Impact of an Intra-Institutional Teledermatology Service: A Mixed Methods Case Study

by

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Abstract

While teledermatology is proven to decrease access times to dermatologists, be clinically equivalent to in-person consults diagnostically, and have high satisfaction rates, less is known about its use in urban settings where geographical challenges to accessing dermatologists are not present. This mixed-methods evaluation of an urban, intra-institutional teledermatology initiative was guided by the Canada Health Infoway Benefits Evaluation Framework and involved a case series review of 76 teledermatology consultations, patient and provider surveys, and semi-structured interviews with health care providers. The study found that 84.2% of all consultations and 95% of inflammatory conditions (rashes) were manageable with teledermatology alone, with benefits to patients including savings in time, money, and preventing missed work. Providers were also highly satisfied with the reliability, timely responses, and quality of consults, but their administrative time increased. Further research on cost-effectiveness and the specific clinical use cases that could be optimized by institutional teledermatology is warranted.

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Chapter 1
Introduction

1 Introduction

1.1 Background

Teledermatology allows dermatologists to manage patients with generally equivalent clinical outcomes while requiring less resources and less time to the consultant[1]. The obvious use case, and therefore the most studied one, is in geographic areas that do not have timely access to dermatology. For example, in the United States, there are four times more dermatologists per patient in the largest metropolitan areas compared to less populated regions [2], and a similar clustering exists in Canada[3]. Relatively less is known about the potential for teledermatology when used "intra-institutionally" (i.e., within the same institution), where geographical barriers to access to care are not a factor included in the net benefit assessment of the value of teledermatology. Pilot studies have assessed the feasibility and diagnostic concordance of these implementations[4], but formal assessments of impact are lacking.

The practice of teledermatology can vary by participant and by the technology used. Primary teledermatology is when a consultant dermatologist interacts directly with a patient. Secondary teledermatology is when a consultant dermatologist interacts with a second health care professional on behalf of the patient. Tertiary teledermatology is when a dermatologist requests a consult from another dermatologist[5]. The two most common technological practices of teledermatology are live videoconferencing, where the interaction is live, and store-and-forward, where the parties interact asynchronously[6].

The hypothesis for this study was teledermatology would have value beyond addressing geographical barriers to access if implemented by the consultants and referring physicians intra-institutionally. We created this study to investigate the potential benefits, barriers, and impact of teledermatology in such an intra-institutional setting where the traditional geographical barriers to access do not exist. We further hoped to identify specific characteristics of a teledermatology service that would be useful for implementing the service at other institutions. For example, the American Telemedicine

Association guidelines for teledermatology[7] suggest it is more difficult to assess pigmented lesions and special sites such as the scalp with teledermatology, but there are few other recommendations in the literature.

1.2 Literature Review

The literature from 1973-2017 was reviewed for pertinent findings and key papers to obtain an understanding of the progression of teledermatology to date over the spectrum of increasingly accessible technology. Google Scholar was used with increasing date ranges and manually inspecting the abstracts in the results for pertinent entries. The start date of 1973 was chosen as the first date that teledermatology was reported according to an external survey of telemedicine[8].

One of the first reported evaluations of teledermatology in 1973 assessed the ability of dermatologists to make diagnoses of coloured slides using grayscale cathode ray tube television technology, and found that diagnostic concordance was still relatively high despite the perceived associated loss of information[9]. In 1976, teledermatology was cited as one of the potential candidates for telemedicine in general, while describing both a “heavy reliance on telecommunication technology, and the development of an organizational structure that is capable of efficiently utilizing this technology” as requirements for a successful implementation[10]. The first reported actual use case for videoconferencing teledermatology also occurred in 1976, as part of a general satellite-based telemedicine consultation service to rural Alaska[11].

By 1995, there were positive results of initial case studies for both synchronous[12, 13], and asynchronous[14] implementations and demonstrations of teledermatology, including the use case of assessing skin lesions for potential skin cancers[15]. Pilot studies demonstrated high satisfaction with telemedicine[16]. Initial descriptions of best standard service requirements were published suggesting that there needs to be security of communication, evidentiary support of equivalent clinical outcomes, and reasonable patient satisfaction [17]. Of relevance to the development of modern teledermatology, a study was published demonstrating the clinical diagnostic equivalence of digital photography to film photography[18].

Towards the end of the millennium, as there were more widely available digital technologies, there was an increase in articles supporting the diagnostic concordance and outcomes of teledermatology, both synchronous and asynchronous. One directly suggested high concordance (83%) between digital images and in-person visits, which almost exactly correlated with the intra-observer diagnostic concordance between dermatologists (84%)[19]. Other papers found similar diagnostic accuracies in synchronous systems[20]. Papers recognized the potential utility for teledermatology to overcome geographic access barriers[21]. An early cost-benefit analysis of teledermatology[22] demonstrated what would become a common theme: "[synchronous] teledermatology has more benefits for the patient than for the health care team." Other studies elaborated that while teledermatology enables patients to receive faster access overall and prevents patients from travelling long distances, the administrative work of providers increases significantly [23]. Given abundant access to new digital technologies, pilot case studies increasingly trialed synchronous teledermatology service designs to improve access to clinical dermatology[24]. Technologically, studies on digital images suggested that a relatively low resolution of 720x550 was sufficient for clinical decision making in synchronous teledermatology[25]. Finally, there were increasing calls for standardizations and creation of practice guidelines that would not be sufficiently addressed until the next decade[26].

In 2000, there were additional case reports describing the successful use of teledermatology in various clinical and research settings[27, 28], calls for the development of standardization of practice[29], and additional comparisons demonstrating the diagnostic concordance of both videoconferencing and store-and-forward teledermatology with in-person assessments[30]. These would serve as the basis for later systematic reviews and meta-analyses. Most notably, the 2011 review in the Journal of the American Academy of Dermatology stated that while the "diagnostic accuracy of clinic dermatology is better than teledermatology; diagnostic concordance of teledermatology with clinic dermatology is acceptable." Some early investigations of cost-effectiveness were negative, citing the specialized equipment, slow networks, and knowledge that was required for digital evaluation on the limited technology available in the early 2000s[31, 32].

Research in the following years expanded on the theme of diagnostic concordance, and saw the publication of systematic reviews, case series in special populations, and practice guidelines. A paper was published demonstrating the concordance of store-and-forward over 2000 teleconsults[33], and more systematic reviews and original papers confirmed the diagnostic concordance and equivalent outcomes between teledermatology and clinical dermatology [34-36]. Case series and pilot projects included the evaluation of hybrid models involving both store-and-forward and real-time videography[37], in pediatric populations[38-40], in prisons[41-43], and many case studies in rural populations such as those in "sub-Saharan Africa"[44, 45], or "remote areas of Brazil"[46, 47], among others. Practice guidelines for teledermatology were developed and published in 2008[7]. These guidelines focused on the requirements for the technological implementation of teledermatology (the pillars of security, identity, privacy, etc.). The clinical recommendations in those guidelines were not entirely in agreement with other papers that also evaluated the clinical situations most appropriate to teledermatology, such as the triage of pigmented lesions[48]. However, there was agreement in other aspects, such as utility in monitoring leg ulcers[49], other chronic wounds[50], and skin emergencies[51]. Overall, the sum of evidence-based clinical specifications for the best practice of teledermatology was inconsistent. The larger systematic reviews in the last decade targeted at teledermatology have evaluated aspects such as satisfaction and cost-effectiveness. Satisfaction by referring providers and patients is generally quite high in teledermatology[52, 53]. However, cost-effectiveness was not guaranteed and was very dependent on regional and implementation factors (such as billing, the technology used, etc.)[54].

1.3 Rationale

At Women's College Hospital in 2016, a consultant dermatologist (who is the primary investigator of this study and author of this dissertation) created a local, intra-institutional teledermatology service. Intra-institutional refers to the referring physician and the dermatologist being located within the same institution (in this case same building), so there are no geographic barriers to access. This was created because even though the wait times at the institution were among the best in the city (4-6 weeks), there were still

clinical scenarios where either significant conditions were seen too slowly, such as obvious malignancy or skin infections[55] and scenarios where self-limited but symptomatic skin eruption may have already resolved, removing the opportunity for diagnosis and symptomatic treatment[56]. It was hoped clinically this would be a way to improve care for those scenarios and led to the development of this evaluation.

1.4 Research Questions

This thesis sought to answer the main research question: What is the impact of an intra-institutional teledermatology service? Research sub-questions include: 1) What are the potential impacts and benefits for patients, for providers, and for the health care system? and 2) What are the educational benefits for providers in teledermatology, if any?

