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Teledermatology: Outcomes and Economic Considerations

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1. Introduction

Teledermatology is defined as the provision of dermatologic care through the use of communications technology (Goldyne & Armstrong, 2010). It offers many benefits that include increased access to dermatologic services and potential reduction in costs associated with care. Teledermatology is traditionally categorized into two different models based on the technology that is employed: store-and-forward (S&F) teledermatology, and live, interactive (LI) teledermatology (Goldyne & Armstrong, 2010). While hybrid models (a combination of S&F and LI technology) are practiced at selected institutions, this chapter focuses primarily on S&F and LI models. We will present operational flows of these two technology-enabled modalities, common outcomes measures used for evaluation of teledermatology quality metrics, and economic analyses.
At the end of the chapter (in section 5), we will consider a novel, technology-independent framework for categorizing teledermatology models as well. This system relies on classification of teledermatology based on healthcare delivery models, and serves as an alternative way to organize and evaluate the provision of teledermatologic care.

2. Store-and-forward teledermatology

Store-and-forward teledermatology is an asynchronous means for providing dermatologic care, as it relies on the *asynchronous* transmission of static digital images, patient histories, and specialist recommendations rather than real-time interaction between the specialist and the patient (Goldyne & Armstrong, 2010).
In the S&F model, a medical staff personnel at the referral site typically takes images of the relevant skin condition and obtains medical history. This information is then sent to a dermatologist via a secure internet connection. The dermatologist evaluates the patient's condition asynchronously and transmits the recommendations back to the primary care provider at the referral site (Pak et al., 2009).

2.1 Outcomes measures of store-and-forward teledermatology

Teledermatology studies have assessed numerous outcomes measures, including learning effects, length of consultation, and technical aspects (Eminovic et al., 2007). We will focus this discussion on four extensively used outcomes measures: diagnostic accuracy, diagnostic reliability, clinical outcomes, and satisfaction.

2.1.1 Diagnostic accuracy of store-and-forward teledermatology

Diagnostic accuracy refers to whether or not a diagnosis is correct, based on comparison to a gold standard reference test. While histopathological review or other laboratory tests are often used as the gold standard for diagnosis, results of these types of gold standards are not always available in clinical practice in dermatology. Furthermore, it is difficult to generate cumulative data regarding accuracy, because different studies use different methodologies and standards.

Several studies have found diagnostic accuracy of S&F teledermatology to be comparable to in-person consultations (Barnard & Goldyne 2000; High et al., 2000; Krupinski et al., 1999; Oakley et al., 1997; Whited et al., 1999). Other studies have found that in-person consultation provides a significantly greater diagnostic accuracy than S&F teledermatology (Warshaw et al. 2009a; Warshaw et al. 2009b). One study found that S&F teledermatology had a significantly greater diagnostic accuracy than in-person consultation (Lozzi et al., 2007).

Different findings on diagnostic accuracy may be attributable to several factors. First, the "gold standard" used among the studies differ from in-person evaluations to pathologic evaluation. Second, patient populations and types of skin lesions differ among the various practices that were examined. Future studies can focus on tools or interventions to increase diagnostic accuracy of S&F teledermatology, such as routine incorporation of dermoscopy (Warshaw et al., 2010a).

2.1.2 Diagnostic reliability of store-and-forward teledermatology

Diagnostic reliability is a measure of concurrence in diagnosis. It may refer to intraobserver reliability (whether one examiner makes the same diagnosis in two different examinations), or interobserver reliability (whether two different examiners make the same diagnosis). These measures of reliability may evaluate either complete agreement, which refers to comparison of the most likely diagnosis, or partial agreement, which accounts for differential diagnoses.

Studies of intraobserver reliability between S&F teledermatology and in-person consultation found that agreement ranges between 31-88% for complete diagnostic agreement, and between 50-95% for partial diagnostic agreement (Table 1).

Reference	Complete Diagnostic Agreement	Partial Diagnostic Agreement
(Romero et al., 2010)	.85	.92
(Tan et al., 2010)	.74	.88
(Heffner et al., 2009)	.82	-
(Ebner et al., 2008)	.74	.90
(Pak et al., 2003)	.70	.91
(Lim et al., 2001)	.88	.95
(Taylor et al., 2001)	.31-.64	.50-.70
(Krupinski et al., 1999)	-	.76-.90

Table 1. Intraobserver Reliability for S&F Teledermatology and Conventional Care

Studies have found that interobserver reliability ranges between 41-92% for complete diagnostic agreement and between 51-100% for partial diagnostic agreement (Table 2). A review of studies between 1997 and 2005 revealed that the aggregate complete diagnostic agreement was 60%, and partial diagnostic agreement was 80% (Romero et al., 2008).

Reference	Complete Diagnostic Agreement	Partial Diagnostic Agreement
(Tan et al., 2010)	.75-.82	.83-.89
(Heffner et al., 2009)	.69	-
(Silva et al., 2009)	.87-.92	.96-1.0
(Edison et al., 2008)	.73	-
(Ebner et al., 2008)	.71-.76	.90-.97
(Bowns et al., 2006)	.55	-
(Oakley et al., 2006)	.53	.64
(Tucker & Lewis, 2005)	.56	.68
(Baba et al., 2005)	.75	-
(Mahendran et al., 2005)	.44-.48	.64-.65
(Du Moulin et al., 2003)	.54	.63
(Eminovic et al., 2003)	.41	.51
(Lim et al., 2001)	.73-.85	.83-.89
(Taylor et al., 2001)	.44-.51	.57-.61
(High et al., 2000)	.64-.77	.81-.89
(Whited et al., 1999)	.41-.55	.79-.95
(Lyon & Harrison, 1997)	.89	-
(Zelickson & Homan, 1997)	.88	-
(Kvedar et al., 1997)	.61-.64	.67-.70

Table 2. Interobserver Reliability for S&F Teledermatology and Conventional Care

Based on this data on diagnostic reliability, it appears that S&F teledermatology is a functional and reasonably reliable tool for diagnosis of skin disorders.

