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The use of eConsults to Improve Access to Dermatological Care for Underserved Populations in Connecticut

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APPROVAL PAGE

Master of Public Health Thesis

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ABSTRACT

Importance: Medically underserved populations receiving care at community health centers lack access to specialty care.

Objective: To evaluate the impact of a dermatology electronic consultation (eConsult) program on a statewide scale focusing on access to care for medically underserved patients.

Design: Retrospective cohort study of 2385 dermatology referrals from June 2014 through November 2015.

Setting: Large, multi-site Federally Qualified Health Center in Connecticut.

Participants: Dermatology referrals pre-eConsult implementation from June to November 2014 (n=1258) and post-eConsult implementation from June to November 2015 (n=1127). All referrals came from primary care providers from twelve primary care sites in CT.

Intervention: Implementation of a dermatology eConsult program.

Main outcomes and measures: Outcome measures included appointment completion rates, eConsult utilization, PCP diagnoses, teledermatologist diagnoses, reasons for face-to-face (F2F) consultation recommendations, and biopsy results for those diagnosed with suspicious neoplasm.

Results: Prior to the eConsult program implementation there were 1258 dermatology referrals, with 514 patients (41%) never receiving an appointment. Among those who received an appointment only 139 patients (11%) were actually seen by a dermatologist, with a median appointment wait time of 77 days. Post eConsult implementation there were 1127 referrals to dermatology of which 499 were sent electronically. Of these, 78 (16%) required a face-to-face visit, with a median wait time of 28 days. The most common reason for a F2F recommendation was suspicious neoplasm (n=29). One in three (35%) patients with this clinical impression had biopsy-confirmed skin cancer.

Strengths and Limitations: Main strength of the study is the large scale implementation of eConsults across multiple community health centers. Main limitation is the narrow generalizability of the data to other medical settings.

Conclusions and Relevance: Implementation of an eConsult program at a statewide level increases access to dermatologic care and reduces wait times for underserved populations receiving medical care at community health centers. The system also appears to provide an effective mechanism for early detection of skin cancer in medically underserved populations.

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INTRODUCTION

The implementation of the Affordable Care Act (ACA) in 2010 made several strides towards expanding and improving coverage for many individuals. Since its implementation, the rate of uninsured has declined from 16% in 2010 to 9.1% in 2015.[1] Despite the expanded access to insurance coverage brought about by the ACA, access to specialty care for uninsured and Medicaid patients remains limited. Access to dermatological care in particular presents its own difficulties because of the general shortage of dermatologists. Furthermore, many private dermatologists do not take Medicaid, and those who do, won`t enroll new Medicaid patients, hence placing a huge limitation on the services offered to these patients.[2] Telehealth systems such as electronic consultations (eConsults) may provide an answer that could improve access to dermatology care.[3] Electronic consult systems employ the use of images captured by the primary care provider (PCP) and the store-and-forward technology to provide off-site dermatologic evaluation and treatment recommendations to patients.[4] Dermatology is well suited for this type of approach because it has a strong visual aspect and most dermatologic conditions are not urgent in nature.[5] Dermatologic conditions affect approximately one third of people in the United States and are the fourth leading cause worldwide of years lost due to disability.[6, 7]

Use of such eConsult systems has increased across the US from small private practices to large academic institutions, as well as the Veterans Health Affairs (VHA) systems.[3] Federally Qualified Health Centers (FQHCs) are an ideal place to implement eConsults because problems of limited access to dermatologic care are particularly acute. FQHCs provide comprehensive primary care to over 24 million medically underserved patients and represent the largest care delivery system in the country outside the VHA.[8] Less than half of patients seen in the primary care setting who need

to be evaluated by a dermatologist actually receive an appointment, partially due to the limited access to dermatologic care.[9] This limitation is especially noted in medically disadvantaged individuals.[10, 11] In Connecticut, for instance, only 37% of dermatologists accept new Medicaid patients. While in other states, these rates are as low as 20%.[12] The average wait time to see a dermatologist is approximately 39 days. Medicaid patients, however, have to wait 34% longer for an appointment compared to patients with private insurance or Medicare.[10] Moreover, underinsured and Medicaid patients are more likely to miss appointments.[13] Most common reasons for patients missing dermatology appointments include but are not limited to, simply forgetting about it, work conflicts, transportation barriers and skin condition improving on its own.[14] Furthermore, patients tend to miss more appointments when the wait times are longer. There is a strong positive correlation between missed appointments and wait times.[15]

With appropriate infrastructure and institutional support, this study aims to demonstrate that dermatology eConsults implemented on a large, statewide level have the potential to provide a significant public health benefit by reducing barriers to receiving dermatologic care in the medically underserved population.

BACKGROUND

Telecommunication is highly suitable for deployment within the field of dermatology because dermatology has a strong visual aspect, most dermatologic conditions are not urgent in nature, and there is a shortage of dermatologic services in the United States.[1] The use and expansion of eConsults has become an important solution to the issue of limited access to dermatologic care, especially for underserved populations seeking care at community health centers. Community health centers (CHCs) provide comprehensive primary care to many uninsured and Medicaid patients. They have become critical players in serving medically underserved populations, especially since the adoption of the Patient-Centered Medical Home model (PCMH). The PCMH is a model for integrated primary care delivery where the PCP coordinates all aspects of a patient`s medical needs by directing a team of healthcare providers.[4] eConsults fit in well with the PCMH model because they allow primary care physicians to manage the patient`s conditions with valuable input from specialists. Although, CHCs continue to provide much needed primary care services, they are limited in their ability to provide specialty care. Approximately 25% of visits to a community health center result in referrals for services that cannot be provided at the health center.[16] Limited access to specialty services contributes to poorer health outcomes, impacting mostly racial/ethnic minorities who tend to get their medical care at CHCs.[4]

