Patients with surgical wounds who had undergone surgery at the Ambulatory Surgical Unit (ASU) of a tertiary care teaching hospital were selected. Before leaving the ASU, patients were instructed on how to use the mobile phone (Nokia 6600) to take photographs and send over the images. They were also given a 9-item questionnaire designed to capture patient responses on satisfaction with the telemedicine scheme. During the postoperative follow up, patients could consult the healthcare professional at the surgical unit by phone as normally done. If deemed necessary, the patient was instructed to send immediately photographs of the wound area. All images were analyzed by three physicians. Based on the images and clinical information obtained, the patient was phoned and instructed on how to handle the complication or advised to visit the ASU. The mobile phones were configured to transfer images by e-mail to a receiver account address that was preset so that messages could not be sent to other accounts. The images were viewed on a standard personal computer.
ASU = ambulatory surgical unit; ED – emergency department, h= hour	

APPENDIX 3: Summary of Study Strengths and Limitations

First Author, Publication Year, Country	Strengths	Limitations
Randomized controlled trial		
Vowden,[6] 2013, UK	• Objectives were stated. • Inclusion/ exclusion criteria were stated. • Patient characteristics, interventions, and outcomes were described. • Randomized • Conflict of interest was declared and there was none	• Randomized by groups (nursing homes). RCT design with grouping, has a disadvantage as there is potential for patients within a group being more similar to each other than to patients in other groups • Sample size calculation was not described • Generalizability limited to nursing homes in Bradford and Sheffield area in UK
Non randomized studies		
Shin,[7] 2014, Korea	• Objectives were stated. • Inclusion/ exclusion criteria were stated. • Patient characteristics, interventions, and outcomes were described.	• Non randomized • Sample size calculation not described • Generalizability limited as results pertain to army personnel in Korea • Conflict of interest was not mentioned
Kalyadan,[8] 2013, Saudi Arabia	• Objectives were stated. • Patient characteristics, interventions, and outcomes were described.	• No specific inclusion/ exclusion criteria. • Non randomized • Sample size calculation not described • Generalizability limited as results pertain to patients attending an out-patient clinic at a University health centre • Conflict of interest was not mentioned but it was mentioned that the study was funded by the University
Quinn,[9] 2013, Ireland	• Objectives were stated. • Patient characteristics, interventions, and outcomes were described.	• Inclusion/ exclusion criteria were not stated. • Non randomized • Sample size calculation not described • Generalizability limited as results pertain to eight patients attending a University teaching hospital • Conflict of interest was not mentioned

First Author, Publication Year, Country	Strengths	Limitations
Sikka,[10] 2010, USA	• Objectives were stated. • Inclusion/ exclusion criteria were stated. • Patient characteristics, interventions, and outcomes were described. • Authors declared there was no competing financial interest	• Non randomized • Sampling method was called convenience sampling (Research assistants who enrolled patients in the ED were available 12h/day on weekdays.) • Sample size calculation not described • Generalizability limited as results pertain to patients in nursing home in the Bradford and Sheffield area in UK
Martinez-Ramos,[11] 2009, Spain	• Objectives were stated. • Patient characteristics, interventions, and outcomes were described. • Authors declared there was no competing financial interest	• Inclusion/ exclusion criteria were not stated. • Non randomized • Sample size calculation not described • Generalizability limited as results pertain to patients who underwent surgery at a tertiary care teaching hospital.

APPENDIX 4: Main Study Findings and Authors' Conclusions

<table>
<tr><th>First Author, Publication Year, Country</th><th>Main Findings and Authors' Conclusion</th></tr>
<tr><td colspan="2">Randomized controlled trial</td></tr>
<tr><td>Vowden,[6] 2013, UK</td><td>Main Findings:

Table: Comparison of outcomes between evaluation and control groups for nursing home patients with any type of wound
<table>
<tr><th>Outcome</th><th>Evaluation group (standard care + using smartphone and accessing expert input)
N= 17 with 23 wounds</th><th>Control group (standard care)
N= 9 with 11 wounds</th></tr>
<tr><td>Wound healed</td><td>16/23 (69.6%)</td><td>2/11 (18.2%)</td></tr>
<tr><td>Wound not healed</td><td>2/23 (8.7%)</td><td>6/11 (54.5%)</td></tr>
<tr><td>Lost to follow up</td><td>0/17 (0%)</td><td>1 /9 (11.1%)</td></tr>
<tr><td>Withdrawal</td><td>1/17 (5.9%)</td><td>1/9 (11.1%)</td></tr>
<tr><td>Death</td><td>3/17 (17.6%)</td><td>1/9 (11.1%)</td></tr>
</table>
Authors' Conclusion:
"The current study supports the potential value of telemedicine in wound care and indicates the value that such a system may have to nursing home staff and patients" p. 488</td></tr>
<tr><td colspan="2">Non randomized studies</td></tr>
<tr><td>Shin,[7] 2014, Korea</td><td>Main Findings:
Table: Comparison of results using face-to-face (FTF) consultation and teledermatalogy consultation for patients with skin lesions in the military service
<table>
<tr><th>Outcome</th><th>Result</th></tr>
<tr><td colspan="2">Diagnostic agreement between FTFconsultation and teledermatology consultation or between different teledermatology consultations</td></tr>
<tr><td></td><td></td></tr>
<tr><td>FTF versus all 3 teledermatologist</td><td>Agreement =70.7% (SD 1.5)
Kappa = 0.73 (SD 0.06)</td></tr>
<tr><td>FTF versus teledermatology 1</td><td>Kappa = 0.70</td></tr>
<tr><td>FTF versus teledermatology 2</td><td>Kappa = 0.69</td></tr>
<tr><td>FTF versus teledermatology 3</td><td>Kappa = 0.80</td></tr>
<tr><td>teledermatology 1 versus teledermatology 2</td><td>Agreement = 77%
Kappa = 0.62</td></tr>
<tr><td>teledermatology 1 versus teledermatology 2</td><td>Agreement = 82%
Kappa = 0.71</td></tr>
<tr><td>teledermatology 2 versus teledermatology 3</td><td>Agreement = 91%
Kappa = 0.77</td></tr>
<tr><td colspan="2">Diagnostic sensitivity with teledermatology consultation</td></tr>
<tr><td>For eczema</td><td>78% (SD 0)</td></tr>
<tr><td>For viral warts</td><td>88% (SD 21)</td></tr>
<tr><td>For fungal infection</td><td>61% (SD 11)</td></tr>
<tr><td colspan="2">Diagnostic specificity with teledermatology consultation</td></tr>
<tr><td>For eczema</td><td>93.1% (SD 5.2)</td></tr>
<tr><td>For viral warts</td><td>99.6% (SD 0.7)</td></tr>
<tr><td>For fungal infection</td><td>98.1% (SD 1.7)</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>First Author, Publication Year, Country</th><th>Main Findings and Authors' Conclusion</th></tr>
<tr><td></td><td>Authors' Conclusion:
"In conclusion, use of smartphones for teledermatology consultations involves simple processes……. In addition, the diagnostic concordance with face-to-face consultation in dermatology clinics is substantial and may be sufficient for routine use in the field. ……..A valuable future study would involve testing and comparing the accuracy of diagnoses made via teledermatology with those made by clinicians who are not specialized in dermatology" p.74</td></tr>
<tr><td>Kalyadan,[8] 2013, Saudi Arabia</td><td>Main Findings:
Table: Comparison of decision agreements using smartphone and in-person evaluation for patients with skin lesions
<table>
<tr><th>Outcome</th><th>Result</th></tr>
<tr><td>Diagnostic concordance</td><td>Kappa = 0.66</td></tr>
<tr><td>Management plan concordance</td><td>Kappa = 0.82</td></tr>
<tr><td>Overall patient satisfaction with teledermatology</td><td>Median score[a] (interquartile range):
10.0 (8.25 to 10.0) for males
10.0 (8.0 to 10.0) for females</td></tr>
<tr><td colspan="2">[a]Scale of 10 where 1 = not at all satisfied and 10 = highly satisfied</td></tr>
</table>
Table: Comparison of diagnostic agreements using smartphone and in-person evaluation for patients with specific skin lesions.
<table>
<tr><th>Skin lesion type</th><th>No of cases</th><th>Result (Kappa value)</th></tr>
<tr><td>Melasma</td><td>4</td><td>1.0</td></tr>
<tr><td>Viral warts</td><td>3</td><td>1.0</td></tr>
<tr><td>Alopecia areata</td><td>4</td><td>1.0</td></tr>
<tr><td>Periorificial dermatitis /Rosacea</td><td>3</td><td>1.0</td></tr>
<tr><td>Acne vulgaris</td><td>27</td><td>0.96</td></tr>
<tr><td>Nummular eczema</td><td>5</td><td>0.8</td></tr>
<tr><td>Atopic dermatitis</td><td>10</td><td>0.7</td></tr>
<tr><td>Urticaria</td><td>5</td><td>0.67</td></tr>
<tr><td>Tinea versicolor</td><td>3</td><td>0.48</td></tr>
<tr><td>Psoriasis</td><td>7</td><td>0.43</td></tr>
<tr><td>Interigo</td><td>3</td><td>0.43</td></tr>
<tr><td>Sebo-psoriasis</td><td>5</td><td>0.40</td></tr>
<tr><td>Seborrheic dermatitis</td><td>16</td><td>0.24</td></tr>
<tr><td>Chronic non-specific eczema</td><td>7</td><td>0.11</td></tr>
</table>
Table: Responses from 161 patients to questions in questionnaire for assessing patient satisfaction
<table>
<tr><th rowspan="2">Response category</th><th rowspan="2">Patients</th><th colspan="3">Number of responses for</th></tr>
<tr><th>Q 1[a]</th><th>Q 2[b]</th><th>Q 3[c]</th></tr>
<tr><td rowspan="2">Strongly agree</td><td>Male</td><td>22</td><td>35</td><td>27</td></tr>
<tr><td>Female</td><td>6</td><td>23</td><td>18</td></tr>
<tr><td rowspan="2">Agree</td><td>Male</td><td>62</td><td>57</td><td>51</td></tr>
<tr><td>Female</td><td>54</td><td>36</td><td>27</td></tr>
<tr><td rowspan="2">Disagree</td><td>Male</td><td>8</td><td>1</td><td>10</td></tr>
<tr><td>Female</td><td>1</td><td>4</td><td>16</td></tr>
</table></td></tr>
</table>