2.1.3 Clinical outcomes for store-and-forward teledermatology

To date, two studies have evaluated clinical outcomes of S&F teledermatology compared to conventional care, and both studies found similar outcomes for each of the two treatment modalities (Krupinski et al., 2004; Pak et al., 2007). Specifically, Pak et al. conducted a randomized controlled trial with patients randomly assigned to either conventional face-to-face care or teledermatology. Another dermatologist, blinded to the randomization, evaluated the clinical outcomes between baseline data and after four months (Table 3). The results suggest that teledermatology and conventional care result in similar outcomes (Pak et al., 2007).

		Clinical Course Rating		
		Improved	No change	Worse
Assigned Group	Teledermatology	64%	33%	4%
	Conventional Care	65%	32%	3%

Table 3. Reported Clinical Outcomes from Pak et al.

We may also consider intermediate clinical outcomes, such as (1) time-to-intervention and (2) preventable clinic visits. Time-to-intervention is usually defined as the wait time prior to being seen by a specialist after a referral has been placed. Preventable clinic visits refers to

the percentage of dermatology clinic visits that could be avoided through use of teledermatology.

The literature suggests that the use of S&F teledermatology may considerably reduce time-to-intervention. Researchers in Spain found that surgical patients managed through S&F teledermatology had a mean waiting interval 34.47 days shorter than those patients managed through conventional care (Ferrandiz et al., 2007). A similar study found that patients at primary care centers managed through teledermatology waited on average 76.31 days less than those with conventional referrals (Moreno-Ramirez et al., 2007). A study of patients at the Durham VA Medical Center found that those that received a S&F teledermatology consultation were seen on average 86 days sooner than those in the conventional system (Whited et al., 2002).

The reduced time-to-intervention may be partially due to the fact that teledermatology can help prevent unnecessary clinic visits. Indeed, studies have found that S&F teledermatology could prevent 13-58% of dermatology clinic visits (Whited, 2010).

2.1.4 Satisfaction with store-and-forward teledermatology

Satisfaction assessments may be subdivided into three categories: patient satisfaction, referring provider satisfaction, and specialist satisfaction. Studies suggest that patients were generally satisfied with receiving care through S&F teledermatology, and typically had no preference between teledermatology and usual care (Warshaw et al., 2010b). One study found that 76% of patients preferred being treated through teledermatology in order to avoid the wait time associated with a face-to-face clinic visit (Bowns et al., 2006). A common patient complaint during the S&F teledermatology process was the length of time between the consultation and being informed of the results by the primary care providers (Whited, 2010).

When referring providers were asked about their satisfaction with S&F teledermatology, referring providers provided varied feedback (Bowns et al., 2006; Collins et al., 2004; Weinstock et al., 2002; Whited et al., 2004). Many referring providers report that they improved their therapeutic and diagnostic ability due to regular feedback and interactions with the dermatologist (van den Akker et al., 2001). From the referring providers' perspective, some dissatisfaction with the S&F teledermatology process stemmed from the additional time and effort required for relaying the diagnoses to patients, prescribing the medications, or performing procedures (Bowns et al., 2006; Collins et al., 2004; Kvedar et al., 1999).

Fewer studies have evaluated satisfaction of dermatologists who practice teledermatology. While most dermatologists practicing teledermatology reported increased satisfaction (Whited, 2010), many report reduced confidence in their diagnoses (Bowns et al., 2006; Pak et al., 1999; Whited et al., 2004).

2.2 Economic considerations of store-and-forward teledermatology

We begin discussion of the economic aspects of S&F teledermatology with a brief review of common types of economic analysis. Three commonly used methods are cost minimization analysis, cost-effectiveness analysis, and cost-benefit analysis (Davalos et al., 2009). Cost-minimization analysis is a type of cost analysis that evaluates two systems that produce equivalent outcomes. Cost-effectiveness analysis compares monetary costs (cost) in the context of outcomes (effectiveness). However, this type of analysis generally considers only one outcomes measure. In comparison, cost-benefit analysis considers multiple economic costs as well as varied benefits within a system, and it generally includes multiple outcomes measures. Cost-benefit analyses are generally considered the most comprehensive type of

economic analyses. Further information regarding economic evaluation metrics may be found in Davalos et al. (Davalos et al., 2009).

Literature shows that S&F teledermatology is generally economically viable (Table 3). While studies differed in their economic perspective and modality of S&F teledermatology delivery (e.g. triage, consultation, versus provision of care), analyses have generally established that S&F teledermatology offers a cost-effective means of providing dermatologic care especially for those living in geographically isolated communities or medically underserved communities (Pak et al., 2009; Whited et al., 2003). For example, in a cost-minimization analysis that adopted the perspective of the U.S. Department of Defense, Pak et al. concluded that the use of teleconsultations through S&F technology reduced overall costs compared to conventional care (Pak et al., 2009).

Similarly, Whited et al. performed a cost analysis of a consultative model using S&F technology from the perspective of the U.S. Department of Veterans Affairs (Whited et al., 2003). The authors found that teleconsultations are $15 more costly per patient compared to face-to-face consultation. In this study, effectiveness was defined as time-to-specialist evaluation. They found that having teledermatology consultations resulted in shorter time-to-specialist evaluation and was overall more cost-effective. Further analyses showed that, from a *societal* perspective, S&F teleconsultations would be even less costly after accounting for patients' travel time and productivity lost through face-to-face care (Whited et al., 2003).