Lack of timely access to specialty care is made more difficult by extended wait times between primary and specialty care. The Merritt Hawkins` Physician Appointment Wait Times and Medicaid and Medicare Acceptance Rates report stated that “the average appointment wait time to see a dermatologist ranged from a high of 72 days in Boston to a low of 16 days in Miami.” Moreover, underserved populations tend to have higher no-show rates. In Dermatology specifically, the no-show rate can be even higher than other specialties because many skin

conditions, such as rashes, may end up resolving without intervention. This interface between the PCP and specialist is complicated furthermore by the gap in communication, leading to ineffective care for patients. For many community health centers and private primary care offices, eConsults are promising as they seem to eliminate long waiting times, reduce miscommunication and physical barriers to getting to specialty appointments. Further potential benefits include convenience for the specialist and PCP alike, lower overall costs, and good diagnostic accuracy.[17]

There are various studies that provide evidence of the effectiveness of teledermatology in expanding access to care but few have focused on underserved populations receiving care at community health centers. A randomized control trial looking at clinical outcomes of patients seen via teledermatology, as well as those seen via the traditional in-person route found that 65% of the patients seen in the traditional group rated their health as "improved" compared to 64% in the teledermatology group, suggesting that e-consultations and in-person visits produce similar outcomes.[18] Similarly, another group of researchers studied the impact of teledermatology in an urban primary care setting in Philadelphia and determined that teledermatology did expand access to care. Approximately, 60% of consults that were seen via eConsults would not have otherwise been seen via the traditional route.[19] These are patients that would have 'fallen through the cracks' and would have not received the care they needed. The impact of teledermatology on increasing access to care in Medicaid enrollees was also studied in several practices throughout Virginia. These studies established that among newly enrolled Medicaid patients, 75% received care via teledermatology.[2] Further studies have maintained that teledermatology is highly efficient in that it can prevent up to 75% of physical referrals.[20]

In addition to expanding access to care, teledermatology has been evaluated on its diagnostic accuracy and reliability. Diagnostic accuracy has been defined as matching the teledermatology

diagnosis with histopathology, which is the gold standard. Diagnostic reliability, on the other hand, is matching the teledermatology diagnosis with the in-person clinical diagnosis.[21, 22] A large systematic review of teledermatology literature from 1999 until 2011 established that teledermatology diagnostic accuracy was sufficient and comparable to histopathology diagnosis and in-person clinical diagnosis.[21] Other studies have established diagnostic accuracy of teledermatology to be approximately 77%.[20] Most studies report diagnostic reliability to range widely between 40-80% when only the first diagnosis is compared, but this percentage increases to the 90s when considering all differential diagnoses included.[21, 22]

Diagnostic and management concordance is another well-studied measure of teledermatology. Diagnostic concordance is either complete or partial. Complete concordance means that the PCP and teledermatologist diagnosis are the same, while partial concordance means that at least one of the diagnosis on the PCP`s differential diagnoses list matches that of the teledermatologist.[21, 22, 23] Management concordance is defined as agreement on a treatment plan between primary care provider and consulting dermatologist.[21] Diagnostic concordance rates in Medicaid patients are approximately 68%, with a similar percentage for management concordance rates.[19]

A survey of 2,700 primary care physicians working with underserved populations in California revealed that PCPs referred more patients via e-consults than in-person visits. All surveyed PCPs identified “increasing access to specialty services” as the main reason for the e-consult referrals.[24] Increasing access to dermatologic care for patients is crucial for primary care providers because skin conditions account for approximately 12% of their total visits.[25] Another study that explored general practitioner (GP) satisfaction with the teledermatology services in rural Australia found that approximately 70% of GPs saw the program as useful.[26] Under the right infrastructure, teledermatology has the potential of becoming the solution to improving access to specialty care.

PUBLIC HEALTH SIGNIFICANCE

The state of telemedicine has made immense strides in the last couple of years, starting out with a handful of pilot programs scattered across the country and developing into a robust program that seeks to fill critical gaps when it comes to specialty care access. CHC Inc. in partnership with other institutions across Connecticut has created an infrastructure for an eConsult system that will hopefully prove to be effective, efficient and sustainable. This research study looks at the impact that dermatological eConsults have toward increasing access to care, decreasing appointment wait times, screening for skin cancer, and overall improving patient care.

Implementation of a dermatology eConsult program at community health centers can provide a promising solution to the limited access of dermatologic care and high no-show rates seen in medically disadvantages populations. This would provide a solid step toward the overall goal of decreasing health disparities.

This study provides a good eConsult model for high quality teledermatology services focusing on coordination between PCP and dermatologist in treating skin disorders in minority underserved populations. This study evaluates the implementation of a large scale, statewide teledermatology program across various regions and networks.

METHODOLOGY

Main research question: What is the impact of a dermatology eConsult program on access to care in medically underserved populations?

Main research hypothesis: eConsults provide a fast track for diagnosing and treating skin diseases in patients who receive care at community health centers.

Study Design: This was a retrospective, pre-post cohort study. The study design was reviewed and approved by the Community Health Center, Inc. Institutional Review Board. See **Figure 1** for study design timeline. The study consisted of two comparison groups. Group 1 included patients referred to dermatology during six months before implementation of eConsults and Group 2 included patients referred during the 6-month period after eConsult implementation. The post-eConsult group was further subdivided into two cohorts; patients referred via eConsults and patients referred directly for an in-person visit, the traditional route.

Study Population and Unit of Analysis: All adult and pediatric patients with a request for a dermatology referral from any of the PCPs caring for adults in any of CHCI's twelve primary care centers from June 1, 2014 to November 30, 2014, as well as from June 1, 2015 to November, 30, 2015, were included in the study. Patients with a dermatology referrals from March 1, 2015 to May 31, 2015, the ramp-up period during which providers and staff were being trained to implement the eConsult process, were excluded from the evaluation. The unit of analysis, the major entity that we are studying in this project, is the individual patient.

Recruitment methods: The Dermatology eConsult program was implemented in April of 2015, and all the recruitment was done prior to this period. The research team at Weitzman Institute

introduced the study to all the providers through summary fact sheets, emails, and in-person training sessions that were held before the program implementation in April of 2015.