First Author, Publication Year, Country	Main Findings and Authors' Conclusion
	Strongly disagree: Male 5 4 8; Female 3 1 4 [a]Q1 = Question 1: You are comfortable with having your skin lesion photographed to obtain a consultant opinion [b]Q2 = Question 2: This method eliminates the need for seeing a consultant directly for your dermatological problem [c]Q3 = Question 3: You are satisfied with the medical care you have received in this consultation
	Authors' Conclusion: "As far as we are aware this is the first time that 4G smart phones have been used at both ends of a teledermatology consultation. It is also the first study related to mobile teledermatology from the Persian Gulf region and the first to investigate factors like gender which are important in the context of the religious and cultural background of the region. We also tried to evaluate which types of skin disorders would be more suitable for mobile teledermatology based on the diagnostic and management concordance. The study showed a high diagnostic and management concordance for mobile teledermatology, and also high patient satisfaction." P.318-319
Quinn,[9] 2013, Ireland	**Main Findings:** Table: Assessments using smartphone for patients with chronic ulcers

Outcome	Result
Concordance between assessments with smartphone images and FTF clinic consultation	
For wound bed	100%
For peri-wound skin integrity	80%
For exudate	60%
Image quality assessment	Adequate in 80% cases
Image upload success rate	37% (75 successful attempts in 201 total image upload attempts)

	Authors' Conclusion: "Digital image assessment is a safe and reliable means of assessing chronic non-healing ulcers in the community. High quality digital images can be securely sent by PHNs via a specifically designed Smartphone application for review at a tertiary referral centre many kilometers away from the patient's home location. PHNs find this application to be easy-to-use, improves communication with the tertiary referral centre and allows convenient, easily accessible ulcer care in the community. With some minor adjustments to the piloted system developed by this study, this application could be used across the community to reduce patient attendances at vascular outpatient clinics whilst still maintaining active tertiary specialist input to their care." P. 7
Sikka,[10] 2010, USA	**Main Findings:** Table: Comparison of decision agreements using mobile phone and in-person evaluation for patients with lacerations

<table>
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<tr><td></td><td>
<table>
<tr><th>Outcome</th><th>Result</th></tr>
<tr><td>Cases with agreement in laceration management decision</td><td>81 (86.2%)
Kappa= 0.65 (moderate agreement)</td></tr>
<tr><td>Cases with discrepancy in laceration management decision</td><td>13 (13.8%)
(of these 13 cases,
6 cases – image were of poor quality,
3cases –image adequate quality but did not accurately represent the problem,
3cases - other history of findings altered care,
I case – image looked worse than actual injury.)</td></tr>
<tr><td>Cases with agreement in laceration management decision or cases not undertriaged</td><td>89 (95%)</td></tr>
<tr><td>Image quality (using Likert scale, higher score indicating better quality),</td><td>Median (interquartile range) = 6 (4 to 8)</td></tr>
</table>

Authors' Conclusion:
"There is moderate agreement between mobile phone and in-person evaluations of lacerations on the decision to repair. I mages obtained by the patients are of highly variable quality, which may be a key limitation. Mobile phone camera images may be useful to assess lacerations without a clinician assessment; however, additional larger studies are needed to assess safety, outcomes, and cost impacts of a program prior to widespread implementation." P.556
</td></tr>
<tr><td>Martinez-Ramos,[11] 2009, Spain</td><td>
Main Findings:
Assessments with smartphones in patients with surgical wounds
<table>
<tr><th>Outcome</th><th>Result</th></tr>
<tr><td>Agreement among the 3 physicians</td><td>Stated to have agreement (no specific numbers were provided)</td></tr>
<tr><td>Images considered to be of good quality</td><td>95% of images</td></tr>
<tr><td>Hospital visits possibly avoided</td><td>55.2% (16 of the 29 patients with local complications mentioned that had it not been for the telemedicine scheme, they would have gone to the hospital to resolve their concerns)</td></tr>
<tr><td>Patient satisfaction (derived from responses to a questionnaire)</td><td>Patients felt that the telemedicine scheme provided a sense of security during postoperative recovery.
Mean score = 8.9 on a scale of 10</td></tr>
</table>

Authors' Conclusion:
"Our results point to the efficacy and diagnostic effectiveness of the telemedicine system proposed. The system was able to improve the sense of security of patients
</td></tr>
</table>

First Author, Publication Year, Country	Main Findings and Authors' Conclusion
	and quality of postoperative follow-up, avoiding unnecessary hospital visits and clearly increasing patient satisfaction." P. 536
FTF = face-to-face; SD = standard deviation	