Family Practice, 2016, Vol. 33, No. 3, 274–285
doi:10.1093/fampra/cmw024
Advance Access publication 13 April 2016

OXFORD

Review

Electronic consultation systems: worldwide prevalence and their impact on patient care—a systematic review

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Abstract

Background. Many health organizations are exploring the potential of electronic consultation (eConsult) services to address excessive wait times for specialist care.
Objective. To understand the effectiveness, population impact and costs associated with implementation of eConsult services.
Methods. We conducted a systematic review using a narrative synthesis approach. We searched Medline and Embase from inception to August 2014 (English/French). Included studies focused on communication between primary care providers and specialist physicians through an asynchronous, directed communication over a secure electronic medium. We assessed study quality with a modified version of the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies. We synthesized the results using the Triple Aim framework.
Results. A total of 36 studies were included. Most were set in the USA and focused on single-specialty services (most commonly dermatology). Population health outcomes included patient populations, adoption/utilization and provider attitudes. Providers cited timely advice from specialists, good medical care, confirmation of diagnoses and educational benefits. No clinical outcomes were reported. Patient experience of care was generally positive, with quick specialist response times (4.6 hours to 3.9 days), avoided referrals (12–84%) and satisfaction ranging from 78% to 93%. System costs were reported in only seven studies using different outcome measures and settings, limiting comparability.
Conclusion. Though eConsult systems are highly acceptable for patients and providers and deliver improved access to specialist advice, gaps remain regarding eConsult's impact on population health and system costs. To achieve optimized health system performance, eConsult services must include specialty services as determined by community needs and further explore cost-effectiveness.

Key words. Access to care, eConsult, electronic consultation, primary care, referral, wait times.

Introduction

Excessive wait times for accessing specialist care are significant problems faced by many health care systems. In a recent survey by the Commonwealth Fund, Canada had the second longest wait times for seeing a specialist physician (1). In Northern Ireland, recently published wait time statistics showed that the national health service

missed its target of having 80% of patients wait <9 weeks for their first specialist appointment (2). In England, the median referral to treatment time in early 2015 was 9.7 weeks (3). The burden of waiting to see a specialist is significant for patients and in some cases can result in poorer health outcomes (4). Delays in accessing care can cause increased worry and anxiety for both patients and their families (5). Furthermore, delays between referrals and specialist appointments can result in lapses in communication between providers, duplication of services and overall dissatisfaction (4,6).

There is an opportunity to improve access to specialist care through the use of innovative e-health platforms such as electronic consultation (eConsult). eConsult links primary care providers (PCPs) and specialists through electronic means and enables specialist advice to be given directly, often without the need for a face-to-face visit (7–9). eConsult systems can be synchronous, asynchronous or a hybrid of the two; synchronous eConsults occur in real time and involve videoconferencing between providers, whereas asynchronous eConsult systems allow PCPs to submit written questions to a specialist that they can view at a time that is convenient for them, avoiding the need to schedule a time for either the patient or the providers (10).

Our team in Ottawa, Canada, has been working on the development and implementation of eConsult since 2009 (7,11,12). Many other health organizations are seeking solutions to improve access to care and have also begun to examine the implementation of eHealth systems such as eConsult. However, the international literature on the impact of eConsult is mostly limited to services offering access to a single speciality, commonly dermatology (13,14). These services were introduced as extensions of specific speciality-focused telemedicine visits that allowed images to be stored and reviewed at a later time by the specialist (thus making them asynchronous) (14–17). As part of our program of research, we undertook a systematic review of the literature to understand the potential population scope, patient impact and costs of eConsult with a view not only to inform our impact evaluation metrics but also to develop a better understanding of this innovation from a scalability perspective.

The concept of better health, better care and lower per capita cost, as captured by the Triple Aim framework (18), has been increasingly adopted within many organizations around the world to drive health system reform. Developed by the Institute for Healthcare Improvement, Triple Aim describes an approach to optimizing health system performance by simultaneously pursuing three dimensions: (i) improving the health of populations; (ii) improving the patient experience of care; and (iii) reducing the per capita cost of health care. The premise of the framework is that simultaneously pursuing these three objectives enables health care organizations to identify and address problems that lead to poor coordination and inefficient delivery of care and helps focus attention on and redirect resources to those activities that will have the greatest impact on health. The overall intent of Triple Aim as a quality improvement framework is to guide the redesign of health care systems and the transition to population health (18).

Previous reviews have demonstrated the benefits of eConsult services on satisfaction and response times (13,14,16,19). However, these reviews have not viewed the existing literature through the lens of an implementation framework such as Triple Aim. Such frameworks are invaluable for contextualizing the knowledge currently available on a given topic, and allow for a comprehensive and nuanced view of health care innovations by highlighting where evidence is strong and where it needs to be improved. We therefore aim to evaluate eConsult's impact on the three goals for health care improvement described by the Triple Aim framework: improving the health of the population, improving the patients' experience of care and reducing the per capita cost of health care (18), in order to evaluate eConsult's effectiveness under these criteria and identify any gaps in the literature.

Methods

Study design

This study consists of a systematic review of the literature examining the impact of eConsult on the delivery of care. We registered our protocol on PROSPERO (CRD42013004251).

Data sources

On 19 August 2014, we conducted a search of Medline (from 1946) and Embase (from 1947) for titles published in any year in English or French. Our search strategy focused on two different clusters of terms: (i) keywords for electronic consultation (e.g. eConsult, internet-based referral, virtual consult, store and forward), and (ii) keywords for primary care (e.g. family practice, GP, family health team) (Appendix 1) We consulted a librarian for guidance in completing the electronic search. Reference lists of all included titles were reviewed to supplement articles identified from the electronic search.