Theoretical Framework: The theoretical framework for implementation of a teledermatology platform is analogous to implementation of other telemedicine programs. Van Dyk et al[27] compared and contrasted multiple telemedicine theoretical frameworks that explain the relationship between ehealth, telehealth, and telemedicine within the larger context of telecare. See **Figures 2A and 2B.**

Setting: All patients were referred from Community Health Center, Inc. (CHCI) sites. CHCI is a level-three patient-centered medical home (PCMH) which provides comprehensive primary medical, dental, and behavioral health care services to over 145,000 patients throughout Connecticut. Medical care is provided in over 200 practice locations across the state, including primary care centers, school based health centers, homeless shelters, and mobile outreach sites. Over 60% of CHCI's patients are racial/ethnic minorities, and over 90% are at or below 200% of the Federal Poverty Level. Approximately 70% of patients seen at these health centers are enrolled in state funded Medicaid insurance, with 8% being uninsured, and the rest being covered by Medicare or private insurance. Primary medical care at CHCI is provided by internal medicine, pediatric, and family practice physicians as well as physician assistants (PAs) and advanced practice registered nurses (APRNs). The UConn Department of Dermatology is part of UConn Health Center, which is a large, state-funded hospital. Two UConn Health Center board-certified dermatologists participated in the eConsults program. The Connecticut Department of Social Services provided reimbursement for eConsults provided to Medicaid patients.

Intervention: CHCI, in partnership with the University of Connecticut Health Center (UCHC) conducted a clinical trial of eConsults for cardiology between 2010 and 2012.[28] Results demonstrated improvements in access to care and reduced wait times, as well as cost savings. Based on the success of this trial, CHCI and UCHC added additional specialties, including dermatology, to the intervention. Each CHCI practice site was provided with a dermatoscope (3.5V pro-physician dermatolight-LED, cost USD $110) and camera (Cannon Powershot ELPH 360HS, cost USD $200). PCPs and medical assistants were trained in the process of taking photos, using a dermatoscope for close up views, and uploading the information to the electronic health record (EHR). Providers were also given talking points on how to discuss eConsults with their patients. They were provided with the "*Quick Guides for Store-Forward Teledermatology for Referring Providers"* booklet published by the American Teledermatology Association to reference as needed. Training sessions took place prior to the formal implementation of the eConsult program.

After the formal implementation of the eConsult in April 2015, primary care providers identifying the need for a dermatologic consult had the option of offering patients an eConsult or requesting a traditional in-person referral. For non-urgent complaints, providers were encouraged to explain the process to their patients, obtain their verbal consent, take photos of the lesions, and submit their consult request in the electronic health record. The referral was sent to a centralized referral coordinator who then uploaded the request into an eConsult web-based portal. If the primary care provider decided to bypass eConsults entirely, they had the option of directly referring a patient for an in-person appointment with a dermatologist of their choice. If a traditional in-person appointment was requested, the referral coordinator reached out to a local dermatology practice and requested an appointment via phone. For eConsult requests, the referral coordinator entered the consult question(s) and uploaded information from the medical record, such as ICD-code,

clinical and dermoscopic images, relevant labs and clinical notes into a web-based eConsult platform.

The consulting dermatologist would receive notification of the new eConsult by email or text message and logged onto the web-based platform to retrieve, review, and respond to the consult. The teledermatologist had to respond within two business days. Responses generally fell into three main categories: 1) a suggested diagnosis and treatment plan for the PCP to implement, 2) a request for additional information or testing, or 3) a recommendation for F2F evaluation. If a F2F recommendation was made, the patient was prioritized to a fast-track dermatology appointment. Approximately one hour per week was set aside for these patients. The eConsult response was received by the referral coordinator, converted to a printable document, and sent back to the referring PCP in the EHR for review. This allowed for easy communication between PCP and consulting dermatologist and made the system more user-friendly for PCPs given that they did not have to leave the EHR to submit or review an eConsult. This store-and-forward teledermatology (eConsult) platform is demonstrated in **Figure 3**.

Data Collection: We collected clinical and demographic data for all patients in the study from three sources: (1) queries of CHCI's electronic health records, (2) queries of the web-based eConsult platform, and (3) chart reviews of CHCI's and UCHC's EHRs. Data collected included patient demographic information, dates of referral requests, appointment dates, eConsult response dates and times, referring diagnoses and ICD-codes, consultants' diagnoses and ICD-codes, treatment plans, reasons for F2F, and biopsy results.

Analysis: Patients were grouped into two cohorts for analysis: (1) patients referred to dermatology during a six month period prior to implementation of eConsults, and (2) those referred during a

six-month period after eConsults were available. The post-eConsult cohort was further divided into two sub-cohorts consisting of those patients for whom the provider chose to send an eConsult and those who were sent directly for a traditional referral, bypassing eConsults. Statistical analysis was performed using SPSS Statistics version 24.0. We used descriptive statistics to measure frequencies and percentages of dermatology referrals in each patient group. Patient demographic information was compared between groups using chi-squared tests for categorical variables. Yates' chi-squared statistics were calculated as an approximation in the analysis of 2x2 contingency tables, to reduce the error in approximation using Pearson's chi-squared statistics. Independent sample t-test was used to compare mean wait time between patient groups. The statistical tests were two-tailed, and an alpha level of 0.05 was used; hence, all p-values < 0.05 were considered statistically significant.

HUMAN SUBJECTS

Risks to subjects: This research study is comprised of mostly chart reviews and therefore does not present any physical, social or legal risks to the participants. All data that was downloaded from the electronic health records into excel sheets was de-identified. The research investigators who had access to the EHR and SafetyNet (the electronic eConsult platform) have been IRB approved and completed training at CHC Inc.

Confidentiality: Only a limited number of researcher investigators had access to the patient data and those individuals received extensive training at CHC Inc. Data was collected through queries of the electronic health record and all chart reviews of the electronic record were done by trained research assistant. Research data were kept in a password-protected research database. Additionally, all chart reviews took place at Community Health Center, Inc. and the chart abstraction tool data was stored in a password protected Excel file stored in a restricted access folder behind the agency's firewalls. All patient information remained confidential under all circumstances, including publishing and presenting of research findings.

Potential benefits for subjects: There is no direct benefit to the participants. The results of this study will, however, hopefully show the importance of teledermatology in expanding access to dermatological care. This research study will hopefully add to the body of literature that shows the role of eConsults in increasing access to care and decreasing wait times for all patients, but especially underserved populations. Additionally, this research will improve the dermatology eConsult services and improve communications between primary care providers and dermatologists, with the goal of allowing all patients to receive better health care.