The preceding literature review formed the basis for the development of the service. The methodology of this study was guided by the Canada Health Infoway (CHI) Benefits Evaluation Framework[57]. This multifaceted framework describes the various components and stakeholders of e-health interventions, and has been used extensively to evaluate interventions such as electronic medical record systems[58] and telehealth initiatives [59]. Due to the complexity of human-information interactions, mixed-methods approaches have also been used to successfully evaluate other telemedicine initiatives[60] though they to date have not been used to evaluate dermatology or teledermatology initiatives[61], making this one of the first studies to use such an approach to formally evaluate teledermatology. Portions of this thesis was published in JMIR Dermatology in 2018 [62].

Chapter 2
Methods

2 Methods

2.1 Study Design Overview

A mixed-methods evaluation was designed using the broad categories of the CHI Benefits Evaluation Framework (Figure 1). This was chosen for evaluation specifically to assess the components of the service independent of organization or context factors (since these were essentially fixed). The domains of the framework were otherwise highly relevant to the overall evaluation of the service. For example, satisfaction was considered an important and novel domain to evaluate in this institutional context, and productivity was important to consider from both a referring provider and consultant dermatologist perspective. Use and perceived use would be helpful to evaluate in order to understand future scalability.

Case studies, surveys, and interviews were used as data collection methods. The intent was to include methods to evaluate each domain which would include both hypothesis driven and exploratory methodologies. For example, it was anticipated based on existing literature that the service would have reasonable satisfaction for providers, so that was directly evaluated in survey. However, exploratory components were also included, such as freeform comments and using a semi-structured interview approach to allow for emergent themes. To design the evaluation, each domain and sub-construct was reviewed against each stakeholder, and assessment methods were created when the domain could impact the stakeholder, leading to specific survey questions, semi-structured interview prompts, or elements of the chart review. Key results were correlated by concurrent triangulation, where quantitative data was used to attempt to inform qualitative themes and vice versa in a final, overarching analysis.

The study was approved by the research ethics boards at Women's College Hospital, and at the University of Toronto, both in Toronto, Ontario, Canada, REB #2017-0168, approved January 18 2018, terminated January 18 2019.

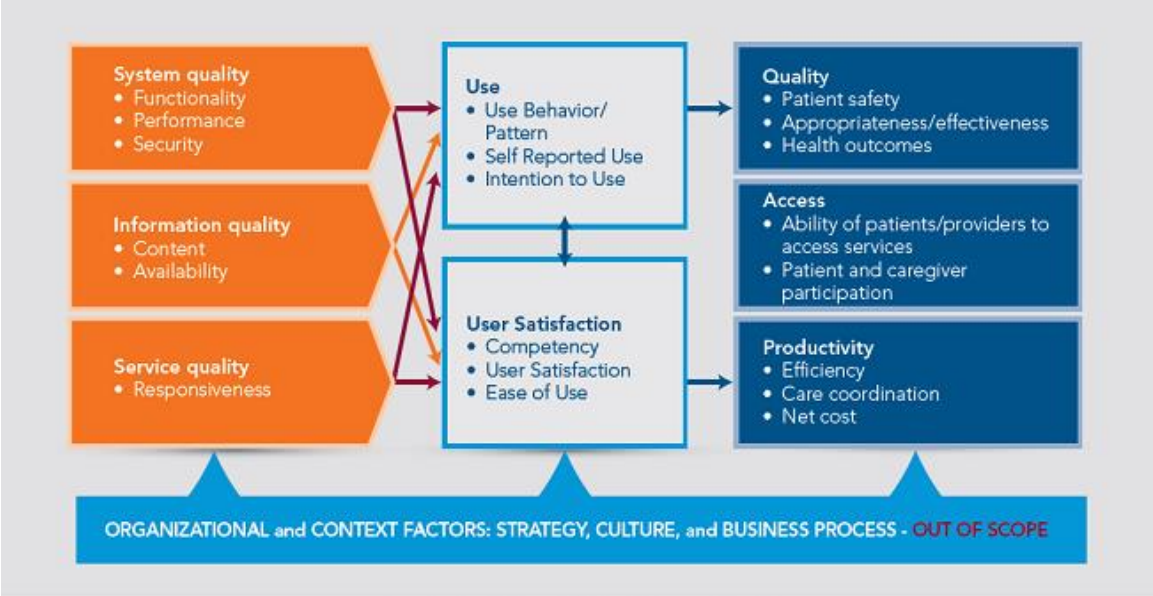

Figure 1. The Canada Health Infoway Benefits Evaluation Framework[57]**.**

2.2 Design of the Intra-Institutional Teledermatology Service

Prior to the implementation of this service, all consultative dermatology services were accessed by fax referral from the primary care providers at Women's College Hospital, who practice in the Family Practice Health Center, a center for family medicine, primary health care, and walk-in services. In Mid-2016, the teledermatology service was created and designed in accordance with the practice guidelines for teledermatology[7]. A store-and-forward model with secondary teledermatology was selected in alignment with existing professional funding in this region, which is flexible and allows dermatologists to bill for e-consultations independent of the technology used to manage them, with the only stipulation that the service not be used exclusively as a triage service. The service utilized the secure institutional email as a common, accessible technology for transfer of information. Clinically, the referring providers were informed that they could send any referral request they deemed appropriate, were provided with the email address, and informed that a response would be guaranteed within one week. No training was necessary. The primary author was the sole consultant providing responses. The service description was presented and offered at internal hospital family practice group meetings

with 28 potential referring clinicians. The details of the implementation are described in Table 1.

Table 1. The components of the intra-institutional teledermatology service and the rationale for choosing those components.

	Component	**Rationale**
Modality		
	Asynchronous	Most convenient method for the consultant dermatologist and requires the least amount of coordination or additional technology.
	Secondary teledermatology (referring health care provider to consultant dermatologist)	Meets identity and privacy guideline requirements, and secondary teledermatology is a regionally insured service by the provincial government.
Technology		
	Secure intra-institutional email	A convenient, ubiquitous technology that is secure, limited to institutional use, with no barrier to entry, and shared across clinics.
	Photography	Referring providers were requested to provide in-focus images, at least one close up, and if widespread, photos representative of the overall distribution.
Clinical		
	1 week response time	A four-fold improvement over existing wait times at this institution, and long enough to discourage urgent consultations in case of system failure.
	Free-form text permitted (no template)	To permit the benefits evaluation, we did not restrict the clinical use of the system or make implicit suggestions about what conditions would be appropriate.

2.3 Data Collection

2.3.1 Chart Review

The stored medical record for each consultation from the initiation of the service in late 2016 through all of 2017 was reviewed. All patients were registered within the hospital information system. Contact information was collected for emailing or mailing surveys. Demographic information including age and gender was collated. Each chart was reviewed for clinical characteristics including diagnosis and management. For each patient, the electronic medical record was additionally reviewed for evidence of treatment failure, symptomatic recurrence of the treated dermatosis, billing information, or any other pertinent follow-up information.

2.3.2 Referring Provider Survey

The email addresses or each referring attending provider who submitted at least one consultation was collated, and an email invitation from SurveyMonkey was used to request their participation in an electronic survey assessing satisfaction, time expenditure, satisfaction, educational value, and adverse events. Invitations were repeated at two weeks and one month after the initial invitation if the provider did not complete the survey.

2.3.3 Patient Survey

Patients were invited to participate in a survey assessing satisfaction with the service, potential benefits, and attitudes surrounding teledermatology. Email invitations were sent to the subset of patients who had provided an email address for hospital registration. A repeat email was sent a month after the initial invitation if a survey was not received by the patient. For all patients, a paper survey with a self-addressed stamped return envelope was mailed. Patient participants were offered the opportunity to submit their email at the end of the study to be entered in a draw to receive a $100 gift card.

2.3.4 Referring Provider and Potential Consultant Semi-Structured Interviews

In the same email invitations as above, referring providers were invited to take part in a semi-structured interview exploring perceived impact, current use, attitudes and opinions surrounding teledermatology. Similarly, potential dermatologist consultants, identified from a convenience sample of dermatologists in academic practice in the same hospital setting who could potentially participate in a teledermatology service, were recruited via email for semi-structured interviews. Interview guides were constructed using the categories of the CHI Benefits Evaluation Framework to be complimentary to other data collection strategies, assessing satisfaction, use, educational benefits, and experience and attitudes surrounding teledermatology.

Interviews were conducted over a three-month period after the initiation of the study. Interviews were conducted by the primary author with no other parties present, were audio-recorded, and were subsequently transcribed verbatim from the recordings by a professional transcription service.

2.4 Data Analysis

2.4.1 Chart Review

Demographic and clinical information was collected, including the complaint and diagnosis. The primary author further characterized the complaint as “lesion,” “rash,” or “other,” depending on whether the consult was most consistent with multiple or progressive skin findings over a generalized area (rash) or a single, stable skin finding in a localized area (lesion). We recorded the immediate follow-up plan including recommended transition to an in-person consultation versus “only need to see a dermatologist if not resolved by…,” and the proposed timing. Given the clinical diagnosis and current treatment plan, each complaint was also rated as “Possible,” “Likely,” or “Unlikely” to resolve before the usual in-person wait time for consultation (4-6 weeks) to capture potential cancellations and no-shows for self-limited conditions or unnecessary visits from patients already getting appropriate treatment from the referring provider. Cases such as urticarial exanthem or appropriately treated mild dermatitis were

rated as “likely” to resolve, whereas chronic skin conditions or lesions were rated “unlikely.”