Inclusion criteria

eConsult was defined as an asynchronous, directed communication over a secure electronic medium that involved sharing of patient-specific information and sought clarification or guidance regarding clinical care. This definition excludes other telemedicine modalities and unsecure email messaging between providers. Studies had to focus on communication between a PCP and specialist physician through an eConsult service. Examples of PCPs included family physicians, nurse practitioners, physician assistants or any medical doctor who considered themselves to deliver primary care; however, dentists and pharmacists were excluded. We also excluded studies if the communication between PCP and specialist occurred in web-based forums, over email/social media if not explicitly stated as secure or if the communication was strictly one-way and did not allow for iterative communication between providers. Pilot/feasibility studies, conference abstracts, letters, editorials and literature reviews were excluded.

We used a modified version of the Effective Public Health Practice Project Quality Assessment Tool (20) to assess the quality of included studies. The tool covers a range of study designs including randomized trials and observational designs. However, some components of the scale were not applicable to all studies. To address this issue, we modified the tool to include only the components relevant to all included studies so that it could be applied evenly (see Appendix 2).

Data extraction and synthesis

We based our data extraction form on a previous review of asynchronous telehealth programs (16). Data extraction elements included author, study design, setting, research question, outcomes, participant characteristics, sample size, specialities consulted and main results. The data extraction form was piloted initially to ensure all relevant data were extracted. Due to large heterogeneity in study design, outcomes and study populations, the results could not be pooled together for a meaningful effect estimate.

We conducted a thematic analysis of findings and synthesized key outcomes using the Triple Aim framework as a guide. The results are presented as a narrative synthesis. We used the PRISMA guidelines for reporting on systematic reviews (21).

Results

The electronic search yielded 1601 records, of which 36 were included (Fig. 1). The majority of studies were conducted in the USA (51%). Most studies still focused on a single-specialty service, commonly dermatology; only 7 studies (9%) described multi-speciality services (Table 1). Study designs included cross-sectional (22–24), qualitative/mixed methods (25,26), cohort studies (27–32) and randomized controlled trials (RCTs) (17,33–38). The majority of studies were given a quality rating of moderate (58%, n = 21) with the remaining rated as weak (22%, n = 8) or strong (19%, n = 7). Given the limited literature and scope of the research question, we did not exclude articles based on quality.

eConsult services were implemented on a variety of technological platforms, often based on the existing private networks within closed systems such as Veteran's Affairs (VA) (15,17,37–42), San Francisco General Hospital (SFGH) (8,25,43), Kaiser Permanente (44,45), Mayo clinic (46) or regional networks such as the Finnish eConsult service (Table 2) (27). In such cases, electronic health records linked providers to an existing set of specialty services via a private network. Providers thus had access to additional patient information through the shared medical record (44). Other eConsult services were developed as stand-alone web-based portals (22,26,31,33,35,36,47–50) or used secured intranet emails as the means of communication (28,29,51,52).

Scope of population health

We identified 24 studies that spoke to the scope of population health. Population health metrics were captured mainly through total patient population served, provider adoption and utilization, and provider satisfaction. Roughly two-thirds of these studies were of moderate quality (n = 15) and 29% were found to be weak (n = 7). Only two of the papers were strong. Furthermore, we found little research that explored the impact of eConsult services on population health through clinical outcomes. No studies included in our review examined services' effects on common measures of population health, such as emergency room visits, hospitalizations or mortality.

Population served

The eConsult platforms discussed in the literature served a wide range of patient populations. Only 28% of studies (n = 10) reported on populations served. Of those that did, there was a wide range depending on the type of service. In the UK, ~20 GPs serve a population of around 38000 in Sheffield, and the Bradford and Airedale Primary Care Trust in Northern England serves ~600000 (9,26,33). The skin cancer clinic in Southern Spain covers a population of 300000 (51,52). The two Dutch district hospitals see ~38000 and 98000 new outpatient visits per year, respectively (34). The Kaiser Permanente network serves 500000 patients in Colorado and 3.2 million in Northern California (44,45). In four Finnish districts, the population ranges from 15000 to 33000 (27,49).

Provider adoption and utilization

Utilization and adoption rates varied among studies. In the span of two years, the Dutch teledermatology service grew from 5 to 28 family practices and expanded to five hospitals (30). Among the 2784 GPs included in van der Heijden *et al.* (32), 65% were active users