RESULTS

Access: referral request outcomes: The appointment outcomes of all 2385 dermatology consult requests are shown in **Figure 4**. There were 1258 referrals in the pre-eConsult period and 1127 referrals in the post-eConsult period. Patient demographics in these two cohorts were similar with minor but significant differences in age and race **(Table 1)**. In the pre-eConsult cohort, 744 out of 1258 patients (59%) for whom a dermatology consult was requested received an appointment. Out of those, 139 (18.7%) patients had documentation of having attended the visit with a dermatologist. This means that of 1258 dermatology referrals that were made in the pre-eConsult period, 139 of 1258 (11%) had evidence of actually being evaluated and treated by a dermatologist. Of the 1127 consults requested in the post-eConsult period, 628 (56%) were sent by the PCP directly for an in-person visit, completely bypassing the eConsult process, while 499 (44%) were sent using eConsults. Of the 499 eConsults, 85% were adults and 25% pediatric **(Table 2).** Of these, 18% of adult eConsults and 10% of pediatric eConsults received a face-to-face recommendation. Patients whose PCP bypassed the eConsult process for an in-person visit request were less likely to have Medicaid insurance compared to those sent for an eConsult [397/626 (63%) vs 403/499 (81%) p=0.001]. Among patient referrals that were sent directly for a traditional in-person visit, approximately 312 (50%) received an appointment, with only 51 (16.3%) actually seeing a dermatologist. All 499 patient referrals that were sent via eConsults received a consultation from a dermatologist that consisted of a diagnosis and treatment plan. Of these, seventy-eight (16%) were recommended for a face-to-face (F2F) evaluation and 70 (90%) received an appointment. Of those who received an appointment 46 (66%) had documentation of having been seen by the specialist (p<.001). Comparing pre-and post- eConsult cohorts, 550 (49%) patients received a diagnosis and treatment in the post-cohort as compared to 139 (11%) in the pre-cohort.

Access - consult completion time: We defined "consult completion" as either the date that an eConsult with a diagnosis and treatment plan not recommending a F2F visit was returned to the provider, or the date that patients for whom a F2F visit was requested by the PCP or suggested by the eConsult reviewer were seen by a dermatologist. **Figures 5A and 5B** show the differences in consult time completion in the three different cohorts. For all patients referred via eConsults, completion time was within 24 hours. For patients who were given an appointment for a F2F visit in the pre-eConsult period, the median time to consult completion was 77 days with a range of one to 353 days. In the post eConsult period, patients whose PCPs bypassed eConsults and requested an in-person visit had a median of 104 days to completion, ranging from one to 300 days. Patients who were first triaged through eConsults and received a F2F recommendation by the consulting dermatologist, received an appointment within 28 days, with a range of 7-143 days **(Table 3).**

Referral Frequency - eConsult impact on overall referral volume: Whether the opportunity to submit an electronic consultation increases the overall PCP referral frequency or not is still debated. One study showed that there was an increase in the number of referrals that were sent over time once an eConsult program was implemented.[2] We wanted to evaluate whether the new eConsult process had an impact on the total volume of referrals made. We evaluated the number of consults requested by all participating PCPs per 1,000 patient visits from January 2014 to November 2016. We conclude that while consult request volume varied somewhat from month to month, the average rate remained stable throughout the entire research period without any significant changes, approximately 10.77 per 1000 patient visits ($p = .142$, 95% CI [-2.53, 1.68]). See **Figure 6**.

Understanding Diagnoses – Common referral and consultant diagnoses*:* We evaluated the referring provider diagnoses and eConsult dermatologist diagnoses (**Tables 4A, 4B and 4C)**. The

most common diagnosis for which teledermatologists recommended a F2F visit was ‘suspicious neoplasm’ (n=29). The most common reason for a face-to-face recommendation was ‘biopsy’ (63%) which is not surprising given that the most common diagnosis for a face-to-face recommendation was suspicious neoplasm. ‘Treatment’ was the second most common reason for a F2F referral. Most common treatments included biologics or light therapy for psoriasis, steroid injections, excisions, and Accutane for acne. See **Figure 7** for a complete list.

Skin Cancer triage – eConsult use for skin cancer screening*:* All 29 patients who received F2F recommendation for ‘suspicious neoplasm’ received an appointment, 27 (93%) at UCHC and two (7%) at a non-UCHC location. See **Figure 8.** Nineteen of these patients (66%) attended their appointment while 10 failed to attend. Biopsies were performed on 15 patients, while upon further in-person evaluation, four were judged not to require a biopsy. Ten of 15 (67%) biopsies were positive for cancer including eight basal cell carcinomas (three patients had multiple BCCs), one squamous cell carcinoma (invasive), and one atypical squamous proliferation **(Table 5).** No melanomas were found. Surgical treatment (either excision or Mohs) was performed for all patients with a biopsy-proved skin cancer.

DISCUSSION

Our study demonstrates that prior to implementation of a dermatology eConsult system, about 60% of patients in need of a referral were able to even receive an appointment, with a median waiting time of nearly three months. In the end, only 11% of patients had a documented visit with a dermatologist. This is consistent with the post-eConsult traditional referral cohort, where only 16% of patients received dermatological care after waiting an average of approximately three months. These findings clearly demonstrate an observable lack of access to dermatologic care in community health centers, which serve primarily medically-underserved minority groups. Consistent with other studies[2, 19, 20, 29-31] our study demonstrated a significant improvement in access to dermatological care. Unlike other studies, however, this study showed how effective an electronic consultation system can be when implemented on a statewide scale where providers are free to choose which route to use for specialty referrals. This provides a real world perspective of how eConsults work within a large multi-site primary care setting.

One hundred percent of patients referred via eConsults received a diagnosis and treatment plan, from a specialist within 24 hours; with 84% of eConsults managed without a face-to-face consultation, and 16% requiring an in-person visit. More importantly, patients who required an in-person consultation after the initial eConsult experienced significantly reduced waiting times for their appointment, compared with patients who received a traditional referral (28 days in eConsult cohort; 104 days in traditional referral cohort, $p<0.01$). Prior establishment of a relationship between patient and dermatologist using eConsults may have contributed to this positive outcome. Consistent with previous reporting,[19, 20] our study suggests that dermatology eConsults dramatically improve access to dermatological care. Compared with the traditional referral system, the dermatology eConsult system provides patients with rapid and reliable access to an in-person

visit when one is necessary. These findings provide further evidence that teleconsultation is an effective platform because of its capacity to provide PCPs with guidance for diagnosing and managing low risk conditions, while simultaneously identifying patients who need further evaluation and treatment. Primary care providers can use these consultative services to refer patients to dermatology in order to optimize patient management.