When S&F teledermatology was used as a primary method for triaging cases appropriate face-to-face encounters, researchers found that this was an economically viable means for prioritizing patients requiring dermatologic care (Ferrandiz et al., 2008; Moreno-Ramirez et al., 2009). By comparing S&F teledermatology and conventional referrals to a skin cancer clinic in Spain, Moreno-Ramirez et al. conducted a cost-identification and cost-effectiveness analysis from a societal perspective (Moreno-Ramirez et al., 2009). The investigators assessed costs associated with travel, lost-productivity, and healthcare delivery. Effectiveness was defined as the wait-time to in-person consultation after the referral. The authors found that teledermatology triage was more cost-effective; specifically, teledermatology yielded cost-savings of €49.59 per patient compared with conventional face-to-face care (Moreno-Ramirez et al., 2009). These findings were corroborated by another cost-effectiveness study in Spain, where the investigators found that the use of teledermatology saved €122.02 compared to conventional care (Ferrandiz et al., 2008).

Reference	Type of Analysis	Teleconsultation	Conventional	Perspective
Provision of Care				
(Pak et al., 2009)	Cost-minimization	$340 / patient	$372 / patient	Department of Defense
(Whited et al., 2003)	Cost / Cost-effectiveness	$36.40 / patient	$21.40 / patient	Department of Veterans Affairs
Triage				
(Moreno-Ramirez et al., 2009)	Cost-identification / Cost-effectiveness	€79.78 / patient	€129.37 / patient	Societal
(Ferrandiz et al., 2008)	Cost / Cost-effectiveness	€156.40 / patient	€278.42 / patient	Societal
$ - US dollars; € - euros				

Table 4. Economic Analyses of Store-and-Forward Teledermatology

3. Live, Interactive Teledermatology

Live, interactive teledermatology involves synchronous interaction between the specialist and patient (Goldyne & Armstrong, 2010). Via videoconferencing or web-conferencing, the specialist obtains a clinical history, examines the patient in real-time, and communicates recommendations to the patient and the primary care provider (Wootton et al., 2000).

3.1 Outcomes measures of Live, Interactive Teledermatology

We will consider the same outcomes measures for LI teledermatology as we did for S&F teledermatology: diagnostic accuracy, diagnostic reliability, clinical outcomes, and satisfaction.

3.1.1 Diagnostic accuracy of LI Teledermatology

Studies comparing diagnostic accuracy of LI teledermatology to pathologic diagnosis are not currently available. Studies comparing diagnoses between LI teledermatology and in-person consultation generally show diagnostic agreement, and will be discussed further under diagnostic reliability.

3.1.2 Diagnostic reliability of Live, Interactive Teledermatology

Studies of intraobserver reliability between LI teledermatology and in-person consultation show complete diagnostic agreement in 59-75% of cases, and partial agreement in 76-87% of cases (Table 5).

Reference	Complete Diagnostic Agreement	Partial Diagnostic Agreement
(Loane et al., 1998b)	.71	.87
(Gilmour et al., 1998)	.59	.76
(Oakley et al., 1997)	.75	.82

Table 5. Intraobserver Reliability for LI Teledermatology

Interobserver reliability between LI teledermatology and in-person consultation ranges from 54-80% for complete diagnostic agreement, and 79-99% for partial agreement (Table 6). A review of aggregate data indicates that complete diagnostic agreement is 70%, while partial diagnostic agreement is 84% (Romero et al., 2008).

Reference	Complete Diagnostic Agreement	Partial Diagnostic Agreement
(Nordal et al., 2001)	.72	.86
(Phillips et al., 1998)	.59	-
(Loane et al., 1998b)	.60	.76
(Lowitt et al., 1998)	.80	-
(Gilmour et al., 1998)	.54	.80
(Lesher et al., 1998)	.78	.99
(Phillips et al., 1997)	.77	-

Table 6. Interobserver Reliability for LI Teledermatology

3.1.3 Clinical outcomes for LI Teledermatology

One study evaluated clinical outcomes for LI teledermatology compared to conventional care. In a retrospective analysis of patients who had two or more teledermatology consultations, Marcin et al. found that diagnosis, treatment, and patient improvement data for the teledermatology patients were consistent with existing literature regarding conventional care (Marcin et al., 2005).

Intermediate outcomes measures include (1) preventable clinic visits and (2) time for completion of consultation. Similar to the S&F modality, LI teledermatology can prevent unnecessary clinic visits. Studies found that 44.4-82% of clinic visits could be avoided through the use of LI teledermatology (Whited, 2010).

LI teledermatology can decrease total time necessary to complete a consultation visit from the patient's perspective. For example, researchers in New Zealand found that, compared to a clinic visit, the use of LI teledermatology saved patients an average of 3.45 hours of time, primarily due to reduced traveling time (Oakley et al., 2000). However, LI teledermatology does not necessarily reduce consult time for the dermatologist (Loane et al., 1999, 2001b; Oakley et al., 2000).

3.1.4 Satisfaction with Live, Interactive Teledermatology

As stated previously, satisfaction in teledermatology is categorized into patient satisfaction, referring provider satisfaction, and dermatologist satisfaction. Patients reported that they were equally satisfied with LI teledermatology and conventional care and had no strong preference for one modality over another (Whited, 2010). Some patients reported initial discomfort due to the presence of camera (Gilmour et al., 1998; Loane et al., 1998a).

Relatively few studies evaluated referring provider satisfaction in LI teledermatology. While there was some dissatisfaction associated with technical difficulties, most referring providers report being satisfied with the LI teledermatology (Gilmour et al., 1998; Jones et al., 1996).