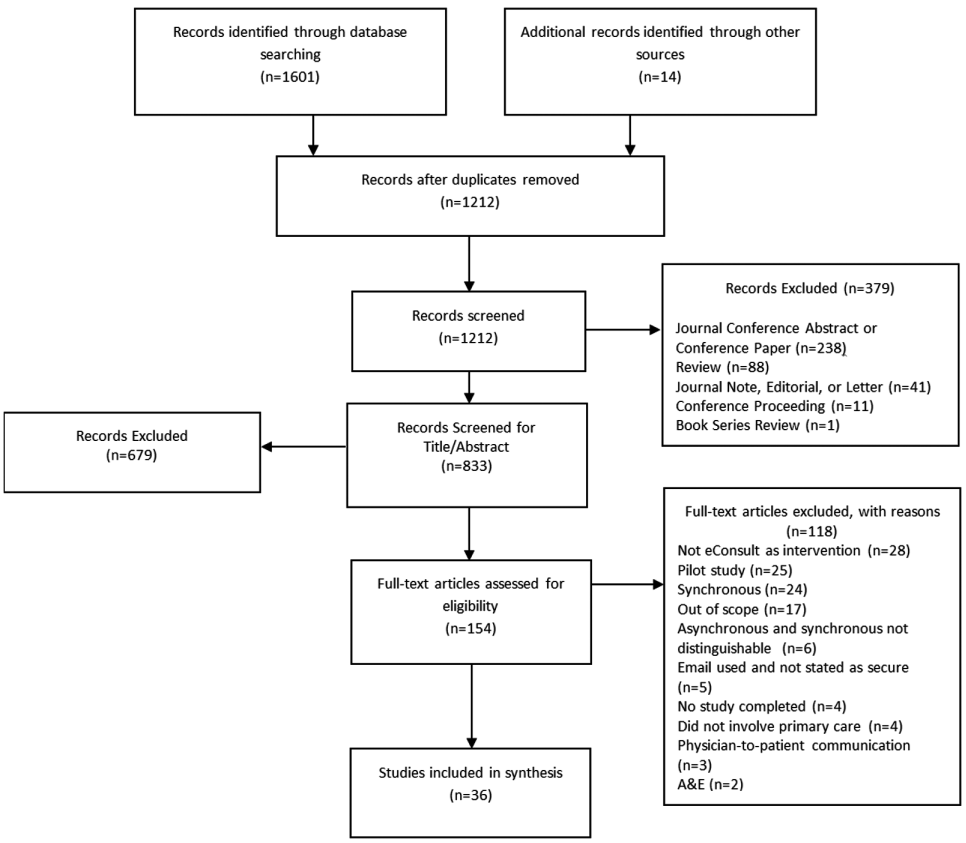

Figure 1. Flow of titles through review

Table 1. Characteristics of included studies

First author (year)	Setting	Type of service	Study design	Study population	Outcomes	Quality rating
Bowns (2006) (33)	UK	STFDerm*	RCT	208 patients 36 PCPs 2 dermatologists	Concordance between consultants. Patient/provider satisfaction	Moderate
Chen (2010) (28)	USA	STFDerm*	Retrospective cohort	429 patients	Diagnostic concordance, treatment patterns and patient demographics	Moderate
Collins (2003) (26)	UK	STFDerm*	Mixed methods	208 patients	Patient satisfaction	Moderate
Eminovic (2009) (34)	Netherlands	STFDerm*	RCT	85 PCPs 31 patients	Proportion of office visits prevented by TD. Secondary: patient satisfaction using PSQ III	Strong
Eminovic (2010) (53)	Netherlands	STFDerm*	Economic	Not applicable	Costs	Strong
Hsiao (2008) (39)	USA	STFDerm*	Chart review	169 patients	Time interval to diagnosis	Moderate
Hsueh (2012) (40)	USA	STFDerm*	Survey	700 patients	Patient satisfaction	Strong
Kahn (2013) (45)	USA	STFDerm*	Chart review	293 patients	Time interval between initial evaluation and biopsy	Moderate
Lasierra (2012) (47)	Spain	STFDerm*	Survey	120 patients 10 dermatologists	Referral avoidance	Moderate
McFarland (2013) (15)	USA	STFDerm*	Survey	21 PCPs	Provider satisfaction	Moderate
Moreno-Ramirez (2005) (29)	Spain	STFDerm*	Prospective cohort	219 eReferrals	Filtering percentage: percentage of patients not referred to the face-to-face clinic, as well as waiting intervals and pick up or skin cancer detection rates, reliability measures, accuracy and diagnostic performance	Moderate
Moreno-Ramirez (2009) (51)	Spain	STFDerm*	Economic	2009 TD referrals	Economic costs	Moderate
Moreno-Ramirez (2007) (52)	Spain	STFDerm*	Descriptive and evaluation	2009 TD referrals	Filtering ability of STFDerm*, agreement between observers, agreement within observers and accuracy of diagnosis	Moderate
Pak (2007) (35)	USA	STFDerm*	RCT	698 patients	Clinical outcomes	Moderate
Pak (2009) (48)	USA	STFDerm*	Economic analysis	698 patients	Economic costs	Moderate
Romero (2009) (36)	Spain	STFDerm*	RCT	457 patients	Diagnostic concordance	Moderate
Ruiz (2009) (22)	Colombia	STFDerm*	Cross-sectional	83 patients	Diagnostic reliability via intraobserver and interobserver concordance. Secondary was patient satisfaction	Moderate
Vallejos (2009) (31)	USA	STFDerm*	Cohort	79 patients	PCP evaluation of TD consultations	Weak
van der Heijden (2011) (32)	Netherlands	STFDerm*	Prospective cohort	37 207 teleconsults	Efficiency (decrease in number of physical referrals), quality (percent for second opinion, physical referrals resulting from them, response time, and educational effect) and costs of care for TD	Weak
Whited (2002) (37)	USA	STFDerm*	RCT	275 patients	Wait time to intervention and referral avoidance	Strong
Whited (2003) (41)	USA	STFDerm*	Economic	N/A	Economic costs	Strong
Whited (2004) (42)	USA	STFDerm*	Survey	275 patients 60 PCPs 8 dermatologists	Patient and provider satisfaction	Strong
Whited (2013) (38)	USA	STFDerm*	RCT	392 patients	Clinical course (comparing image sets between baseline and first clinic visit)	Moderate
Whited (2013) (17)	USA	STFDerm*	RCT	392 patients	Change in Skindex 16 scores between baseline and 9 months	Strong