In anticipation of the cost analysis, each chart was reviewed for subsequent visits with any dermatologist between November 2016 and March 2018. Actual billing information (if recorded) was used wherever possible. Otherwise, the most expensive permitted visit code was used. Actual cost savings were calculated based on this data, and multiple cost scenarios were constructed using the “lesion” and “rash” classification to determine the cost-effectiveness of different billing scenarios.

2.4.2 Referring Provider & Patient Surveys

Results from the Likert scales were collated, and scores averaged with standard deviations calculated. Free-form text answers were collated and reviewed using word cloud analysis and manual inspection for patterns or pertinent feedback to be incorporated into the final triangulation.

2.4.3 Referring Provider & Potential Consultant Interviews

For each set of interviews, the primary author and a secondary independent reviewer conducted independent qualitative analyses according to interpretive description[63]. The transcripts were sequentially reviewed and evaluated against categories originating from the CHI Benefits Evaluation Framework, and thematic analysis was used to identify unique emergent concepts transcending the interview guide. The independent reviewer submitted their qualitative analysis to the primary author for review. Identified themes from both sets of analysis were included in the final mixed-methods analysis. There were no discordant themes requiring dispute management by a third party.

2.4.4 Mixed-methods concurrent triangulation

For the final overarching analysis, we returned to the CHI Benefits Evaluation Framework to organize a mixed-methods concurrent triangulation strategy that used both qualitative and quantitative assessment methods. To this we included the additional evaluative components surrounding potential educational benefits. Emergent themes

derived from any component were triangulated with other data analysis to support conclusions.

Chapter 3
Results

3 Results

3.1 Chart Review

All seventy-six consults from 14 referring providers (comprising 50% of the 28 potential referring providers at Women's College Hospital) completed by the service between November 2016 and December 2017 were subjected to chart review. The average age of patients using the service was 39.3 years, with 17 (22%) pediatric patients, 3 pregnant patients, 28 males (37%) and 48 females (63%). The average time to response was 23.5 hours, with a minimum response time of 0.5 hours and a maximum time of 142.6 hours (6 days). In comparison, demographics of in-person assessments from 2016-2018 by the primary investigator showed an average age of 49 years, with 44% males and 56% female, however, pediatric in-person referrals at this site are automatically directed to a specialty pediatric dermatologist, which results in teledermatology referrals having a younger average age at baseline.

Clinical characteristics were grouped into diagnostic dermatology categories as in other teledermatology evaluations[64], and are presented in Table 2. Each case was also broadly categorized into an easily recognizable presenting complaint – a "rash" which presents in multiple areas of the skin with the same general appearance, most typically represented by eczematous dermatoses, infections, or reactive skin conditions, a "lesion" which is a focal, persistent eruption on the skin typified by benign and malignant growths, or a "question" about a treatment (Table 3). Of all cases, 12 cases (16%) were recommended for a transition into an in-person visit.

All cases were estimated as to the probability of productive attendance at a standard appointment 4-6 weeks after the teleconsultation. 18 cases were rated "Likely" to resolve, 18 cases were rated "Possible," and 40 cases were rated "Unlikely" to resolve before the appointment. "Likely" was indicated for common conditions already appropriately treated by the referring provider (e.g. a mild dermatitis being treated by a moderate potency corticosteroid), or a self-limited eruption such as erythema multiforme or

morbilliform viral exanthems[65]. representing a 23.7-47.4% chance that a patient may not show up to the appointment, cancel, or attend the appointment unnecessarily without any active pathology.

It had been assumed that clinicians would use photos gathered during a patient visit in their office. However, one unexpected result was the use of parental or patient-initiated photos, comprising 14.4% of all consults. In six (35%) of the pediatric cases, the source of photos for analysis were provided by the parents. Similarly, five adult patients provided their own photographs to the clinician. None of these patients required additional photographs or in-person follow-up, and where the data was available, the conditions had appropriately resolved. In one case, the parental-provided photograph provided evidence of skin manifestations of a rare genetic carrier condition that can be replicated only under specific conditions and often not reproducible in clinic.

Table 2. The clinical characteristics of the consultations grouped by dermatology diagnostic category. # of cases refers to the total number of cases seen within the category, and # transitioned to in-person consultation refers to the number of cases where the primary and only recommendation was that they be seen in-person by a dermatologist.

Grouped by Diagnosis	# of cases	% of the total	# transitioned to in-person consultation
Eczematous or Inflammatory (eczema, contact dermatitis)	30	39.4%	1
Infectious Requiring Intervention (fungal, viral, bacterial)	10	13.2%	0
Urticarial or Self Limited (morbilliform eruptions, pediatric urticaria)	7	9.2%	1
Lesion (malignant, premalignant, indeterminate, or benign)	21	27.6%	9 (43%)

Other (genetic, acneiform, etc)	8	10.5%	1
Total	76		12

Table 3. The clinical characteristics of the consultations grouped by presenting complaint.

Presenting Complaint	# of cases	% of the total	# transitioned to in-person consultation
"Rash"	53	69.7%	3 (5.7%)
"Lesion"	22	28.9%	9 (40.9%)
"Question"	1	1.3%	0
Total	76		12

Results identified for further assessment in the final mixed-methods analysis include that 94.3% of "rashes" were able to be managed by teledermatology alone, but only 59.1% of "lesions." Of the lesions that were seen in person, four were benign pigmented lesions, one was actinic keratosis (premalignant), four were basal cell carcinomas (malignancies) and for two of these patients, multiple other malignancies or premalignant lesions were identified in addition to the consulting lesion. Additionally, in 21 cases (27%), the primary management was to increase the prescribed potency of and/or choose a more effective vehicle for the currently used topical steroid. Finally, it was noted that in at least one case, a response time of 24 hours permitted initiation of therapy to prevent post-herpetic neuralgia complications in herpes zoster, whereupon the teledermatology service maximum response time of one week would have exceeded the recommended 72 hour time window for treatment[66].

3.2 Referring Provider Survey

Of the fourteen invitations sent, eleven responses were received for the online survey at a 78.6% response rate. The results of the survey and the Likert interpretation of the average score are detailed in Table 4. Feedback was generally very positive regarding satisfaction and educational value. Clinicians, on average, only slightly agreed that the service saved them time. Comments from the survey suggested that administrative time was in fact increased with the service. However, they did indicate the benefits of the service

outweighed this lost time and that the service had educational value. There were no adverse events reported.

Table 4. Health care providers rated each question on a scale from 1 to 7 where 1 was "Strongly Disagree," 7 was "Strongly Agree," and 4 was "Neutral." Responses were averaged and interpreted according to the final score.

Question	N	StdDev	Average	Interpretation
The responses from the dermatologist were complete.	11	0.6	6.6	Strongly Agree
The responses from the dermatologist were timely.	11	0.4	6.8	Strongly Agree
The service was reliable.	11	0.8	6.5	Strongly Agree
I was satisfied with the answers to the clinical questions.	11	0.7	6.5	Strongly Agree
I was satisfied with the educational value of the system.	11	0.9	6.4	Strongly Agree
The service was easy to use.	11	0.5	6.6	Strongly Agree
The educational value of the e-consults was generally superior to that of in-person consult letters.	11	1.2	5.5	Agree
This service saves me time.	11	1.2	4.9	Neither
This service provides advantages to me that outweigh any lost time.	11	1.0	5.8	Agree
This service saves patients time.	11	0.4	6.8	Strongly Agree
This service saves the health care system resources.	10	0.7	6.5	Strongly Agree

3.3 Patient Survey

76 patients were sent paper surveys and 26 patients who had provided an email for provider registration at the institution were sent a duplicate email invitation. 22 responses were received (28.9%; 10 by paper and 12 electronically). Patients were generally satisfied with the service and reported that it saved them time, money, and prevented them from missing work. However, they were generally split when they were asked if they would "prefer to use this system instead of going to see a specialist in-person." In comments, some patients indicated that they generally prefer in-person consultations as it

provides a greater opportunity to ask questions and be clearer on the rationale for therapeutic choices. The results are summarized in Table 5.

Table 5. Patients rated each question on a scale from 1 to 7 where 1 was "Strongly Disagree," 7 was "Strongly Agree," and 4 was "Neutral." Responses were averaged and interpreted according to the final score.