Similar to dermatologists who practice S&F teledermatology, dermatologists who practice LI teledermatology report being satisfied with practicing LI teledermatology. However, when compared to in-person consultation, dermatologists expressed lower confidence in their diagnoses (Artiles Sanchez et al., 2004; Lowitt et al., 1998).

3.2 Economic considerations of Live, Interactive Teledermatology

Economic analyses of LI teledermatology yielded mixed conclusions regarding its economic sustainability. While some studies have shown LI teledermatology to be cost-effective, others suggested that it may be more costly than conventional care. In a cost-minimization analysis from a societal perspective, authors from New Zealand found that teledermatology consultations using LI technology appeared less costly than that of face-to-face care, especially when patients have longer travel distances (Loane et al., 2001b). In another cost-minimization study of LI teledermatology in the U.S., investigators found that consultative teledermatology using LI technology also appears to be less costly than face-to-face care from a provider perspective (Armstrong et al., 2007).

In a cost-benefit analysis from the societal perspective, Wootton et al. found that a LI teleconsultation system in the United Kingdom was more costly than face-to-face care. Sensitivity analyses showed that LI teledermatology consultations could be a less costly alternative if patients travelled longer distances for in-person consultations and incurred greater lost-productivity costs (Wootton et al., 2000).

Reference	Type of Analysis	Teleconsultation	Conventional	Perspective
(Dekio et al., 2010)	Cost-effectiveness	¥26,040 / week	¥60,500 / week	Societal
(Armstrong et al., 2007)	Cost-minimization	$274 / hour	$346 / hour	Healthcare provider
(Loane et al., 2001b)	Cost-minimization	NZ$279.23 / patient	NZ$283.79 / patient	Societal
(Loane et al., 2001a)	Cost-benefit	£146.48 / patient	£47.13 / patient	Urban Societal
(Loane et al., 2001a)	Cost-benefit	£180.22 / patient	£48.77 / patient	Rural Societal
(Wootton et al., 2000)	Cost-benefit	£132.10 / patient	£48.73 / patient	Societal
(Lamminen et al., 2000)	Cost	FM 18,627 (total cost)	FM 18,034 (total cost)	Societal
(Bergmo, 2000)	Cost-minimization	NKr 470,780 (total cost)	NKr 1,635,075 (total cost)	Healthcare provider
(Chan et al., 2000)	Cost / Cost-effectiveness	HK$57.7 / patient	HK$322.8 / patient	Healthcare provider
(Burgiss et al., 1997)	Cost	$141 / patient	$294 / patient	Societal

¥ - yen; € - euros; $ - US dollars; NZ$ - New Zealand dollars; £ - pounds; FM – Finnish marks; NKr – Norwegian kroners; HK$ - Hong Kong dollars

Table 7. Economic Analyses of Live, Interactive Teledermatology

4. Comparison of store-and-forward and Live, Interactive Teledermatology

Approximately 42% of the United States population lives in medically underserved areas (Suneja et al., 2001). Both S&F and LI teledermatology can increase access to specialty care especially for populations living in rural or medically underserved areas (Hailey, 2005; Kailasam et al., 2010; Pak et al., 2007; Vallejos et al., 2009).

S&F and LI teledermatology present distinct advantages. S&F teledermatology appears to be very cost-effective. Specifically, compared to LI teledermatology, S&F teledermatology requires less equipment or technology costs (Pak, 2008; Watson, 2009). The requirements for administrative support and overhead also appear to be less for S&F teledermatology. Finally, the asynchronous nature of S&F modality affords greater scheduling flexibility for patients and dermatologists since coordinated appointments with specialists are not required (Finch et al., 2007; Watson, 2009). LI teledermatology, on the other hand, more closely mirrors a conventional face-to-face consultation because the specialist can interact with patients and a referring provider in real-time.

S&F and LI teledermatology have their respective disadvantages as well. In S&F teledermatology, because the ability of the dermatologist to diagnose and provide useful

recommendations depends solely on the quality of images and clinical history, suboptimal images or incomplete clinical history can be frustrating for the dermatologist. Furthermore, S&F teledermatology does not allow the development of a patient-dermatologist relationship compared to LI teledermatology (Grenier et al., 2009; Onor & Misan, 2005). LI teledermatology presents alternative challenges in terms of scheduling, coordination, and costs.

Given the unique benefits that each modality offers, some providers have recently started to employ a hybrid model. In the hybrid model, the clinical encounters are conducted via videoconferencing or webconferencing, and the dermatologist reviews static digital images that were acquired by a digital camera prior to the encounter and sent to them during the encounter. Current research efforts are investigating the relative effectiveness of such hybrid systems (Baba et al., 2005; Romero et al., 2010). For example, Baba et al. found that a hybrid modality increased diagnostic accuracy by 7-9%, compared to S&F teledermatology alone (Baba et al., 2005).

5. Novel classification teledermatology based on healthcare delivery models

To date, teledermatology has been categorized by the technology it uses--S&F and LI technology. An alternative model to frame teledermatology is based on the type of healthcare delivery. Specifically, independent of the type of technology employed, we can arrange teledermatology delivery into (1) triage, (2) consultative, and (3) direct-care models. This technology-independent, healthcare delivery-based framework is accessible to policy makers and other stakeholders involved in health policy.

5.1 Triage model

In the triage model, all dermatology referrals are first seen through teledermatology. A specialist reviews the cases rapidly with the goal of prioritizing which patients are suitable for in-person evaluation. The triage model prioritizes patients based on the severity and urgency of their skin condition. This modality has been primarily practiced in Europe in prioritization patients with cutaneous malignancies (Ferrandiz et al., 2007; Moreno-Ramirez et al., 2007).