Table 1. *Continued*

First author (year)	Setting	Type of service	Study design	Study population	Outcomes	Quality rating
Angstman (2009) (46)	USA	Multi-specialty virtual consultations	Survey	56 PCPs 21 specialists	Provider satisfaction (PCP and specialist)	Weak
Jaatinen (2002) (49)	Finland	Multi-specialty web-based referrals	Randomized case control	93 patients	Patient satisfaction, decrease in hospital visits	Weak
Kim (2009) (43)	USA	Multi-specialty eReferrals	Survey	298 PCPs	Overall clinic care measured by time spent submitting referral, guidance of workup, wait times and change in overall clinical care	Moderate
Kim-Hwang (2009) (8)	USA	Multi-specialty eReferrals	Survey	505 specialists	Difficulty in identifying referral question, referral appropriateness, need for and avoidability of follow-up visits	Moderate
Palen (2012) (44)	USA	Multi-specialty virtual consults	Observational case control	267 patients 88 PCPs	Patient satisfaction and avoidance of referral	Weak
Straus (2011) (25)	USA	Multi-specialty eReferrals	Qualitative	Not specified	Understand a more nuanced understanding of benefits and drawbacks of eReferral through semi-structured interviews with eReferrals users	Moderate
Harno (2000) (27)	Finland	Multi-specialty intranet referrals	Prospective study	292 patients	Costs and effectiveness of referrals	Moderate
Scherpbier-de Haan (2013) (30)	Netherlands	Telenephrology	Prospective cohort	122 consults	Primary outcome was potential reduction of in-person referrals, measured as the difference between the number intended referrals by GP and the # requested by nephrologist. Secondary was the usability of the system as measured by time invested, implementation in daily work hours and response time	Moderate
Stoves (2010) (9)	UK	Telenephrology	Before and after	68 eConsults	Number, appropriateness and quality of new referrals, timeliness and satisfaction of patients and health professional with the new service	Weak
Williams (2012) (24)	Ireland	Neurology web-based referrals	Cross-sectional	710 eConsults	Response time, referral avoidance, provider satisfaction	Weak
Callahan (2005) (50)	Western Pacific (military)	Pediatric eConsult using ECHO-Pac	Prospective trial	267 patients	Access (consult response time), quality (physician review panel—was diagnostic or treatment plan changed or modified and was treatment plan changed or modified) and evacuation cost avoidance	Moderate
Thijssing (2014) (23)	Netherlands	Telepulmonology	Cross-sectional	1958 eConsults	Quality of care (five indicators: per cent sent for advice, percent resulting in referral and educational effect) and efficiency (prevent unnecessary physical referral)	Weak

STFDerm*, Store-and-forward teledermatology; PCP, primary care provider; PSQ, patient satisfaction questionnaire; RCT, randomized controlled trial; TD, teledermatology.

Table 2. Description of technology platforms

Name	Setting	Description
Shared health record		
Veteran's Affairs 15,17,37–42	USA	Built into the EMR. Referring PCP generates a consult that is forwarded to the specialist through the EMR. The specialist is able to view the request, the patients' health record, and respond to the PCP, all within the EMR.
Kaiser Permanente (44,45)	USA	Fully integrated EMR using KP HealthConnect. Includes integrated CPOE for all tests, medications and referrals. Within CPOE referring physicians are able to support an 'advice only' consult that is answered by specialists in the department.
SystmOne (9)	UK	SystmOne is an eConsult service using networked electronic health records. GPs can send electronic referrals and share patient data through the EHR. GPs can 'request advice' or 'question the need for "hospital clinic review"'.
San Francisco General Hospital (8,25,43)	USA	The SFGH eReferral system includes integration of existing EMR and allows back and forth communication between referring providers and subspecialist reviewer.
Mayo Clinic (46)	USA	Virtual consults available as an order placed in EMR that goes to a particular specialty and not a specialist. Specialists then complete a note in the EMR, giving recommendation to PCP. PCP is then responsible for contacting patient and/or enacting the advice.
MUSTI Hospital Information System (27)	Finland	Built into hospital information system that utilizes an investigation request-and-answer system. GPs could choose between two types of referral: clinic or consultation.
Secured web-based portals		
KSYOS TeleConsultation System (23,32,34,53)	Netherlands	Secured website where PCPs can log in and upload patient information and images that are stored on secured servers. Specialists receive a notification email and log in to same secure site to view referral information.
TeleMC (30)	Netherlands	Secured web-based website that PCPs can access through their EMR by logging onto the site with their username and password. TeleMC interacts with the patients' health record and extracts relevant data to include in the referral along with the specific question from the PCP. Both specialist and PCP are notified by email each time an update is available.
Neurolink (24)	Ireland	Web-based application where PCPs fill out an electronic template using a series of drop-down menus and text boxes and send the referral. Neurologist is alerted by email and is able to log on and view the referral.
Web-based platforms (secure servers) (22,26,31,33,35,36,47–50)	USA, UK, Finland, Spain, Colombia	Web applications that PCPs and specialists can easily access using a standard web browser. PCPs log in to the site and can submit their patient specific question to a specialist along with any attachments deemed helpful (images, lab results, etc.).
Intranet referrals		
Encrypted email (28,29,51,52)	Spain, USA	PCPs complete a standardized referral form that is sent via encrypted email for review by a specialist.