Question	N	StdDev	Average	Interpretation
I would want to use this service again.	22	0.6	6.7	Strongly Agree
I would recommend this service to a friend or family member.	21	0.7	6.6	Strongly Agree
I was satisfied with how my skin issue was managed.	21	1.0	6.4	Strongly Agree
I am comfortable with the idea of a physician I have never met evaluating my skin condition based on pictures.	22	0.7	6.2	Strongly Agree
I would prefer to use this system instead of going to see a specialist in-person.	20	1.8	4.9	Neutral
I would recommend this type of medical care to a friend or family member.	22	1.1	5.8	Agree
I think that the government should pay for me to talk to the dermatologist online directly.	21	1.8	5.4	Agree
I would personally pay to talk to the dermatologist online directly if it was not paid for by the government.	20	2.0	3.7	Disagree
I would have liked to see what was said between my family doctor and the dermatologist.	22	1.8	5.2	Agree
Overall this service saved me time.	22	0.6	6.6	Strongly Agree
Overall this service saved me money.	15	1.8	5.7	Agree
Because of this service I missed less work for my health appointments.	16	1.3	5.9	Agree

3.4 Referring Provider & Potential Consultant Interviews

A total of eight interviews were conducted: with four referring providers who had experience with the system out of fourteen invited, and four consultant dermatologists who either had experience with other implementations of teledermatology or were open to the idea of participating in the service. Interviews are referenced in the text as

"Interview F#" for family medicine/referring provider interviews, and "Interview D#" for consultant dermatologist interviews.

Fifteen themes emerged from a pooled analysis between the primary investigator and the independent assessor. Overall, all identified themes generally reflected the domains and constructs of the Benefits Evaluation Framework used to create the interview guide. For example, efficiency of care (with respect to productivity) emerged as a theme identified by both assessors. For referring providers, "the option to send a photo with a quick email and get a response really quickly is actually a huge asset… [The patients are] really happy not to go and see another physician for the same matter because some things are easily treatable or diagnosed through that service" (Interview F2). Dermatologists were open to the idea of email communication, however, expressed concern that additional administrative overhead of the email implementation may prevent uptake: "[In some systems,] the platform is not efficient, it doesn't keep track of cases seen, billing codes, billing numbers, the kind of information that we need in the logistics of how we provide care… a proper kind of charting system or billing system" (Interview D3).

Interviews supported the data from the patient survey that both providers and patients were satisfied with the service. One stated: "The patients are absolutely thrilled because... You can get back to them so quickly with such an informed opinion" (Interview F4). Providers also expressed satisfaction at the educational value of the system, as related to the speed of access: "When you get a referral back a month later or a few weeks later, sometimes you can't relate the two things and remember exactly, but when you get it back in real time or very promptly, it's a better learning experience for me and I can do a better job" (Interview F4).

Finally, referring providers noted that the service was very useful for telemonitoring situations where they had a good idea of the diagnosis but wanted to be up to date on management: "Next time that I see a similar presentation I know how to treat it and then if it doesn't work then I know where I should go." (Interview F2). Dermatologists agreed that management questions are more comfortable to answer than diagnostic questions in

telemedicine or remote situations: “I like questions about disease entities and management, as long as the diagnosis has already been established” (Interview D4).

3.5 Mixed-methods analysis

3.5.1 Triangulation using the CHI Benefits Evaluation Framework

In the concurrent triangulation evaluation, we correlated the categories of the CHI Benefits Evaluation Framework against the multiple methods of inquiry (Table 6). The hypothesis of net benefit was supported by both qualitative and quantitative evidence.

Table 6. Summary of the unified mixed-methods evaluation using the Canada Health Infoway Benefits Evaluation Framework [57].

Component	Chart Review	Quantitative (Surveys)	Qualitative (Interviews)	Triangulated Interpretation
System quality: Functionality, performance, security.	The technology demonstrated robustness with no lost messages.	Providers "strongly agreed" the service was reliable, and easy to use.	Referring providers and dermatologists found institutional email to be an appropriate medium, though with increased administrative burden.	Institutional email facilitated a functional service with adequate performance and security.
Information quality: Content and availability.	All consults were generally completed with one question and one response.	Providers "strongly agreed" the responses were complete, provided satisfactory answers to the clinical questions, and had educational value.	Interviewees spoke positively of the structure of the consults: "What I like to have the best is a plan that has multiple steps if the first doesn't work" (Interview F1).	A consult format that incorporates morphology, diagnosis, reasoning used, and a treatment ladder was satisfactory and educational to providers.
Service quality: Responsiveness.	The average response time was consistent with other systems in the literature[67], and in at least one case, potentially prevented morbidity.	Providers "strongly agreed" the responses were timely. Patients also commented positively on the rapid response.	"It works because your notes are good and your turnaround time is fast." (Interview F5).	A 24 hour average response rate was appropriate for most outpatient clinical situations.

Use: Behaviour, self reported use, intention to use.	Unexpectedly, there was utilization of parental and patient photos.	Though the service did not generally save providers time, they "agreed" that there were benefits that outweighed the increased administrative burden.	In interviews, dermatologists expressed that they would be more likely to offer the service if it represented an integrated workflow with medical records and billing.	Though the evident benefits to patients and the educational value ameliorates the burden to providers, a more integrated workflow may have increased utilization by referees and potential consultants.
User satisfaction: Competency, satisfaction, ease of use.	92.8% (13/14) providers used the service more than once.	Providers and patients "strongly agreed" they were satisfied with the outcomes of the system.	"Most patients that I follow up with afterwards are really happy that they didn't have to go to any more measures [to be treated]" (Interview F2)	The service demonstrated satisfaction for providers and patients.
Quality: Safety and outcomes.	Where independent followup was noted, the results supported the diagnosis and management plan of the teledermatology consult.	Zero adverse events were reported on the survey. Patients "strongly agreed" that they would use this service again or recommend its use. Patient comments supported the idea that the correct management plan had been identified.	No adverse events or areas for improvement were reported in interviews.	Intra-institutional teledermatology (concordant with existing literature) was safe and effective.

Access: Ability to access services, patient and caregiver participation.	The service was used for a broad demographic of patients and complaints, suggesting no barriers to access.	Patients "strongly agreed" they were comfortable with a physician they had never met evaluating their skin. However, they also "agreed" they would like to see what was said between the consultant and referring physician, an idea supported by patient comments.	Interviewees cited several patient factors (anxiety, sensitive locations, etc) that could theoretically prevent use, but there were no barriers noted in interviews that actually prevented use.	Though easy to access, further integration of the patient into the physician-physician communication channel may have been beneficial.
Productivity: Efficiency, care coordination, net cost.	For the Ontario billing codes, managing 84% of the consults by teledermatology in a representative population results in a 29.8% savings overall for visits to consultant dermatologists.[a]	Providers "strongly agreed" that the service saved health care system resources. Patients "agreed" that the service saved them time, money, and resulted in less work missed.	Both potential dermatologists and referring providers characterized institutional email as an efficient tool for consults. This efficiency was increased when email communication was used between the provider and the patients.	Intra-institutional teledermatology increased productivity and efficiency even when geography is not a barrier to care.

[a]A dermatology consult is billed at $72.15, a teleconsult at $44.45, a subsequent visit required after teledermatology at $38.70. The calculation on savings from billing of services is as follows: 1 - (0.16 * (44.45+38.70) + 0.84 * 44.45) / 72.15 = 0.298.

3.5.1.1 System Quality

Intra-institutional email provided a functional, easy, robust solution for consultative services. It required no additional training to implement. The referring physicians and potential dermatologist consultants in interviews considered formal email communication with consultants to be an improvement over fax consultations, well accepted by patients and providers, and a very straightforward and accessible method of communication: One dermatologist noted in their interview that they "receive multiple email requests from referring providers already," and as such the service is a formal extension and evaluation of an existing informal process.

In surveys, providers "strongly agreed" the service was reliable, and easy to use. There were no instances of lost messages or significant downtimes or outages that prevented use of the institutional email system. Drawbacks to the use of email that were noted in the interviews and comments included the increased need for further effort of documentation (either printing emails or transcribing them into an electronic medical record system) and a lack of integrated billing.

3.5.1.1.1 Information Quality

The information quality was found to be beneficial. Surveyed referring providers strongly agreed that the responses from the dermatologist were complete, provided satisfactory answers to the clinical questions, and had educational value. This sentiment was correlated in multiple comments, e.g. "Many cases the recommendations confirmed I was using correct management and provided further options if initial management failed" and interviews, e.g. "What I like to have the best is a plan that has multiple steps if the first doesn't work."

A comment in the referring provider survey suggested that consult templates may be helpful: "If there was a suggested template to use when providing requests for e consults, this could be very helpful (e.g. selectable descriptors of a lesion, what types of photos to include, any other yes/no info that might help the dermatologist)." However, in chart review, all cardinal skin symptoms that may help the dermatologists were appropriately reported (pruritus, burning, pain) and in no cases did an insufficient history prevent a response. Overall, 83% of all consults only required a single request and response. The remainder were either administrative clarifications, one request for photos that were erroneously not sent, and one request for repeat photos that were initially sent at a prohibitively low resolution for evaluation.