5.2 Consultative model

In the consultative model, the referring providers decide which dermatology referrals are appropriate for teledermatology evaluation. From the dermatologist's perspective, the primary goal of the consultative model is to provide detailed and useful recommendations to the primary care provider. In this healthcare delivery model, the dermatologist reviews the cases via either S&F or LI technology and provides detailed recommendations to the primary care provider. The primary care provider assumes responsibility for communicating with the patient and carrying out the recommendation plans. The consultative model is currently the most common model in the United States (Goldyne & Armstrong, 2010).

5.3 Direct-care model

In the direct-care model, the dermatologist assumes the responsibility of communicating and treating the patient. This model differs significantly from the triage or consultative

model in that the dermatologist is responsible for caring for the patient. The provision of direct care includes evaluation, communicating the treatment plan to the patient, writing prescriptions, carrying out laboratory evaluations, and monitoring disease progression.
The direct-care model has generally been practiced using S&F technology and in research settings (Chambers et al., 2010; Parsi et al., 2010; Watson et al., 2010).

6. Conclusion

As healthcare delivery becomes more patient-centered and distance-independent (Hibbard, 2004; Hogarth et al., 2010; Robinson et al., 2011), proper application of teledermatology offers a versatile means of providing high quality care to patients in their own communities. Teledermatology can be used in various healthcare delivery modalities, including triage, consultation, and direct care.
In addition to gathering the support of healthcare workers and patients for these newer models of healthcare delivery, those who work at the forefront of telemedicine need to also advocate for policy changes and technological innovations to continually improve the quality and experience of telemedicine. It is likely that the cost of technology will decline as the reliability and user-interface of technology continually improve. In this healthcare environment, innovations in teledermatology serve as examples for emerging paradigms in healthcare delivery.

7. References

Armstrong AW, Dorer DJ, Lugn NE, and Kvedar JC. 2007. Economic evaluation of interactive teledermatology compared with conventional care. Telemed J E Health 13(2):91-99.

Artiles Sanchez J, Suarez-Hernandez J, Serrano P, Vazquez C, Duque B, and Cuevas C. 2004. Evaluación cualitativa en teledermatología: Resultados del proyecto piloto en telemedicina 2000. Actas Dermosifiliogr 95(5):289-294.

Baba M, Seckin D, and Kapdagli S. 2005. A comparison of teledermatology using store-and-forward methodology alone, and in combination with Web camera videoconferencing. J Telemed Telecare 11(7):354-360.

Barnard CM, and Goldyne ME. 2000. Evaluation of an asynchronous teleconsultation system for diagnosis of skin cancer and other skin diseases. Telemed J E Health 6(4):379-384.

Bergmo TS. 2000. A cost-minimization analysis of a realtime teledermatology service in northern Norway. J Telemed Telecare 6(5):273-277.

Bowns IR, Collins K, Walters SJ, and McDonagh AJ. 2006. Telemedicine in dermatology: a randomised controlled trial. Health Technol Assess 10(43):iii-iv, ix-xi, 1-39.

Burgiss SG, Julius CE, Watson HW, Haynes BK, Buonocore E, and Smith GT. 1997. Telemedicine for dermatology care in rural patients. Telemed J 3(3):227-233.

Chambers, CJ, Parsi, K, Schupp, C, and Armstrong, AW (2010). Patient-Centered Online Healthcare Delivery Model for Psoriasis: A Randomized Controlled Equivalency Trial. Manuscript submitted for publication, University of California, Davis School of Medicine, Department of Dermatology, Sacramento, CA.

Chan HH, Woo J, Chan WM, and Hjelm M. 2000. Teledermatology in Hong Kong: a cost-effective method to provide service to the elderly patients living in institutions. Int J Dermatol 39(10):774-778.

Collins K, Bowns I, and Walters S. 2004. General practitioners' perceptions of asynchronous telemedicine in a randomized controlled trial of teledermatology. J Telemed Telecare 10(2):94-98.

Davalos ME, French MT, Burdick AE, and Simmons SC. 2009. Economic evaluation of telemedicine: review of the literature and research guidelines for benefit-cost analysis. Telemed J E Health 15(10):933-948.

Dekio I, Hanada E, Chinuki Y, Akaki T, Kitani M, Shiraishi Y, Kaneko S, Furumura M, and Morita E. 2010. Usefulness and economic evaluation of ADSL-based live interactive teledermatology in areas with shortage of dermatologists. Int J Dermatol 49(11):1272-1275.

Du Moulin MF, Bullens-Goessens YI, Henquet CJ, Brunenberg DE, de Bruyn-Geraerds DP, Winkens RA, Dirksen CD, Vierhout WP, and Neumann HA. 2003. The reliability of diagnosis using store-and-forward teledermatology. J Telemed Telecare 9(5):249-252.

Ebner C, Wurm EM, Binder B, Kittler H, Lozzi GP, Massone C, Gabler G, Hofmann-Wellenhof R, and Soyer HP. 2008. Mobile teledermatology: a feasibility study of 58 subjects using mobile phones. J Telemed Telecare 14(1):2-7.

Edison KE, Ward DS, Dyer JA, Lane W, Chance L, and Hicks LL. 2008. Diagnosis, diagnostic confidence, and management concordance in live-interactive and store-and-forward teledermatology compared to in-person examination. Telemed J E Health 14(9):889-895.

Eminovic N, de Keizer NF, Bindels PJ, and Hasman A. 2007. Maturity of teledermatology evaluation research: a systematic literature review. Br J Dermatol 156(3):412-419.

Eminovic N, Witkamp L, Ravelli AC, Bos JD, van den Akker TW, Bousema MT, Henquet CJ, Koopman RJ, Zeegelaar JE, and Wyatt JC. 2003. Potential effect of patient-assisted teledermatology on outpatient referral rates. J Telemed Telecare 9(6):321-327.