CPOE, computer provider order entry; PCP, primary care provider; EMR, electronic medical record KP, Kaiser Permanente; SFGH, San Francisco General Hospital; EHR = electronic health record.

of the service (i.e. submitted at least one eConsult), submitting an average of 9.1 eConsults per year. At the Mayo clinic, 71% of PCPs (n = 40) had tried the eConsult system after it had been in place for one year (46). The Electronic Children's Hospital of the Pacific (ECHO-Pac) service (which offered access to 33 different paediatric subspecialty services) reported an average of 11.5 eConsults per 1000 children, though utilization rates varied widely depending on the site location (50). In Peijas, Finland, where eConsult was available, rates were reported as 7.5 referrals per 1000 inhabitants (27).

Provider satisfaction

Thirteen studies examined PCPs' perspectives on the eConsult service (9,15,24,25,29,31–33,42–44,46,47). Few of these studies discussed the validity of the survey used or described the questions they asked PCPs in detail. The majority of studies reported positive reviews of eConsult and noted that providers expressed enthusiasm for the service. PCPs reported that eConsult led to timely advice from specialists (9), provided good medical care (46), improved overall clinic care/was a good addition to regular services (15,43) and helped confirm diagnoses (47). Drawbacks or concerns regarding eConsult included deficiencies in technology (25,47) and information technology support (15), medico-legal concerns (46) and increased workload (15,25,47). However, in the vast majority of studies, these issues were minor and did not overshadow PCPs' positive responses to the service. The sole exception was a study by Bowns *et al.* (33), in which only 21% of PCPs reported being satisfied or very satisfied with the service. Some of the main issues reported in this study included problems with the software itself, including connectivity issues, increased workload and an overly complex referral process (33).

PCPs in several studies reported that eConsult had an added educational benefit, as answers to questions about a specific patient improved their ability to treat other patients with similar problems. PCPs using the SystmOne and Neurolink reported that the services gave them greater confidence when managing chronic kidney disease and neurological conditions, respectively (9,24). The educational benefits of using eConsult were regularly mentioned in interviews with PCPs who used the eReferral system at the SFGH (25). PCPs reported educational benefits in 92% of teledermatology consults and 85% of telepulmonology consults (23,32). Among the nine users of the KSYOS telenephrology system surveyed (21.4% of total), eight reported that their knowledge of nephrology had increased through using eConsult (30). About 55% (n = 21) of users of the teledermatology service at a VA clinic in the USA reported an educational benefit compared to 34% (n = 18) using usual care (42).

Fewer studies examined specialists' perspectives on eConsult (8,9,22,25,33,42,46). Among those that did, the majority reported high levels of satisfaction with eConsult. Specialists reported that eConsult made it easier to ascertain clinical referral questions (8) and triage patients for clinical appointments (42), was an efficient use of their time and was less disruptive than telephones or pagers (46). The two specialists in the study by Bowns *et al.* (33) expressed overall dissatisfaction with eConsult, citing similar reasons as the PCPs who used the same service (i.e. need for a reliable and configurable teledermatology system). Other areas of concern were lack of patient contact and medico-legal issues. The dermatologists studied in the VA setting, while being satisfied overall, expressed similar issues around feeling less confident in their diagnoses and management plans compared to seeing patients face-to-face (42).

Patient experience of care

A total of 27 studies included in our review examined the patient experience of care. Slightly over half of these studies were of moderate quality (n = 15). Of the remainder, slightly more were weak (n = 7) than strong (n = 5). The patient experience of care was captured through four measures: access, efficiency, effectiveness and satisfaction.

Access

Studies used a number of factors to measure eConsult's impact on patient access to care, including specialists' response times to questions posed via eConsult, wait times to intervention, time to initial evaluation and biopsy, and time to diagnosis. The majority of studies that evaluated access to care found positive results. Average specialist response times varied between 4.6 hours and 3.9 days (9,24,29,30,32,50). Hsiao and Oh (39) reported that eConsult resulted in shorter time intervals for initial consultation, biopsy and surgery for remote patients compared to traditional systems. Similarly, Kahn *et al.* (45) found that remote patients with skin cancer who used teledermatology waited less time for biopsies compared to conventional referrals. Overall waiting intervals were shorter through eConsult (12.3 days) compared to traditional referrals (88.6 days) for patients with pigment lesions (29). Whited *et al.* (37) reported shorter wait times to intervention among patients in the teledermatology arm compared to the traditional referral process.

Efficiency

Studies measured efficiency as the proportion of referrals that were avoided as a result of using eConsult. Each service measured referral avoidance differently, making it difficult to compare overall avoidance rates. In the Netherlands, studies that asked PCPs their intention before they submitted the case (i.e. if they are asking for a second opinion or if they intend to prevent a referral) reported rates of referral avoidance of between 27% and 84% (23,30,32). Studies of systems that considered referral avoidance based on the opinion of specialist physicians reported rates between 12% and 39% (34,50). In the USA, VA clinics reported dermatology avoidance rates of 18.5% (37). In Spain, 51% of referrals were avoided in pigmented lesion clinics and 42% for general teledermatology (47,52). Among multi-specialty eConsult services, avoidance rates in Finland were 52% (49) and 57% (27) and 40% at the larger Kaiser Permanente in the USA (44). In Ireland's Neurolink service, 19% of referrals processed were avoided (24).