One patient specifically noted in comments on the survey that they did not try the suggested management, and instead, an alternative treatment that worked but took significantly longer than the proposed strategy would have, citing a lack of confidence in the dermatologist's proposed treatment plan: "I was not sure why they prescribed something so greasy." Comments were anonymous, so it is unclear whether this was a failure of the dermatologist to provide the necessary rationale of treatment choice to the referring provider, a failure of the provider to provide the necessary information to the patient, or if there was an alternative reason.

3.5.1.2 Service Quality

While the initial design of the system was to guarantee a response time of one week, organically the service arrived at an average response time of 24 hours. In at least one case, in chart review, this prevented morbidity by initiating treatment for herpes zoster within the 72 hour window of effectiveness[66]. Without teledermatology, this would have resolved by the time a classic appointment was booked and completed, and the patient would have had a greater chance of developing a debilitating post-herpetic pain syndrome.

In surveys, referring providers strongly agreed that the responses from the dermatologist were timely. This was echoed in the patient survey, where speed of service was mentioned in comments: "Was very impressed with information provided to my GP by email which she forwarded to me and also impressed with "speed." A referral would mean I'd be waiting for the appointment during which time I would be nervous. This way, very short/short time to stay anxious!" Referring providers also noted a fast response time in interviews: "The experience with email has been great, I've raved about it to residents, and we've found the access is quick, as fast access to dermatology can be challenging in the city."

3.5.1.3 Use

The perceived usefulness of teledermatology by the referring health care providers was generally positively correlated with the results of actual use as determined through chart reviews. Referring providers in interviews suggested the service was helpful for rashes: "Getting a rapid derm opinion that can act to reinforce my opinion really helps, and one or two rashes where it's a very significant rash and the patient is worried, and it turns out to be eczema or contact dermatitis, so

we can quickly implement a plan and options, and it's been really helpful for those patients." This is correlated by actual use, where rashes comprised 69.7% of consults.

One unexpected result was the use of parental or patient-initiated photos, which comprised 14.4% of all consults. In six (35%) of the pediatric cases, the source of photos for analysis were provided by the parents. Similarly, five adult patients provided their own photographs to the clinician. None of these patients required additional photographs or in-person follow-up, and where the data on patient outcomes were available, the conditions had appropriately resolved. In one case, the parental-provided photograph provided evidence of a rare condition that occurs only under specific conditions.

In some cases, perceived use did not reflect actual use. Interviews with referring providers and potential dermatologist consultants mentioned that certain patient factors including the number of comorbidities and advanced age were the most effective determining factors for what patients would utilize the service. However, 76% of all consults were for patients under the age of 65, showing actual utilization was for relatively younger patients. Because of limited access to complete medical records, it was not possible to formally quantify the morbidity load of patients in the consult service.

Factors affecting potential use by consultant dermatologists were assessed in interviews. When asked to consider under what circumstances they would consider engaging in this service, they outlined system requirements that minimized the administrative burden of teledermatology – namely, efficient user interface, permanent archival functions, and integrated billing. They were reluctant to evaluate pigmented skin lesions or potential skin cancers by teledermatology. This correlated with actual use of the service, where 40% of lesion assessments were triaged to an in-person assessment. A further theme was that an ideal use of teledermatology is for the follow-up of existing patients. Though the service mostly involved the consultation of new conditions, one request found through chart review, did involve the specific reassessment of a prior condition seen in person by the consulting dermatologist. This was successfully managed by the service and did not require transition to an in-person visit.

3.5.1.4 User Satisfaction

Satisfaction was high for both providers and patients. Providers strongly agreed they were satisfied with the answers and the educational value of the system. Patients strongly agreed they were satisfied with how their skin issue had been managed. Comments from providers included items such as: “Excellent service for patients and learning opportunity for me.” Comments from patients included: “It was very helpful and reassuring to me.” Interviewed providers reported high satisfaction with patients: “Most patients that I follow up with afterwards are really happy that they didn’t have to go to any more measures [to be treated],” and with themselves: “I’ve been very impressed with the process and with the value that it has added to this unit and me personally, and the care of this patients.” These sentiments were correlated by actual use in chart reviews, with 92.8% (13/14) of referring providers using the service more than once.

3.5.1.5 Quality

There were no noted adverse events in the case studies or follow-ups, reported by physicians in the survey, or reported by patients. Referring providers reported that in all cases, they implemented at least part of the recommendations from the consult. Patients strongly agreed they would want to use this service again and would recommend this service to a friend or family member.

Important clinical conditions that are time sensitive in terms of diagnosis and rapid management in dermatology are the infections requiring intervention and serious drug rashes[68] because of the risk of significant morbidity and mortality. There were no severe drug rashes and no severe infections sent to the consult service; this is at least partially because the referring pool is an ambulatory service, and people with skin manifestations of serious disease are likely to be quite ill and usually seen or rapidly triaged to the ED or inpatient setting. On case review, the clinical features of the infections managed by the service are detailed in Table 7. There is an apparent direct relationship between the time onset of the skin manifestation and need for rapid treatment.

Table 7. Clinical characteristics of infections managed by the teledermatology consult service. Time goals of treatment are derived from standard dermatological guidelines of disease management[55].

Description	# of cases	Typical acuity of onset	Time goal of treatment

Chronic dermatophytic or yeast infections/infestations (tinea, pityriasis versicolor)	4	Weeks	Weeks to months
Chronic viral infections (e.g. HPV)	2	Weeks	Weeks to months
Acute viral infections (HSV, VZV)	3	Days	Within 72 hours (to prevent post-herpetic neuralgia and other complications)[69]
Acute bacterial infections	1	Days	As soon as possible (to prevent extension, bacteremia, sepsis)

3.5.1.6 Access

Generally, there were no barriers that prevented accessibility of the system. Interviewed referring providers expressed hesitancy with sensitive areas of the skin, e.g. “if it’s a sensitive area of the body I would have a real concern sending a vulva lesion across or something like that. I think that would be a concern, or a breast lesion, if the breast was identifiable” (Interview F5), and with potentially identifying photos: “I think, we do … make sure there’s nothing identifying” (Interview F1). However, on case review, there were consults that involved sensitive areas such as the vulva or breast, and multiple identifying facial photos. This suggests there are other factors at play that may determine the comfort of using this service with identifying photographs or for sensitive areas. Correlating with the patient survey, patients “strongly agreed” that they were comfortable with a physician they had never met evaluating their skin. However, one patient commented: “If it had been on an area I had to undress to reveal, I would be less comfortable using this service.”

Patients also “agreed,” that they would like to see what was said between the consultant and referring physician. The desire for a deeper integration into this communication pipeline was directly expressed by three patients in comments, and indirectly through the patient who expressed that they did not understand the rationale of treatment choice. Comments included:

"The downside is the [lack of] opportunity to ask questions," and "I would like the ability to view my file online."

3.5.1.7 Productivity

From the survey, providers "strongly agreed" that the service saved health care system resources. Patients "strongly agreed" that the service saved them time, and "agreed" (with greater variance) that the service saved them money and prevented them from missing work. The general sentiment could be summed up by the patient comment: "Anything that saves patient time (inc travel time) is a win in my eyes!" One patient commented: "I am retired so I did not miss any work." It is possible that, as phrased, the service would not prevent patients from "missing work" if they were retired or not working which may have negatively skewed these results. However, the generally younger demographics of the service and the proportion of patients who responded "N/A" would suggest against it.

In interviews, both dermatologists and referring providers spoke positively about the efficiency of intra-institutional email. One dermatologist noted "it's a quick and efficient way, comes right into your inbox. It would be an easy thing to incorporate into your workflow" (Interview D4). One referring provider stated "I actually think it's much more safe and efficient than fax because in emergencies you don't know what's happening with the fax, and whether it's still being scanned in. So I much prefer the response time and you can follow up very quickly so I think it's quite good" (Interview F1). Patient comments echoed this sentiment. There was also mention of the efficiency of potential follow-up through email: "If they do have to go, come here and see a dermatologist then they're in the system already and that communication is really easy right because we're already communicated by email and we know that that line is secure … it's good to know that that line of communication is open and we have a way to reach the clinic if we need to" (Interview F2).

3.5.1.7.1 Cost Analysis

A cost analysis was completed looking at the impact on the professional fees of dermatologists charged to the Ontario health insurance system. There are multiple ways a dermatologist can be remunerated for a patient visit. A consultation (A025) is billed to the Ontario Health Insurance Plan at $72.15 and requires a "consult request" from a referring provider, and a provider can only

bill a consult for a patient once a year. The equivalent teleconsultation (U025) or an "e-assessment" has essentially identical requirements but is remunerated at $44.45. If the requirements for a consult cannot be satisfied, there are "repeat consults," "specific assessments," and "repeat assessments," that are billed at decreasing amounts with fewer documentation and referral requirements. These are detailed in Table 8.