A previous study identified four factors contributing to decreased necessity for F2F appointments: (1) preselection of patients for eConsults, (2) production of high-quality imagery, (3) the use of dermoscopy, and (4) effective infrastructure.[32] In our study, slightly less than 16% of those seen via teledermatology were recommended for a F2F consultation, indicating an 84% reduction in F2F dermatology visits. This is the highest rate reported in the current literature, followed closely by Nelson et al[19], who found a 77% reduction in F2F visits. Other studies have reported significantly greater rates of patients requiring a F2F visit after teledermatology consultations, ranging from 31% to 68% of total eConsults.[19, 31, 33] Primary reasons for our study's success in resulting to lesser F2F recommendation rate include implementing comprehensive training for PCPs on producing high-quality images using a dermatoscope and effective coordination between PCPs and dermatologists facilitated by the referral coordinator. Our experience has further confirmed the importance of training and coordination between PCP and dermatologist in order to implement a highly efficient teledermatology program.

In our study patients who received traditional referrals for an in-person dermatology visit had a remarkably high no-show rate of about 80%. The root causes for high patient no-show rates, especially among Medicaid patients, are complicated and multifaceted. Resneck et al[10] found that Medicaid patients waited an average of 34% longer for an appointment. Higher rates of chronic physical and psychological conditions among patients with Medicaid insurance additionally

contribute to high non-attendance rates.[8, 10] Furthermore, as a result of long waiting times, patients are more likely to forget their appointments or seek care elsewhere, using emergency rooms or urgent care centers. Substantially high non-attendance rates expose the structural flaws inherent in our traditional referral system. The traditional system fails to prioritize resources, eventually leading to significant waste of valuable time for both patients and physicians. As our study suggests, a highly efficient and coordinated teledermatology system could be a promising solution. It could reduce no-show rates dramatically through easy access to teleconsultation, in which 100% of patients receive a diagnosis and treatment plan by the specialist which is then implemented by the PCP. More importantly, for patients who require a face-to-face visit subsequent to the use of teledermatology, the no-show rate decreased significantly (88% among traditional cohort and 24% among eConsult cohort), possibly due to decreased wait times and the prior establishment of a relationship between dermatologist and patient via the eConsult. Patients for whom providers chose to bypass eConsults had fewer scheduled appointments and a longer median wait time of 104 days for those who received an appointment, compared to 28 days for patients who obtained a F2F visit after eConsult. The faster appointment time is most likely due to the fast-track appointments reserved for eConsult patients who need to be seen F2F. Interestingly, bypassing eConsults actually reduced the likelihood of the patient being seen.

It is unclear whether implementation of a teledermatology teleconsultation program affects referral frequency, with arguments made for each side. As of this publication, few studies have investigated the topic thoroughly. Uscher-Pines et al[2] reported a statistically significant increase in the rate of teledermatology referrals over time after implementation of store-and-forward teledermatology for nine months in California under a Medicaid managed care plan. We initially postulated that teledermatology might lead to a decrease in referrals over time, primarily due to efforts to educate

PCPs with regard to common skin conditions. Contrary to the findings of this study, we did not observe an increase in PCP utilization of dermatology referrals. Our study shows that the average rate of referrals remained stable at about 11 referrals per 1,000 patient visits (1.1%). This reflects referrals made both before and after eConsult program implementation during a 3-year period from 2014 to 2016. Therefore, we demonstrated that implementation of store-and-forward teledermatology does not lead to over-referring, which suggests that PCPs continue to use appropriate discretion in selecting patients to send for in-person visits or teledermatology. This strengthens contrary arguments against the concern that teledermatology potentially burdens the system with excessive referrals. Long-term studies, however, are required to further evaluate whether teledermatology might decrease referrals through PCP education.

This study also addresses another concern regarding the ability of eConsults to identify skin cancers effectively. Suspicious neoplasm was the primary diagnosis for patients receiving a recommendation for a F2F consultation. Of the 78 patients recommended for a F2F visit after initial teleconsult, 29 of them carried the diagnosis of suspicious neoplasm. This is approximately 6% of total eConsults, a rate similar to reports from Leavitt et al.[31] In this study, 66% of patients with 'suspicious neoplasm' attended their in-person appointment, and 80% of these patients had a biopsy performed. Pathology confirmed that two-thirds of these patients (10 of 15) had biopsy-proven skin cancers, including basal cell carcinoma and squamous cell carcinoma. Our study is consistent with previous work demonstrating the potential of teledermatology to aid in identification of skin cancers.[35-37] However, to our knowledge most studies have focused on pigmented malignancy, such as melanomas. Only a few studies have looked at non-melanoma skin cancers. All cancers discovered by our teledermatology services were non-melanomas (80% BCCs; 20% SCCs). Possible reasons for not identifying any melanomas could be related to our

limited sample size, as well as patient demographics, since the majority of our patients were Hispanic or Black. These populations tend to experience lower overall rates of melanoma incidence.[38] Unfortunately, 10 patients diagnosed with 'suspicious neoplasm' through the electronic platform failed to attend their appointments despite multiple tries reaching out to the patients. This finding demonstrates the process limitations and the need for more comprehensive and aggressive interventions to ensure that patients with potentially serious conditions actually receive the care they need. Furthermore, all patients diagnosed with skin cancer received pre-surgical consultation and treatment. Overall, our results indicate that a store-and-forward teledermatology system with the integration of dermoscopy is an effective platform for skin cancer screening and improves access to skin cancer treatment for medically disadvantaged patients.