Effectiveness

To measure the effectiveness of eConsult, studies explored outcomes pertaining to clinical, diagnostic or treatment measures. In nearly all cases, results were comparable between usual care and eConsult. All but one study focused exclusively on single-specialty services (dermatology, nephrology and paediatrics). There was no significant difference in clinical course outcomes or skin-related quality-of-life scores in RCTs comparing traditional groups of dermatology patients to those using eConsult (17,35,38). In a paediatric dermatology setting, Chen *et al.* (28) noted overall diagnostic concordance in 48% of cases. Stoves *et al.* (9) assessed PCPs' adherence to clinical advice they received via eConsult, noting high adherence in additional tests (82%), treatment changes (97%) and monitoring schedules (89%) for patients with chronic kidney disease. Vallejos (31) reported that PCPs changed their diagnosis in 13% of cases. After conducting a survey of participating PCPs, Kim *et al.* (43) found that 71.9% of providers who used a multi-specialty eReferral service reported that electronic referrals had improved their overall clinical care.

Satisfaction

Ten studies in six different settings examined patients' experiences with eConsult services (17,22,26,29,33,34,40,42,44,49). Patient satisfaction with and acceptability of eConsult was examined through surveys and semi-structured interviews. Many researchers used modified versions of the patient satisfaction questionnaire III (26,33,34), the visit specific questionnaire (42) or the Ambulatory Care survey (44). Others simply asked patients if they were satisfied overall with their eConsult services (17,22,29,40,49). Patients were consistently satisfied with the service, with average satisfaction scores ranging from 78% to 93% and mean satisfaction scores of 3.8 and 8.5 on 5- and 10-point Likert scales, respectively (22,26,29,33,34,40,42,44).

What are the costs of eConsult?

Seven studies reported on costs of eConsult systems (Table 3) (27,32,41,48,50,51,53). Four of these studies were of moderate quality, one was weak and two were strong. Five were based on dermatology services (32,41,48,51,53), one on a paediatric subspecialty eConsult service (50) and one on a multi-specialty eConsult service (27). Four studies examined costs from a health system perspective (32,41,48,50) and three examined costs from a societal perspective that factored in such items as out-of-pocket expenses for patients (e.g. travel costs, parking) (27,51,53). All studies differed in outcomes measured, costs considered and study setting. Some studies employed established methodologies to capture a comprehensive picture of the costs associated with eConsult (41,48,51,53). For instance, Eminović *et al.* (53) compiled an economic model using a decision analytical approach in which 282 variables were grouped into five major cost components for analysis, and performed a

Table 3. Summary of findings—reduce per capita cost of care

First author (year)	Specialty	Characteristics a. Comparison group b. Type c. Perspective	Cost parameters	Results
Callahan (2005) (50)	Pediatric eConsult using ECHO-Pac	a. None b. CA c. Health service	Patient travel costs for air evacuation.	Estimated costs per one air evacuation at $5794 for a total saving of $185 408.
Eminovic (2010) (53)	STFDerm*	a. Traditional b. CMA c. Societal	Main cost components included investments, GP care, specialist care, patient expenses and employer costs.	Total mean costs for teledermatology were higher than conventional process costs [mean difference €32.5 (95% CI: −29 to 74.7)]. Cost savings occur only when distance to specialist is longer or by having higher proportion of referrals avoided.
Harno (2000) (27)	Multi-specialty intranet referrals	a. Traditional b. CBA and CMA c. Societal	Direct costs for referrals were calculated from patients through questionnaires, by time keeping in the hospital and through estimates of direct costs of health services. This included personnel costs, service charges and equipment. Patient costs included travel costs, other associated costs and arranging home help.	Cost minimization of alternative interventions found a net benefit of 7876 in favour of the telemedicine option.
Moreno-Ramirez (2009) (51)	STFDerm*	a. Traditional b. CE c. Societal	GP care, specialist care and travel expenditures for patients for both teledermatology and conventional processes.	Costs per patient in teledermatology were less than conventional costs (incremental cost of €49.59 in favour of teledermatology).
Pak (2009) (48)	STFDerm*	a. Traditional b. CMA c. Health service	Direct medical costs included clinic-based visits (primary and specialty care), teledermatology consults, lab/procedural costs and medication. Indirect costs included lost productivity.	Average cost for teledermatology patients ($340) was less than the comparable costs for usual care patients ($372). Teledermatology is cost saving from the payer perspective when indirect costs due to lost productivity are accounted for.
van der Heijden (2011) (32)	STFDerm*	a. Traditional b. CA c. Health service	Costs for teledermatology were a fixed price per each consult. Included wages, GP insurance, software, training, cameras and helpdesk services. Traditional costs were estimated by health care costs issued by the Dutch government.	Average costs per patient in conventional care were €192 and €157.06 in teledermatology. Teledermatology represented an 18% reduction when compared to traditional costs.
Whited (2003) (41)	STFDerm*	a. Traditional b. CA and CE c. Health service	Examined fixed costs which included teledermatology equipment, communication and training costs. Variable costs for teledermatology included labour, overhead and rental costs, supply and travel compensation costs for patients.	While implementation was not cost saving overall, found that it was cost-effective to decrease time to initial definitive intervention in settings that require long waiting periods.

CA, cost analysis; CMA, cost minimization analysis; CE, cost-effectiveness; STFDerm, store-and-forward teledermatology.

Monte Carlo simulation using 31 distributions in the used cost model. Others looked only at the direct costs of the eConsult service (27), used billing data to compare average costs of eConsult versus usual care (32) or used only one aspect of service cost, such as avoided travel (50).