In the simplest billing scenario, a dermatologist performs a virtual consult (U025 = $44.45), and if needed, sees the patient in person themselves, billing a "specific assessment" (A023 = $38.70). If the dermatologist were to use the system as a triage mechanism, where all patients receive a virtual consult and then are eventually seen in person, the expected cost per patient would be $83.15, or 15% more expensive than usual care. If, however, the service follow-up requirements were similar to those observed in this study, where only 16% of virtual consults required in-person follow-up, then the expected savings would be: 1 - (0.16 * (44.45+38.70) + 0.84 * 44.45) / 72.15 = 0.298, a 29.8% savings, or an expected cost per patient of $50.56.

Billing information was obtained or extrapolated where possible from the electronic medical record system. When actual billing information is used (Table 8), the cost savings drops to 24%. This is partly because, as shown, there are multiple ways that a patient could potentially be seen in follow-up after a virtual consult. Also in this case, in addition to the 12 patients evaluated by teleconsult and then deliberately transitioned to in-person assessment, there were 4 patients who both used the teledermatology service, and were subsequently seen by a different dermatologist at Women's College Hospital – for which they can bill a full new in-person consult rate. Of these, 2 were distant subsequent follow-ups for the same issue, and 2 were new referrals for new issues. However, the tele-consult issue was mentioned in the note for these 4 patients. All were included in the cost analysis in order to create the fairest evaluation possible. This may still overestimate cost savings because data on patients who were sent outside of the institution to another dermatologist in the city was unavailable for this study.

Table 8. Actual OHIP (Ontario Health Insurance Plan) billings for visits as interpreted from the electronic medical record system. [70]

Billing code	Description	# of codes billed	Cost per code	Total
U025	Teleconsultation	76	44.45	3378.20

A023	Specific assessment	5	38.75	193.75
A026	Repeat consultation for the same issue (one month or more after the teleconsultation)	3	44.45	133.35
A024	Repeat assessment	2	21.90	43.80
A025	Consultation	6	72.15	432.90
Total				4182.00
Billings if all consults were seen in person		76	72.15	5483.40
			Cost savings	24%

Given the wide discrepancy between "rashes" and "lesions," it was instructive to analyze the potential expected cost of a patient, relative to the standard in-person consultation ($72.15) under multiple potential scenarios. Any expected cost below $72.15 per patient represents a cost savings on the existing system. In this way, we can construct expected costs for a number of theoretical service designs and billing scenarios. One such design would be the use of a virtual consult service to triage patients – where all patients seen virtually are eventually seen in-person. However, this use is obviously immediately more expensive than the traditional in-person assessment based on visits alone ($44.45 for virtual consult + $38.70 for specific assessment = $83.15, 15.2% more expensive than usual care). Another scenario could be where a system is set up where one clinician assesses a patient virtually, but all in-person consults are done and billed by another clinician. Using the system only for "rashes" where only 5.8% required follow-up would have an expected cost per patient of $55.85 but using the system for "lesions" with a 40.1% follow-up rate would have an expected cost of $73.96, meaning that strategy is not cost effective for lesions.

In Ontario, there are also teleconsultation benefit codes that can be billed by the referring provider. In this service, it was assumed that the referring providers did not bill this code, as there are certain restrictions that may prohibit its use outside of the Ontario Telemedicine Network infrastructure[70]. However, this "K-code" benefit (K738 = $16.00) raises the cost of a virtual consult to $60.45 – which is 84% of an in-person consult instead of 62%, because there are now two components to the billing cost of a teleconsultation – $44.45 for the consultant, and $16.00 for the referring provider. In this scenario, the overall service is cost effective and managing rashes is cost effective, but services directed at lesions are *never* cost effectively managed with teledermatology in Ontario. Various theoretical cost scenarios are outlined in

Table 9. Notably, services targeted at rashes where the same dermatologist sees patients in in-person assessment if needed are always cost effective, whereas services targeted at lesions where a different dermatologist sees patients for in-person assessment are always cost prohibitive.

Table 9. Theoretical expected patient cost scenarios in Ontario. A patient seen for in-patient consultation costs $72.15, and a patient seen for virtual consultation costs $44.45. If a referring provider elects to bill K738, the total cost of virtual consultation rises to $60.45. Any scenario where the expected cost is greater than $72.15 is more expensive than usual care. Using our current study data, across all virtual consultative services, 15.8% of patients will require follow-up. For rashes and lesions, 5.7% and 40.1% will require follow-up through an in-person assessment, respectively. Figures bolded represent scenarios that are not cost effective.

	If referring providers do not bill K738.				If referring providers do bill K738 (additional $16.00 per virtual consult)			
	If all patients were seen virtually, then followed up in person	General virtual consultative service	A service that manages "rashes"	A service that manages "lesions"	If all patients were seen virtually, then followed up in person	General virtual consultative service	A service that manages "rashes"	A service that manages "lesions"
The same dermatologist sees the patient for the in-person assessment	**$83.15**	$50.56	$46.66	$60.28	**$99.15**	$66.56	$62.66	**$76.28**
A different dermatologist sees the patient for the in-person assessment	**$116.60**	$55.85	$48.56	**$73.96**	**$132.60**	$71.85	$64.56	**$89.96**

Finally, for the conditions that could potentially self-resolve, it is necessary to consider the impact of no-shows, where in the worst-case scenario, the condition has resolved, but patients do not cancel the appointment and simply do not attend. There is certainly an impact of no-shows on wait times and clinic efficiency of consultant dermatologists, but no-shows result in no billings and less overall cost to the system. If the 23.7% of patients who were rated "unlikely" to attend a standard in-person dermatologist appointment because their condition resolved subsequently did not attend, then those patients would never be seen and the visits would never be billed to the system and not incur direct health care costs. In which case, the expected cost of a patient with a 24% no-show rate is effectively lowered to $72.15 * 0.76 = $54.83. In this scenario, teledermatology is never cost effective when referring providers are remunerated (all expected costs are > $54.83), but is cost effective overall, especially when managing rashes.

Chapter 4
Discussion

4 Discussion

4.1 Overview

This study evaluated whether intra-institutional teledermatology service was effective and satisfying to providers and patients when geographic access is not a barrier. The CHI Benefits Evaluation Framework was a helpful tool in developing an assessment for the multiple factors of the teledermatology service. In general, the study found benefits of intra-institutional teledermatology to clinical care and high satisfaction by providers and patients, but there were aspects of the service that could be improved on from the perspective of the patient, the practitioners, and the health care system. While this implementation was essentially dictated by the practical considerations and the technology that was available, future robust service design research may benefit from approaching teledermatology from a more stakeholder-oriented perspective or using a "public health/stakeholder first" evaluation and implementation framework [71].

A similar implementation that used an intra-institutional electronic medical record system for dermatology consults reported essentially 100% diagnostic concordance between teledermatologists but found a lower teledermatology management rate of 64% than the 84% reported here, despite the fact that the rough proportion of type of clinical condition was similar (18% "lesions" and 75% "rashes"). That implementation did not assess satisfaction or perform a cost analysis. though they did indicate that teledermatology resulted in a greater proportion of patients actually being assessed by a dermatologist - which has the potential to improve care, but at the same time, would increase the direct costs of the system[4]

This thesis was successful in applying a "mixed-methods" approach to qualitative and quantitative data analysis, with reciprocal explanatory findings. In many cases, the qualitative data explained or supported the quantitative data, such as the high satisfaction rates or the reasons for using the system despite the increased administrative burden. In others, the quantitative data or case reviews helped clarify perceptions and ideas expressed in the qualitative data, such as the idea expressed in interviews that patients may be uncomfortable with using the

service for sensitive areas, but the case review showed that was certainly not true for all patients, particularly for acute issues. In the following sections, the triangulated findings from the Benefits Evaluation Framework will be discussed in the context of current literature and studies of other implementations.

4.2 Correlation of the Benefits Evaluation with Relevant Literature

4.2.1 System Quality

Secure email is an appropriate and secure method of performing consultations and has been used extensively for teleconsults by other specialties. A meta-analysis in 2013 noted that formal email consultations between providers was widely used, and was associated with high satisfaction and fast response times[72], concordant with this study. However, fundamentally, email is perceived as a very old, insecure technology[73] which can limit its use subject to regional and institutional privacy policies as email can be sent between institutions even if security and encryption is not installed. Intra-institutional email would be generally acceptable when access to the email server is encrypted and the email never leaves the server, but this means email as a scalable inter-institutional service would be limited, yet applicable to replicating the intra-institutional model.

The benefits of email are that it is a mature technology, with no accessibility barriers. The service required a point of contact with a provider which permits identity verification (as opposed to unsolicited emails). For a smaller institution, this can be ideal; however, when scaling, making an email publicly known can create security issues and may be unpalatable to clinicians. Nevertheless, there is also in Ontario a province-wide OneMail initiative which can be used to securely transmit personal health information. In addition to identity, privacy, and security issues, studies have suggested that patients would use unsolicited email for very different purposes than clinicians would prefer, such as requesting services outside of what is medicolegally appropriate [74]. It also creates issues if the service needs to be suspended (for example, if there is no consultant dermatologist available to take consults). This leads to wasted time because email will only reject messages once they have been sent, which means the referring provider has the burden of creating the consult and sending it, only to find out that the service is no longer available due to the reasons above.