STRENGTHS AND LIMITATIONS

This study possessed several strengths. We obtained a large sample size of 2,385 referrals, with a pre-eConsult cohort and post-eConsult traditional referral cohort to use for side-by-side comparison with the eConsult group. We demonstrated a highly efficient and coordinated store-and-forward teledermatology model by implementing comprehensive training for all participating health care providers, including training with regard to the use of dermoscopy and clinical photography. This study is unique in that it analyzes implementation of eConsults on a statewide scale in an "open system" where primary care physicians have a choice whether to use the program or not. It gives a more 'real world' perspective. Our study suggested that teledermatology may be a promising solution to the problem of low access to specialty care and high no-show rates. Moreover, this study is the only one of its kind to incorporate the use of dermoscopy as part of the eConsults, contributing to high rates of skin cancer detection.

Several limitations need to be considered when interpreting the results. First, there may be a narrow generalizability of the data seeing as our study population included only individuals who sought care at community health centers in the state of Connecticut. Furthermore, all eConsults that received F2F recommendation received an in-person appointment at UConn Health. This could have been aided by the long-standing relationship between CHCI and UConn Health, and may, therefore, not be generalizable in other settings. Second, two dermatologists at UConn Health reviewed all of our electronic consultations, and we did not test for inter-observer reliability between teledermatologists. Third, it is the responsibility of the primary care provider to communicate with the patient when it comes to implementation of the recommended treatment plan. Based on PCPs' patient contact methods, therefore, variability may exist.

MAIN CONCLUSIONS

This study provides evidence that eConsults increase access to dermatologic care for underserved populations and produce shorter wait times for those patients who require a F2F consultation. Our data also demonstrates that eConsults is an effective mechanism for early detection and treatment of skin cancers among medically underserved populations receiving care at community health centers. Overall, we have demonstrated the effectiveness of a dermatology eConsult program in real-time statewide primary care settings. We hope the findings from this study will aid in the reduction of unnecessary appointments and referrals to dermatology and help decrease delays for patients who require a F2F consultation with a dermatologist. Additionally, we hope that our experience and results will encourage other community health centers to implement a similar dermatology eConsult program.

FIGURES AND TABLES

Figure 1. Research study design timeline

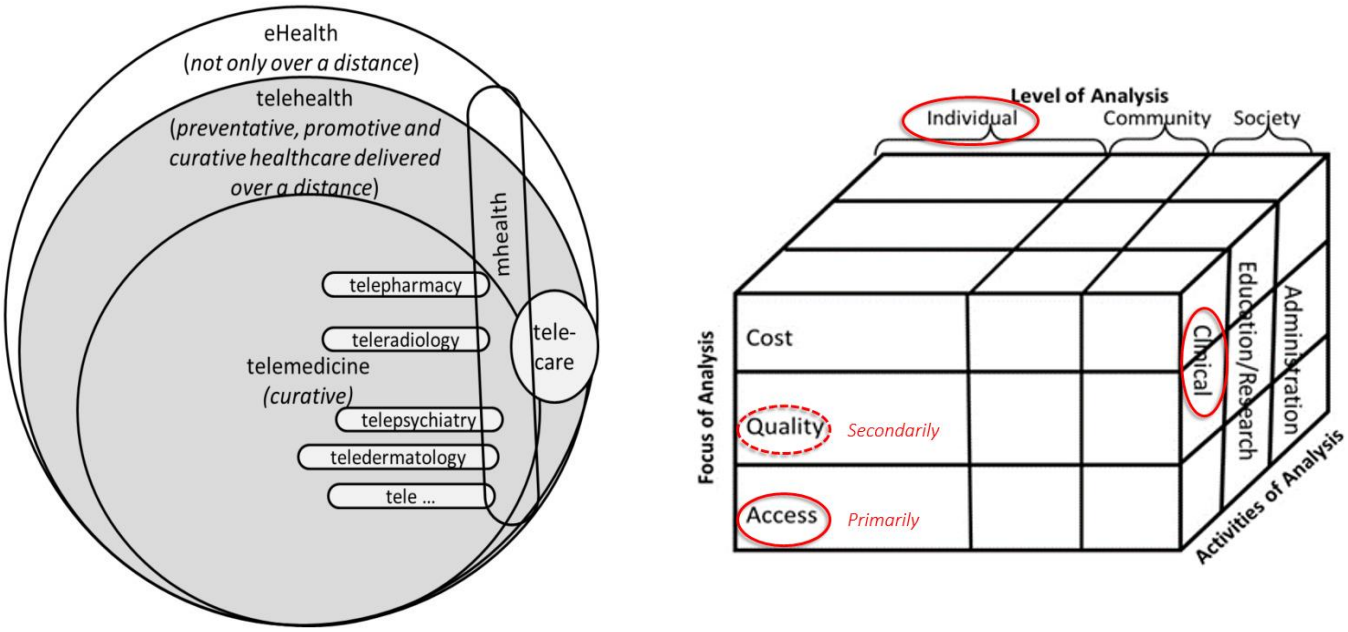


Figure 2A & 2B. Telehealth theoretical framework as described by Van Dyk, 2014 [28]