Reports varied regarding the overall cost-effectiveness of eConsult versus usual care. In the Netherlands, total costs were higher for teledermatology compared to conventional care though potential cost savings were noted in cases where patients had to travel longer distances or if a higher number of face-to-face specialist visits were avoided (53). The VA service was not cost saving overall, but Whited *et al*. (41) reported cost savings when considering the service's ability to decrease time to initial definitive intervention. In both studies, the costs associated with additional tasks required on behalf of PCPs when submitting an eConsult were included when estimating the overall costs (taking images, completing and submitting the form). Pak *et al*. (48) found that costs per patient were less for teledermatology than conventional referrals from the payer perspective. Researchers from the ECHO-Pac study reported cost savings of upwards of $180 000 in evacuation costs alone (50). Both van der Heijden and Moreno-Ramirez (32,51) reported that teledermatology was cost saving compared to usual care, though both differed in perspective taken and economic analysis methods used. Researchers from Finland conducted a cost minimization analysis, which found that eConsult was less costly compared to outpatient clinic costs (27).

Discussion

Viewing eConsult through the lens of the Triple Aim framework highlights both the service's potential and the gaps in the literature. The framework specifies that its three pillars should be considered equally in order to enhance health care delivery and improve patient outcomes. Similar to past reviews, we found the majority of the research on eConsult services examined outcomes related to patient and provider experience, with limited focus on population health and cost measures (13,14,16,19).

Our review found substantive gaps on the impact of eConsult services on patients' clinical outcomes, which would arguably provide the clearest picture of their impact on population health. Consequently, our examination of population health focused primarily on measures of scope (i.e. how many patients the programs reached and how many providers used them) and provider attitudes (i.e. levels of satisfaction). These elements, although valuable, speak to two separate issues and paint an incomplete picture of eConsult's impact on population health, demonstrating a potential limitation of the Triple Aim framework. This limitation has been previously reported and Bodenheimer and Sinsky (54) have developed a proposed amendment to the Triple Aim framework. Called the Quadruple Aim, their framework expands Triple Aim to include a fourth goal of improving the work life of health care providers. Viewed through this modified lens, the papers discussing provider attitudes, previously grouped under population health, would fit comfortably under the fourth pillar, demonstrating that eConsult's high levels of provider satisfaction and educational benefits provide robust support of its success.

Without provider adoption, new systems and models of care are unlikely to succeed, especially in the case of the referral pathway, given that it is directly initiated and responded to by the providers. eConsult services offer a relative advantage over current practice and were often seen as easy to use and well integrated into everyday workflow (55). Another commonly reported benefit of eConsult services was their ability to act as educational tools for providers. In some instances, the advice PCPs received not only helped them treat the initial patient, but also provided an educational benefit supporting their ability to care for patients with similar concerns in the future. This educational element was reported by many providers across multiple studies. Future research should examine whether eConsult's potential to build PCP capacity through education is being realized.

Finally, despite more than 10 years of work in eConsult, the question of cost-effectiveness remains unanswered. Health care systems cannot afford to implement high-cost services that have limited impact on outcomes or are not sustainable. The studies of real-time telehealth services have not demonstrated cost-effectiveness (56); therefore, it is critical to include an economic analysis in all eConsult studies. In our review, we found only seven studies that reported on the economic impact of eConsult services. Most of these studies were of single-specialty systems (i.e. teledermatology). Two studies were based on RCT results, of which both reported that mean costs for teledermatology were higher compared to usual care (41,53). However, both studies examined populations with limited generalizability. All seven studies used different methods to compare costs, which further limits our capacity to draw broad conclusions from their findings. Recent advances in the approach of economic analysis health systems innovations such as eConsult call for uniform reporting of results to enable cost comparisons (57). This is critical, because it is only possible to expand successful projects into wide-scale services if the new approach is cost-effective in the health care system in which it is to be employed.

While eConsult services show great promise in improving care, our review found that their implementation is still largely limited to programs focused on a single-specialty, generally dermatology. The predominance of dermatological services is likely due to the long wait times and insufficient supply of physicians associated with the specialty (34), the ease of conveying many dermatological questions using digital images and transition of real-time telemedicine services to store-and-forward teledermatology. However, such an approach subverts the patient-first thinking necessary to successful innovations. To have true population impact, regions must implement eConsult services based on the needs of the community and not the interest or availability of individual specialty groups. Technology should be the vehicle of change, not the driver. When designing eConsult innovations, developers should measure waits times from PCP referral to specialist visit for a number of specialties in the target region, and design a service that best addresses the identified gaps. Such a strategy is endorsed by the Patient-Centered Medical Neighbourhood (PCMN) model of care, an extension of the Patient-Centered Medical Home (PCMH), which 'aims to transform the delivery of comprehensive primary care to children, adolescents, and adults' by establishing physician-led primary care practices that offer a comprehensive basket of services, improve coordination of and access to care, and support evidence-based medicine (58). PCMHs have proven effective at improving patient health outcomes, reducing hospital readmission rates and emergency room visits, and lowering costs (59). The PCMN builds on this concept, emphasizing the importance of continuity and comprehensiveness of care not just among providers within the PCMH, but specialist clinics, community services and hospitals in the broader community (60,61). Though still in the early stages of evaluation, the PCMN has received a great deal of support from medical professionals (62). However, developing effective linkages has been challenging (63), and efforts

to expand the PCMH model into a PCMN model have only just begun (64). By providing a fast and secure link between primary and specialist providers, eConsult services have been identified as having the potential to support this inclusive model of care delivery (65).