Ferrandiz L, Moreno-Ramirez D, Nieto-Garcia A, Carrasco R, Moreno-Alvarez P, Galdeano R, Bidegain E, Rios-Martin JJ, and Camacho FM. 2007. Teledermatology-based presurgical management for nonmelanoma skin cancer: a pilot study. Dermatol Surg 33(9):1092-1098.

Ferrandiz L, Moreno-Ramirez D, Ruiz-de-Casas A, Nieto-Garcia A, Moreno-Alvarez P, Galdeano R, and Camacho FM. 2008. [An economic analysis of presurgical teledermatology in patients with nonmelanoma skin cancer]. Actas Dermosifiliogr 99(10):795-802.

Finch TL, Mair FS, and May CR. 2007. Teledermatology in the UK: lessons in service innovation. Br J Dermatol 156(3):521-527.

Gilmour E, Campbell SM, Loane MA, Esmail A, Griffiths CE, Roland MO, Parry EJ, Corbett RO, Eedy D, Gore HE et al. . 1998. Comparison of teleconsultations and face-to-face consultations: preliminary results of a United Kingdom multicentre teledermatology study. Br J Dermatol 139(1):81-87.

Goldyne M, and Armstrong AW. 2010. Teledermatology Practice Guide. California Telemedicine and eHealth Center.

Grenier N, Bercovitch L, and Long TP. 2009. Cyberdermatoethics II: a case-based approach to teledermatology ethics. Clin Dermatol 27(4):367-371.

Hailey D. 2005. Technology and managed care: is telemedicine the right tool for rural communities? J Postgrad Med 51(4):275-278.

Heffner VA, Lyon VB, Brousseau DC, Holland KE, and Yen K. 2009. Store-and-forward teledermatology versus in-person visits: a comparison in pediatric teledermatology clinic. J Am Acad Dermatol 60(6):956-961.

Hibbard JH. 2004. Moving toward a more patient-centered health care delivery system. Health Aff (Millwood) Suppl Web Exclusives:VAR133-135.

High WA, Houston MS, Calobrisi SD, Drage LA, and McEvoy MT. 2000. Assessment of the accuracy of low-cost store-and-forward teledermatology consultation. J Am Acad Dermatol 42(5 Pt 1):776-783.

Hogarth M, Hajopoulos K, Young M, Cowles N, Churin J, Hornthal B, and Esserman L. 2010. The Communication and Care Plan: a novel approach to patient-centered clinical information systems. J Biomed Inform 43(5 Suppl):S6-8.

Jones DH, Crichton C, Macdonald A, Potts S, Sime D, Toms J, and McKinlay J. 1996. Teledermatology in the Highlands of Scotland. J Telemed Telecare 2 Suppl 1:7-9.

Kailasam S, Kumar S, and Dharanipragada J. 2010. Arogyasree: an enhanced grid-based approach to mobile telemedicine. Int J Telemed Appl 2010:536237.

Krupinski EA, Engstrom M, Barker G, Levine N, and Weinstein RS. 2004. The challenges of following patients and assessing outcomes in teledermatology. J Telemed Telecare 10(1):21-24.

Krupinski EA, LeSueur B, Ellsworth L, Levine N, Hansen R, Silvis N, Sarantopoulos P, Hite P, Wurzel J, Weinstein RS et al. . 1999. Diagnostic accuracy and image quality using a digital camera for teledermatology. Telemed J 5(3):257-263.

Kvedar JC, Edwards RA, Menn ER, Mofid M, Gonzalez E, Dover J, and Parrish JA. 1997. The substitution of digital images for dermatologic physical examination. Arch Dermatol 133(2):161-167.

Kvedar JC, Menn ER, Baradagunta S, Smulders-Meyer O, and Gonzalez E. 1999. Teledermatology in a capitated delivery system using distributed information architecture: design and development. Telemed J 5(4):357-366.

Lamminen H, Tuomi ML, Lamminen J, and Uusitalo H. 2000. A feasibility study of realtime teledermatology in Finland. J Telemed Telecare 6(2):102-107.

Lesher JL, Jr., Davis LS, Gourdin FW, English D, and Thompson WO. 1998. Telemedicine evaluation of cutaneous diseases: a blinded comparative study. J Am Acad Dermatol 38(1):27-31.

Lim AC, Egerton IB, See A, and Shumack SP. 2001. Accuracy and reliability of store-and-forward teledermatology: preliminary results from the St George Teledermatology Project. Australas J Dermatol 42(4):247-251.

Loane MA, Bloomer SE, Corbett R, Eedy DJ, Evans C, Hicks N, Jacklin P, Lotery HE, Mathews C, Paisley J et al. . 2001a. A randomized controlled trial assessing the

health economics of realtime teledermatology compared with conventional care: an urban versus rural perspective. J Telemed Telecare 7(2):108-118.

Loane MA, Bloomer SE, Corbett R, Eedy DJ, Gore HE, Hicks N, Mathews C, Paisley J, Steele K, and Wootton R. 1999. Patient cost-benefit analysis of teledermatology measured in a randomized control trial. J Telemed Telecare 5 Suppl 1:S1-3.

Loane MA, Bloomer SE, Corbett R, Eedy DJ, Gore HE, Mathews C, Steele K, and Wootton R. 1998a. Patient satisfaction with realtime teledermatology in Northern Ireland. J Telemed Telecare 4(1):36-40.

Loane MA, Corbett R, Bloomer SE, Eedy DJ, Gore HE, Mathews C, Steele K, and Wootton R. 1998b. Diagnostic accuracy and clinical management by realtime teledermatology. Results from the Northern Ireland arms of the UK Multicentre Teledermatology Trial. J Telemed Telecare 4(2):95-100.