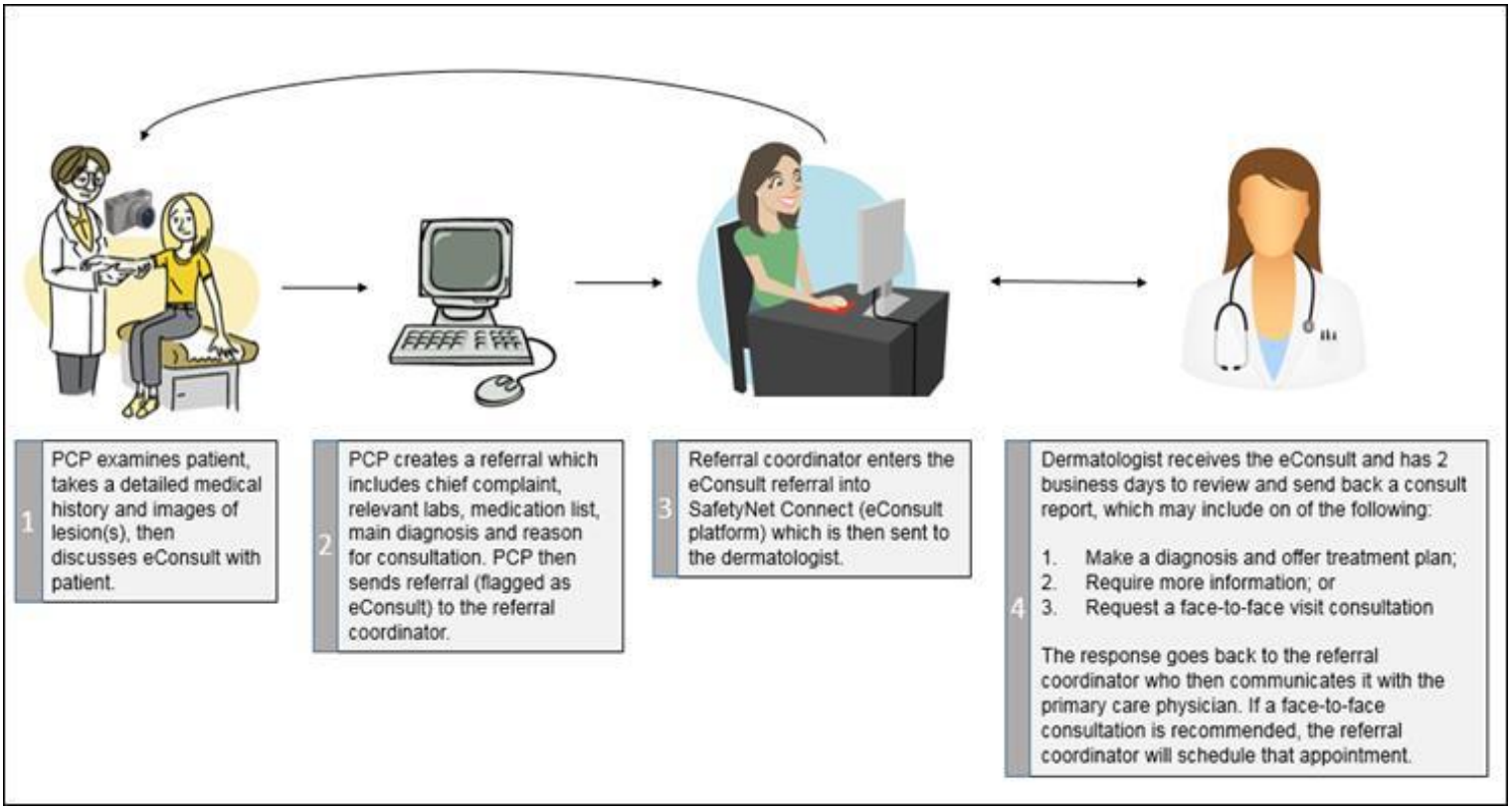
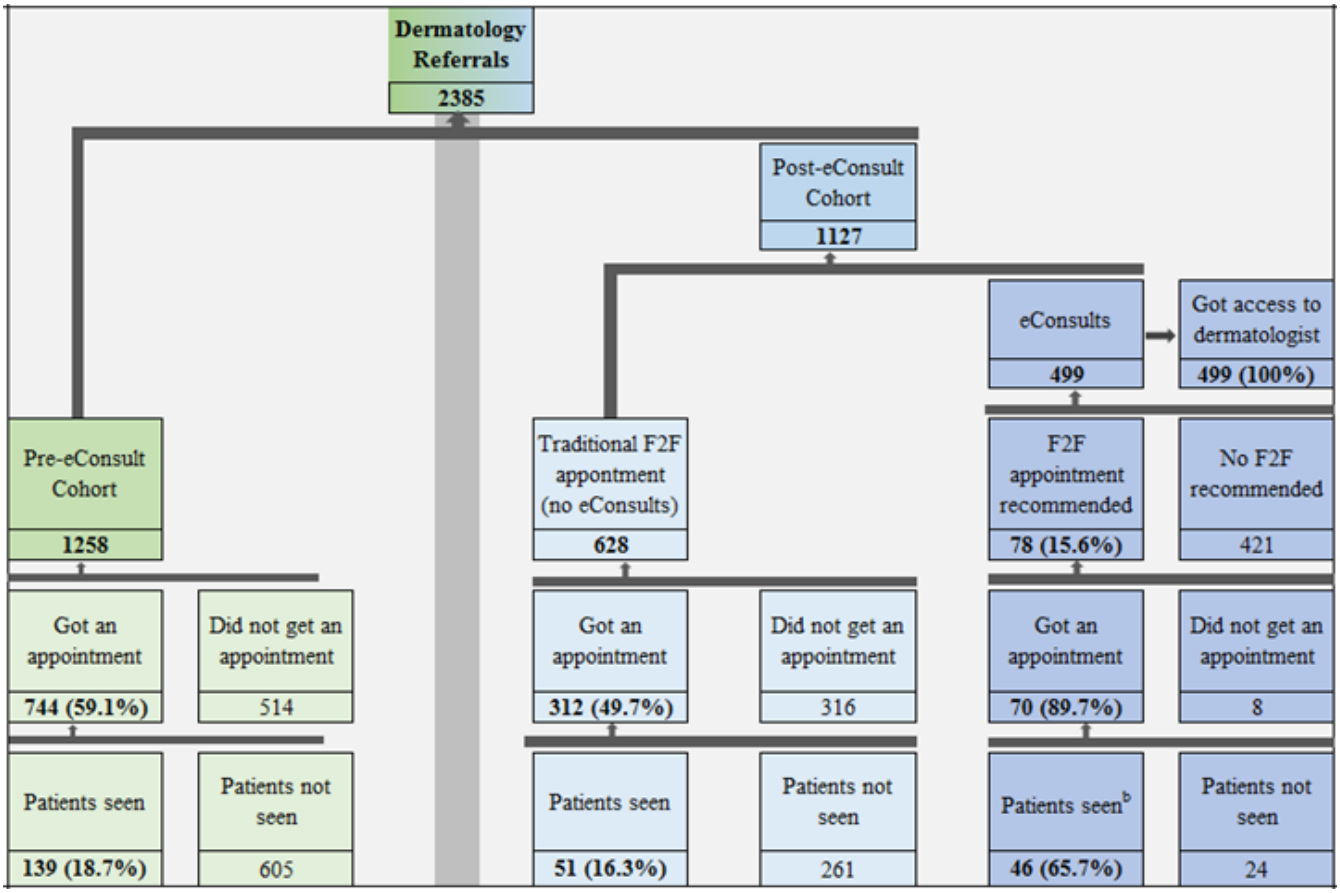