Strengths and limitations

Few of the studies included in our review were of high quality. Most exhibited limitations in their methodology or reporting. The relative dearth of high-quality articles suggests that many eConsult systems may be implemented in an ad hoc manner by adding on to existing services. To improve the quality of the literature, future studies could utilize more pragmatic methods such as stepped wedge RCT design, delayed study designs and/or interrupted time series with a component of random selection at a practice or geographic level. In addition, heterogeneity in study design, outcomes and patient populations prevented us from completing a meta-analysis.

This review has several strengths. The characterization of the various technology platforms had not yet been reported in the literature. We found three main approaches: services built into existing shared electronic health systems, stand-alone web-based portals and extensions of the existing teledermatology services. Using the Triple Aim framework to guide, our narrative synthesis is a novel approach. However, we noted a limitation with the application of this framework, with regard to incorporating the provider perspectives.

Conclusion

The results from our review illustrate that eConsult systems are efficient, acceptable and may have a potential for large cost savings. Few studies reported on outcomes related to overall health and economic analyses.

Acknowledgements

We would like to thank Matthew Hogel and Jatinderpreet Singh who helped us with the electronic search and screening articles for inclusion. Registration: PROSPERO CRD42013004251.

Declaration

Funding: Ministry of Health and Long-Term Care's Primary Health Care System Program.
Ethical approval: not needed for this study due to its non-invasive approach.
Conflict of interest: CL and EK are the creators of the Champlain Building Access to eConsult Service eConsultation service. The service is freely available to all providers in the health region, and CL and EK have no financial interests associated with the service. The authors have no competing interests to declare.

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Appendix 1. Electronic search strategy

1. (Electronic consult* or eConsult* or e-Consult*)
2. (electronic referral* or eReferral* or e-Referral*)
3. (electronic communicat* or eCommunicat* or e-Communicat*)
4. (electronic collaborat* or eCollaborat* or e-Collaborat*)
5. (electronic discuss* or eDiscuss* or e-discuss*)
6. (electronic advi#e or eAdvi#e or e-Advi#e)
7. (web based consult* or web-based consult*)
8. (web based referral* or web-based referral*)
9. (web-based communicat* or web based communicat*)

10. (web based collaborat* or web-based collaborat*)
11. (web based discuss* or web-based discuss*)
12. (web based advi#e or web-based advi#e)

13. (internet consult* or internet-based consult* or internet based consult*)
14. (internet referral* or internet-based referral* or internet based referral*)
15. (internet communicat* or internet-based communicat* or internet based communicat*)
16. (internet collaborat* or internet-based collaborat* or internet based collaborat*)
17. (internet discuss* or internet-based discuss* or internet based discuss*)
18. (internet advi#e or internet-based advi#e or internet based advi#e)

19. (online consult* or online referral* or online communicat* or online collaborat* or online discuss* or online advi#e)
20. (virtual consult* or virtual referral* or virtual communicat* or virtual collaborat* or virtual discuss* or virtual advi#e)

21. (computer-based consult* or computer-based referral* or computer-based communicat* or computer-based collaborat* or computer-based discuss* or computer-based advi#e)
22. (computer based consult* or computer based referral* or computer based communicat* or computer based collaborat* or computer based discuss* or computer based advi#e)

23. (intranet consult* or intranet referral* or intranet communicat* or intranet collaborat* or intranet discuss* or intranet advi#e)
24. (store-and-forward or 'store and forward')
25. (teleconsult* or telereferral*).

26. 1 or 2 or 3 or 4 or 5 or 6
27. 7 or 8 or 9 or 10 or 11 or 12
28. 13 or 14 or 15 or 16 or 17 or 18
29. 19 or 20
30. 21 or 22
31. 23 or 24 or 25

32. 26 or 27 or 28 or 29 or 30 or 31

33. (primary care or family medicine or family practice* or family clinic or health clinic* or family health or walk in clinic* or walk-in clinic* or family physician* or family doctor* or family practitioner* or general practitioner* or GP or generalist* or regular provider* or generalist physician* or general physician* or nurse practitioner*)

34. 32 and 33

35. limit 34 to (English or French)

36. remove duplicates from 35

Appendix 2. Quality rating tool. Modified version of Effective Public Health Practice Project tool [Thomas *et al*. (20)]

A) Selection bias

Q1. Are the individuals selected to participate in the study likely to be representatives of the target population?

1. Very likely
2. Somewhat likely
3. Not likely
4. Can't tell

Rate this section	Strong	Moderate	Weak
	1	2	3

B) Confounders

Q1. Were there important differences between groups prior to the intervention?

1. Yes
2. No
3. Can't tell

The following are examples of confounders:
1. Race
2. Sex
3. Marital status/family
4. Age
5. Socioeconomic status (income or class)
6. Education
7. Health status
8. Pre-intervention score on outcome measure

If yes, indicate the percentage of relevant confounders that were controlled [either in the design (e.g. stratification, matching) or analysis]?

1. 80–100% (most)
2. 60–79% (some)
3. <60% (few or none)

Rate this section	Strong	Moderate	Weak
	1	2	3

C) Data collection methods

Q1. Were data collection tools shown to be valid?
1. Yes
2. No
3. Can't tell

Q2. Were data collection tools shown to be reliable?

1. Yes
2. No
3. Can't tell

Rate this section	Strong	Moderate	Weak
	1	2	3

D) Analyses

Q1. Are the statistical methods appropriate for the study design?
1. Yes
2. No
3. Can't tell

Rate this section	Strong	Moderate	Weak
	1	2	3

Overall rating for this paper (circle one):
1. Strong
2. Moderate
3. Weak