Loane MA, Oakley A, Rademaker M, Bradford N, Fleischl P, Kerr P, and Wootton R. 2001b. A cost-minimization analysis of the societal costs of realtime teledermatology compared with conventional care: results from a randomized controlled trial in New Zealand. J Telemed Telecare 7(4):233-238.

Lowitt MH, Kessler, II, Kauffman CL, Hooper FJ, Siegel E, and Burnett JW. 1998. Teledermatology and in-person examinations: a comparison of patient and physician perceptions and diagnostic agreement. Arch Dermatol 134(4):471-476.

Lozzi GP, Soyer HP, Massone C, Micantonio T, Kraenke B, Fargnoli MC, Fink-Puches R, Binder B, Di Stefani A, Hofmann-Wellenhof R et al. . 2007. The additive value of second opinion teleconsulting in the management of patients with challenging inflammatory, neoplastic skin diseases: a best practice model in dermatology? J Eur Acad Dermatol Venereol 21(1):30-34.

Lyon CC, and Harrison PV. 1997. A portable digital imaging system in dermatology: diagnostic and educational applications. J Telemed Telecare 3 Suppl 1:81-83.

Mahendran R, Goodfield MJ, and Sheehan-Dare RA. 2005. An evaluation of the role of a store-and-forward teledermatology system in skin cancer diagnosis and management. Clin Exp Dermatol 30(3):209-214.

Marcin JP, Nesbitt TS, Cole SL, Knuttel RM, Hilty DM, Prescott PT, and Daschbach MM. 2005. Changes in diagnosis, treatment, and clinical improvement among patients receiving telemedicine consultations. Telemed J E Health 11(1):36-43.

Moreno-Ramirez D, Ferrandiz L, Nieto-Garcia A, Carrasco R, Moreno-Alvarez P, Galdeano R, Bidegain E, Rios-Martin JJ, and Camacho FM. 2007. Store-and-forward teledermatology in skin cancer triage: experience and evaluation of 2009 teleconsultations. Arch Dermatol 143(4):479-484.

Moreno-Ramirez D, Ferrandiz L, Ruiz-de-Casas A, Nieto-Garcia A, Moreno-Alvarez P, Galdeano R, and Camacho FM. 2009. Economic evaluation of a store-and-forward teledermatology system for skin cancer patients. J Telemed Telecare 15(1):40-45.

Nordal EJ, Moseng D, Kvammen B, and Lochen ML. 2001. A comparative study of teleconsultations versus face-to-face consultations. J Telemed Telecare 7(5):257-265.

Oakley AM, Astwood DR, Loane M, Duffill MB, Rademaker M, and Wootton R. 1997. Diagnostic accuracy of teledermatology: results of a preliminary study in New Zealand. N Z Med J 110(1038):51-53.

Oakley AM, Kerr P, Duffill M, Rademaker M, Fleischl P, Bradford N, and Mills C. 2000. Patient cost-benefits of realtime teledermatology--a comparison of data from Northern Ireland and New Zealand. J Telemed Telecare 6(2):97-101.

Oakley AM, Reeves F, Bennett J, Holmes SH, and Wickham H. 2006. Diagnostic value of written referral and/or images for skin lesions. J Telemed Telecare 12(3):151-158.

Onor ML, and Misan S. 2005. The clinical interview and the doctor-patient relationship in telemedicine. Telemed J E Health 11(1):102-105.

Pak H. 2008. Teledermatology: A User's Guide. New York: Cambridge University Press.

Pak H, Triplett CA, Lindquist JH, Grambow SC, and Whited JD. 2007. Store-and-forward teledermatology results in similar clinical outcomes to conventional clinic-based care. J Telemed Telecare 13(1):26-30.

Pak HS, Datta SK, Triplett CA, Lindquist JH, Grambow SC, and Whited JD. 2009. Cost minimization analysis of a store-and-forward teledermatology consult system. Telemed J E Health 15(2):160-165.

Pak HS, Harden D, Cruess D, Welch ML, and Poropatich R. 2003. Teledermatology: an intraobserver diagnostic correlation study, part I. Cutis 71(5):399-403.

Pak HS, Welch M, and Poropatich R. 1999. Web-based teledermatology consult system: preliminary results from the first 100 cases. Stud Health Technol Inform 64:179-184.

Parsi, K, Chambers, CJ, and Armstrong, AW (2010). Cost-Effectiveness Analysis of a Patient-Centered Online Care Model for Management of Psoriasis. Accepted for publication by the Journal of the American Academy of Dermatology.

Phillips CM, Burke WA, Allen MH, Stone D, and Wilson JL. 1998. Reliability of telemedicine in evaluating skin tumors. Telemed J 4(1):5-9.

Phillips CM, Burke WA, Shechter A, Stone D, Balch D, and Gustke S. 1997. Reliability of dermatology teleconsultations with the use of teleconferencing technology. J Am Acad Dermatol 37(3 Pt 1):398-402.

Robinson JD, Turner JW, Levine B, and Tian Y. 2011. Expanding the walls of the health care encounter: support and outcomes for patients online. Health Commun 26(2):125-134.

Romero G, Cortina P, and Vera E. 2008. [Telemedicine and teledermatology (II): current state of research on dermatology teleconsultations]. Actas Dermosifiliogr 99(8):586-597.

Romero G, Sanchez P, Garcia M, Cortina P, Vera E, and Garrido JA. 2010. Randomized controlled trial comparing store-and-forward teledermatology alone and in combination with web-camera videoconferencing. Clin Exp Dermatol 35(3):311-317.