4.2.2 Information Quality

This study suggested that clinical management decisions were able to be made despite the lack of templates for referring providers to use to guide taking a relevant patient history, though at least one comment suggested it may be helpful. Prior implementations have used templates to ask about items such as cardinal skin symptoms (pain, itch, burning), duration of issue, pertinent change[75, 76]. However, one study assessing this issue found that the only historical item that aids in diagnosis is whether or not there was a previous treatment[40]. This supports the interpretation of this study that templates are an unnecessary administrative burden for an outpatient population. However, because of the high acuity and specific questions needed for an inpatient population, intra-institutional teledermatology serving inpatients may still benefit from a more structured history collection[77].

There is limited literature on education in teledermatology, and this is one of the first studies to investigate the deliberate educational intent of teledermatology for referring providers as embedded in a consult service, and to attempt to clearly define the elements of a consult that referring providers find to be educational. A recent published retrospective survey corroborates the finding that teledermatology consults improve the educational knowledge of referring providers[78] Other papers have noted the value in incorporating trainees into the teleconsult process[79], or initiatives such as project ECHO that explore virtual education divorced from service[80], but generally specific initiatives directed at teledermatology are lacking. Furthermore, it is not entirely clear if special skills or dedicated education is necessary for teledermatology practice by consultants, or if it is a matter of simply increasing exposure through residency training programs [81]. This is a potential area of future research.

4.2.3 Service Quality

Response time is dependent on a number of systemic factors. The Ontario Telemedicine Network offers two different turnaround times, 72 hours for “urgent” consults and 1 week. The lowest average response time observed in studies was 2 hours in a pilot project in New Zealand[75]. However (as may even be the case in this system) that response time exclusively as part of a study may trend towards more rapid care that would not be sustainable in practice. Extremely rapid responses can be seen in some implementations where specialists are provided a stipend to

be “on call” 24 hours a day [82]. Other, more similarly designed outpatient consultative implementations guarantee 24 hour response times [83].

The administrative burden to referring providers may also be extensive. This study did not quantify time estimates but prior studies have reported that teleconsults under a similar model adds approximately 8.1 minutes to send the consultation and 11.6 minutes to manage the results of the consultation [84]. In a fee-for-service model, this is significant. Ontario has attempted to incentivize referring providers by funding the sending of the e-consult, but ideally further efforts should be made to reduce this administrative penalty, such as tight integration of a consult system within an electronic medical record system [4].

4.2.4 Use

Parental or patient self-acquired photographs were used in a relatively high proportion of cases. Recent research has suggested that, as in this study, they can be used accurately for diagnosis while preventing visits [85]. Another potential use is for the initial assessment of infrequently triggered dermatoses, such as contact dermatitis, urticaria, polymorphous light eruption, or aquagenic palmar wrinkling [55], which may or may not be present at an in-person specialist appointment and thus delay or prevent accurate diagnosis.

4.2.5 User Satisfaction

The positive satisfaction rates seen in this study echo numerous works on satisfaction in teledermatology, including systematic reviews [52, 53, 86]. Patients, providers, and consultants generally have high satisfaction for teledermatology initiatives. Aspects of satisfaction for e-consult services generally include access and response time [87]. However, this may be potentially relative to regional wait times, and do not capture the whole story, as some services reported an exceptionally high satisfaction rate (near 100%) when median wait times for a response were up to 2 weeks [88]. Two weeks may be demonstrative of an exceptionally satisfying service if the average wait time is otherwise months. Further study on the exact domains of satisfaction in teledermatology is warranted.

4.2.6 Quality

Adverse events seem to be rare in teledermatology. There are no systematic reviews directed at safety and studies generally report few to no adverse events. This may be in part due to the fact that adverse events may be lost to the system. In this implementation, if for example, a condition dramatically worsened as a result of misdiagnosis, there would be the possibility for a patient to seek dermatologic care on an urgent basis without involving their primary care provider or the teledermatology service and as such the adverse event would not be captured. The converse may also be true: considering the herpes zoster example, in populations that are at higher risk from zoster (increased age and immunosuppression) the ability for those less mobile patients to obtain urgent care by this method may ultimately reduce morbidity[69]. Patient comments expressed how they would like to be able to ask questions, or that they were not sure what they would do if they had a problem with a treatment, or if something precipitously worsened, then they did not know how to manage it. This is a sentiment echoed in the literature, with one paper showing patients were concerned about the "potential loss of quality in the doctor-patient relationship" [89]. Further integration of patients into the consultative process, such as directly and immediately sharing consult notes, or providing the opportunity to ask questions [90] may be helpful.

4.2.7 Access

The multiple small implementations of teledermatology in the literature generally reflect the profile of clinical conditions assessed in this study, and its use for severe skin disease in the outpatient setting is practically nonexistent. Minor, common inflammatory conditions (such as eczema or psoriasis) and minor, common infectious conditions (such as tinea), and evaluation of skin lesions predominate[64, 91, 92]. This could reflect the ability of referees to appropriately select patients for the service, or that teledermatology is used with a different cohort of patients. For example, one study suggested it was used primarily on a "younger, healthier population"[91]. Other papers echo the caution expressed in this study (and the original American Telemedicine Association guidelines) about the use of teledermatology to evaluate lesions, particularly pigmented lesions[93].

4.2.8 Productivity

The effectiveness of teledermatology at preventing visits (and therefore preventing visit fees and saving travel time) is not uniform across case studies in the literature. However, a similar system in a European region with a larger patient base also using email showed that 17% of referrals required a subsequent in-person follow-up[94], which is concordant with these results.

Although lesions were not necessarily cost effective from a billing perspective, there is a possibility that earlier identification of skin malignancies would be cost effective overall. The cost of melanoma is estimated at approximately $4000 CAD per year in direct health care costs for stage I, compared to $32,000 direct costs in stage 4 [95], and pharmaceutical costs with estimates ranging from $13,000 per month [96] to over "$1 million per patient" to achieve an additional 8 months in median disease-free survival [97]. There is no agreement in time to excision [98], but the UK government suggests a 2 week rule from identification to excision [99], considering that melanoma can grow by 0.5mm/month which can dramatically increase stage at time of diagnosis [100], and more recent literature suggests melanoma should be fully treated within 30 days of identification to prevent increasingly poor outcomes [101]. Together, this suggests that even if there is a small net negative cost to the earlier identification and triage of lesions, there could be enormous savings by identifying melanoma earlier.

Finally, while patients with self-resolving dermatoses may ultimately cancel or no-show, a greater proportion of patients would then still receive a specialist dermatology assessment of their condition if teledermatology was used. This finding was consistent with a similar teledermatology implementation in literature that suggested an increase from 64.2 to 83.3% in the proportion of patients referred to dermatology who actually received a specialty assessment [4]. However, this improved access to specialty opinion for patients may or may not impact cost effectiveness or clinical outcomes and this could be an avenue of further research.

4.3 Survey Responses Demonstrating High Rater Disagreement

In the survey, there was generally reasonable agreement within a single point of the Likert scale. However, there were instructive statements with significant disagreement (with the highest standard deviation of responses) was in the patient survey with a 1.8-2 point deviation, or a 25-30% overall disagreement. These responses are discussed in the following sections.

"I would prefer to use this system instead of going to see a specialist in-person" was a statement with neutral agreement and a large standard deviation of response (Mean=4.9, N=20, StdDev=1.8). Literature has supported that while satisfaction is high with all forms of teledermatology, patients prefer to be seen in person. This observation has been consistent over 15 years of technological development, from 2001 [102] to 2016, and does not appear to change whether or not videoconferencing is used [86]. However, comments suggested that the ability to ask questions is an important component that would have elevated the service: "The downside is the lack of opportunity to ask questions and raise other issues." This suggests that the interactivity of the patient with the provider is an important component to satisfaction, particularly given that there was also high disagreement on "I would have liked to see what was said between my family doctor and dermatologist," which still suggests a passive involvement in the encounter. A stronger relationship is formed between patient and provider in a face-to-face encounter. As stated in one interview, "I will say that at the crux of family medicine and the delivery of this patient-centered care, relationships matter" (Interview F4). Patients would seem to prefer to have an ongoing relationship and open line of communication with their providers. One patient suggested this could avert unnecessary duplication of care: "Only suggestion not addressed is follow-up … I had to see another doctor while travelling as the skin condition worsened."