Silva CS, Souza MB, Duque IA, de Medeiros LM, Melo NR, Araujo Cde A, and Criado PR. 2009. [Teledermatology: diagnostic correlation in a primary care service]. An Bras Dermatol 84(5):489-493.

Suneja T, Smith ED, Chen GJ, Zipperstein KJ, Fleischer AB, Jr., and Feldman SR. 2001. Waiting times to see a dermatologist are perceived as too long by dermatologists: implications for the dermatology workforce. Arch Dermatol 137(10):1303-1307.

Tan E, Yung A, Jameson M, Oakley A, and Rademaker M. 2010. Successful triage of patients referred to a skin lesion clinic using teledermoscopy (IMAGE IT trial). Br J Dermatol 162(4):803-811.

Taylor P, Goldsmith P, Murray K, Harris D, and Barkley A. 2001. Evaluating a telemedicine system to assist in the management of dermatology referrals. Br J Dermatol 144(2):328-333.

Tucker WF, and Lewis FM. 2005. Digital imaging: a diagnostic screening tool? Int J Dermatol 44(6):479-481.

Vallejos QM, Quandt SA, Feldman SR, Fleischer AB, Jr., Brooks T, Cabral G, Heck J, Schulz MR, Verma A, Whalley LE et al. 2009. Teledermatology consultations provide specialty care for farmworkers in rural clinics. J Rural Health 25(2):198-202.

van den Akker TW, Reker CH, Knol A, Post J, Wilbrink J, and van der Veen JP. 2001. Teledermatology as a tool for communication between general practitioners and dermatologists. J Telemed Telecare 7(4):193-198.

Warshaw EM, Gravely AA, and Nelson DB. 2010a. Accuracy of teledermatology/teledermoscopy and clinic-based dermatology for specific categories of skin neoplasms. J Am Acad Dermatol 63(2):348-352.

Warshaw EM, Hillman YJ, Greer NL, Hagel EM, Macdonald R, Rutks IR, and Wilt TJ. 2010b. Teledermatology for diagnosis and management of skin conditions: A systematic review. J Am Acad Dermatol.

Warshaw EM, Lederle FA, Grill JP, Gravely AA, Bangerter AK, Fortier LA, Bohjanen KA, Chen K, Lee PK, Rabinovitz HS et al. . 2009a. Accuracy of teledermatology for nonpigmented neoplasms. J Am Acad Dermatol 60(4):579-588.

Warshaw EM, Lederle FA, Grill JP, Gravely AA, Bangerter AK, Fortier LA, Bohjanen KA, Chen K, Lee PK, Rabinovitz HS et al. . 2009b. Accuracy of teledermatology for pigmented neoplasms. J Am Acad Dermatol 61(5):753-765.

Watson A, Pena, V., Kvedar, J.. 2009. Teledermatology. eMedicine.

Watson AJ, Bergman H, Williams CM, and Kvedar JC. 2010. A randomized trial to evaluate the efficacy of online follow-up visits in the management of acne. Arch Dermatol 146(4):406-411.

Weinstock MA, Nguyen FQ, and Risica PM. 2002. Patient and referring provider satisfaction with teledermatology. J Am Acad Dermatol 47(1):68-72.

Whited JD. 2010. Summary of the Status of Teledermatology Research. Teledermatology Special Interest Group - American Telemedicine Association.

Whited JD, Datta S, Hall RP, Foy ME, Marbrey LE, Grambow SC, Dudley TK, Simel DL, and Oddone EZ. 2003. An economic analysis of a store and forward teledermatology consult system. Telemed J E Health 9(4):351-360.

Whited JD, Hall RP, Foy ME, Marbrey LE, Grambow SC, Dudley TK, Datta S, Simel DL, and Oddone EZ. 2002. Teledermatology's impact on time to intervention among referrals to a dermatology consult service. Telemed J E Health 8(3):313-321.

Whited JD, Hall RP, Foy ME, Marbrey LE, Grambow SC, Dudley TK, Datta SK, Simel DL, and Oddone EZ. 2004. Patient and clinician satisfaction with a store-and-forward teledermatology consult system. Telemed J E Health 10(4):422-431.

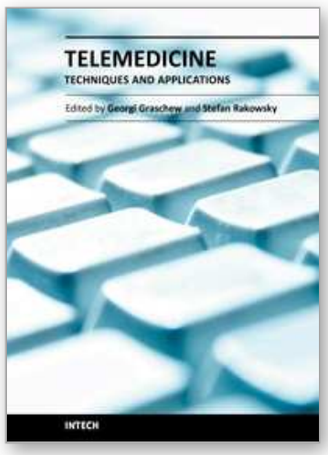
Whited JD, Hall RP, Simel DL, Foy ME, Stechuchak KM, Drugge RJ, Grichnik JM, Myers SA, and Horner RD. 1999. Reliability and accuracy of dermatologists' clinic-based and digital image consultations. J Am Acad Dermatol 41(5 Pt 1):693-702.

Wootton R, Bloomer SE, Corbett R, Eedy DJ, Hicks N, Lotery HE, Mathews C, Paisley J, Steele K, and Loane MA. 2000. Multicentre randomised control trial comparing real time teledermatology with conventional outpatient dermatological care: societal cost-benefit analysis. BMJ 320(7244):1252-1256.

Zelickson BD, and Homan L. 1997. Teledermatology in the nursing home. Arch Dermatol 133(2):171-174.

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Telemedicine is a rapidly evolving field as new technologies are implemented for example for the development of wireless sensors, quality data transmission. Using the Internet applications such as counseling, clinical consultation support and home care monitoring and management are more and more realized, which improves access to high level medical care in underserved areas. The 23 chapters of this book present manifold examples of telemedicine treating both theoretical and practical foundations and application scenarios.

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