Even though patients wanted a more direct line of communication and stronger relationship with their provider, they were not necessarily willing to fund it, and finances were another area of broad disagreement. Patients agreed (though not uniformly) that "Overall this service saved me money," and that "I think that the government should pay for me to talk to the dermatologist online directly," though they disagreed (with the widest margin) that "I would personally pay to talk to the dermatologist online directly if it was not paid for by the government." The willingness of patients to self-pay for health care services is dependent on both cultural and socioeconomic factors and can be quite divisive[103], though recently new services have launched for patients in Canada to directly pay and access dermatological consultative opinions. The existence of such a service contravenes American Academy of Dermatology guidelines[104] and the effectiveness of this service remains to be seen.

4.4 Summary

The hypothesis that the intra-institutional teledermatology service would be effective and satisfying to providers and patients even when geographic access is not a barrier was upheld by the concurrent triangulation analysis. Store-and-forward teledermatology has demonstrated diagnostic concordance[105] and there are systematic reviews that additionally support the idea that teledermatology is associated with high satisfaction[53]. The service demonstrated a 29.8% savings in visit fees and according to patients, saved them time and money and prevented them from missing work, which are important components to social cost but are difficult to formally incorporate into a cost analysis. Prior work has suggested that cost effectiveness is not a universal feature of teledermatology[54] and would be highly dependent on regional billing codes.

In this initiative, it emerged that an appropriately structured consult note that explains clinical reasoning and offers a treatment ladder is educational and helpful to the referring provider. Furthermore, dermatologists and referring providers both suggested in interviews that the greatest educational value lay in management, not diagnosis. This is supported by the chart review where 27% of all recommendations only involved altering the existing topical treatment. A dermatologist noted that "We all know that the challenge with skin diseases; people don't think about it from a morphology point of view. They think about it as; that person I saw with psoriasis three years ago, this looks like that, right? And so that educated piece, in terms of diagnostics, I think would be lost." (Interview D4) Incorporating formal management educational initiatives into teleconsults is an area of potential future expansion and study.

In this chart review it emerged that 40% of lesions required a transition to an in-person visit, compared to only 5.7% of rashes. This suggests that a future service would be most productive and efficient if targeted solely at the management of "rashes." This correlates with dermatologists in interviews who expressed concern about their comfort of managing lesions by traditional teledermatology, and with respect to education there are far fewer management options for lesions and therefore potentially less educational value in the discussion of those consults.

Despite the inability to completely manage many lesions by teledermatology, there may be an opportunity for teledermatology initiatives to be used to triage and therefore expedite limited

access to dermatologists when needed for obvious skin malignancies, skin infections, drug rashes, or other dangerous conditions. However, the OHIP billing guidelines explicitly forbid the use of teledermatology as an intended triage service[70]. In this study, the malignancies identified were premalignant or slow-growing malignancies without the possibility of metastasis. The mortality impact of waiting for an assessment for these conditions was low, but not inconsequential. For example, facial basal cell carcinomas are most appropriately managed by Moh's micrographic surgery [106], but the current wait time at Women's College Hospital is 6-9 months. Delay in referral to dermatology leads ultimately to delay in definitive management. Basal cell carcinomas can bleed frequently, be painful, are cosmetically unsightly, and can eventually invade surrounding structures[55]. In this case, delay is not life threatening but there is significant morbidity associated that could be ameliorated by faster diagnosis and triage using telemedicine techniques.

Future services could also consider having a 24 hour consult response time to capture the most serious outpatient clinical scenarios. Other pilot services in the literature meet this response time or even better[75, 107]. Important clinical conditions that are time sensitive to 24 hours or less in terms of diagnosis and rapid management in dermatology are the infections requiring intervention and serious drug rashes[68] because of the risk of significant morbidity and mortality. In this study, there was only one instance of a treatable infection where identification in this time period prevented morbidity. This may be because referring providers would be less likely consider using it for high acuity dermatoses when the "maximum" response time was suggested to be one week. However, setting the response time too low may decrease the number of potential dermatologists willing to participate in the service, unless adequately remunerated and with an appropriate administrative support infrastructure.

4.5 Limitations

This study is an example of a case series in a very specific setting: an urban center with relatively accessible dermatology services compared to elsewhere in the country. It occurs at a site with a relatively large dermatology clinic and staffing compared to other institutions in the country. Different mean access times at different sites may also affect the generalizability. Different provinces have different wait times and other countries may have wait times longer or shorter than the average here. The prohibition against self-payment for care in Ontario may alter the

generalizability when compared to sites where patients can self-pay for faster access to specialty care.

As the primary author is also currently the sole consulting teledermatologist at the institution of the study, there may be both a trend to provide better care and faster response times than a "usual case" scenario, and a potential bias towards positivity. An overburdened dermatology presence at another site may not be as amenable to doing consults or able to keep to a 24 hours average response time, which could impact satisfaction levels or willingness to use the service. In addition, dermatologists with less experience on computer equipment and less comfortable with using computers may find it a frustrating style of practice with similar barriers as to Electronic Health Record adoption [108]. This is equally true for the referring providers. In some cases, the administrative barrier of navigating different systems may be easily overcome.

Similarly, as the principal investigator was also the only consultant dermatologist in the service, data acquisition and analysis may be affected. First, since the referring providers are part of the same institution, they may be less forthcoming or more selective in interviews or more positive about the results and with their opinions than they may be with a fully independent entity. Secondly, the analysis (including qualitative analysis) was predominantly performed by the principal investigator/consultant dermatologist and so that bias, despite best efforts, may have resulted in a more positive interpretation of findings. This may also be a possible limitation for domains and constructs in the chart review that required interpretation (such as follow-up probability).

The cost analysis is very regionally specific. It also takes place in an academic setting where clinic costs for personnel and equipment are fully subsidized and not dependent on physician billings, and as such the consideration of an under-utilization of clinic resources is not an issue. Other provinces, countries, or insurance institutions may not have established physician remuneration for secondary store-and-forward teledermatology, and even in Ontario, the restriction that it "may not be used as a triage"[70] potentially limits service expansion. They may also place restrictions on the technology used to perform these services which may exclude intra-institutional email as a potential solution. Finally, in this location, we do not have access to information as to who gets care from dermatologists: "follow-ups or "second opinion"

consultations may not have been accounted for if they were sent outside the circle of care of the institution to other care clinics in the city.

Finally, the patient population in this study is a subsection of those seen in Women's College Hospital, and a predominantly younger and healthier population. Satisfaction is partially based on the alignment of an initiative with personal values and it is possible that in this case, satisfaction was directly linked to the service saving patients time, saving them money, and preventing them from missing work. This could be further skewed by demographic differences in the population that registered their emails with the hospital and therefore were given more opportunities to respond to the survey (i.e., both a paper and an electronic invitation). There may be other populations that instead are more likely to place value on aspects this service did not emphasize such as the continuation of the consultant-patient relationship. In this case, even if such a service decreases access times, it may not actually provide more satisfaction for the patients.

Chapter 5
Conclusion

5 Conclusion

This is one of few studies to examine the impact of intra-institutional teledermatology, and the first to study it from a mixed-methods perspective to explore benefits beyond diagnostic concordance or satisfaction. It clearly suggests that there is significant potential value in the integration of teledermatology into a routine clinical pipeline, irrespective of existing access to consultative dermatology. It can improve the social impact of multiple visits on patients, saving them time, money, and preventing them from missing work. It can offer educational value to referring providers. There is a potential for cost savings if used effectively. Based on this, all the stakeholders: patients, providers, dermatologists, and health care institutions, stand to potentially benefit from implementing teledermatology.

This study also provides evidence that an ideal fit for teledermatology services is in the management of rashes. In this study, the assessment of rashes resulted in a very low percentage of in-person visits and is concordant with the expressed wishes of dermatologists to not assess lesions with traditional teledermatology. The impact and satisfaction of a dedicated teledermatology service that primarily targets rashes and, according to this study, ideally provides responses within 24 hours to maximize safety, is worthy of further study.

Store-and-forward teledermatology is a relatively simple service design with multiple appropriate technological solutions in the health care settings. The use of email means it may require relatively little infrastructure or software investment for institutions to benefit from teledermatology, provided a research base exists for evidence that closely matches the demographics and practice patterns of the institution considering implementing it. More services need to be evaluated to improve the generalizability for these institutions. Increasing reliance on teledermatology could potentially change the way consultative dermatology is practiced, and these changes must be carefully evaluated for all stakeholders.

In summary, this study provides evidence of the benefits of intra-institutional teledermatology, and this is one of the first evaluations of an intra-institutional teledermatology service. There are clear advantages to this method of teledermatology even when geographic access is not a barrier

to consultative services, including less time to receive a consult, savings in direct health care billings, time savings and work loss prevention for patients, and educational benefits for providers. A wider implementation of teledermatology could lead to a potential change in the model of dermatology services, not only in remote areas, but in urban areas to improve the efficiency and effectiveness of the practice of dermatology.

5.1 Conflicts of Interest

None declared.

5.2 Abbreviations

CHI – Canada Health Infoway

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