Figure 3. The store-and-forward teledermatology (eConsult) platform as adopted by the Community Health Center Inc. and UConn Dermatology



Number of patients seen in the pre-eConsult cohort and post-eConsult traditional F2F cohort was determined by the number of consults reports received. While the number of patients seen was determined by HER. Chi-squared tests for two-by-two contingency tables for patients who saw dermatologist from total referred per cohort: Pre-eConsult vs. post-eConsult traditional F2F cohort p<.561. Post-eConsult cohort: traditional F2F vs. eConsult F2F p<.001

Figure 4. Flow diagram of dermatology referrals in each of the three cohort groups

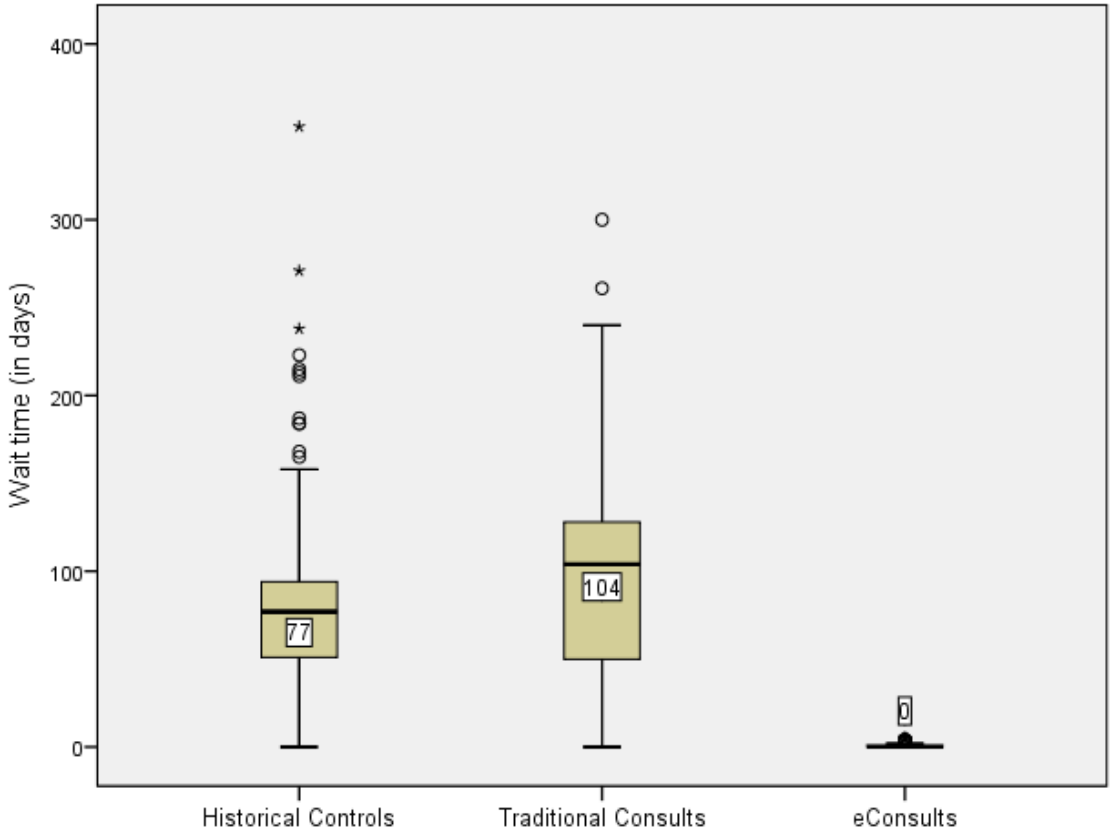
Table 1. Patient demographic characteristics by referral group (n = 2385)

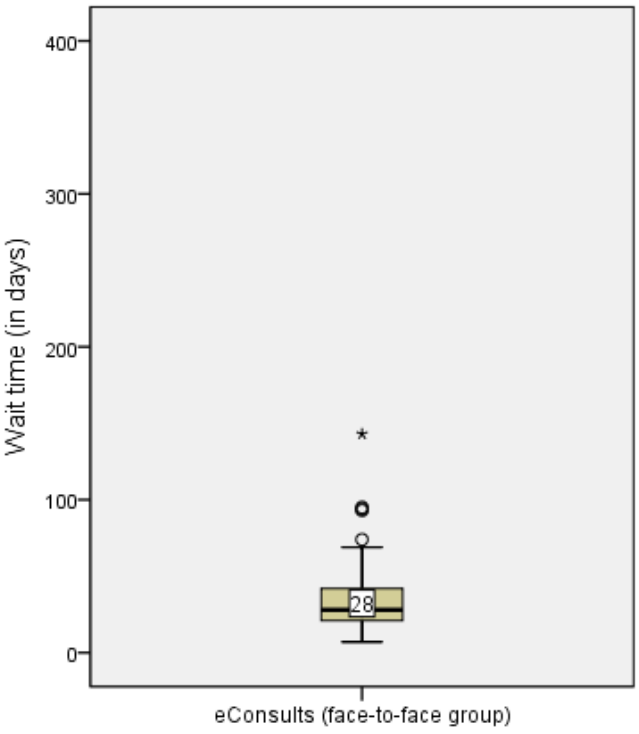
					Post-eConsults		
		Pre-eConsult Cohort	Post-eConsult Cohort	Pre-eConsults vs. Post-eConsults [a]	Traditional F2F consults	EConsults	Traditional consults vs. eConsults [a]
		(n=1258)	(n=1127)		(n=628)	(n=499)	
		No. (%)	No. (%)	*p* value	No. (%)	No. (%)	*p* value
Gender [b]	**Female**	808(64.3)	703(62.4)	.336	403(64.2)	300(60.1)	.163
	Male	449(35.7)	424(37.6)		225(35.8)	199(39.9)	
Age, y	**Mean (SD)**	39.29(19.18)	37.94(19.96)	.004*	39.57(19.96)	36.31(19.96)	.856
Age, y	**0-18/pediatrics**	218(17.4)	240(21.3)	.014*	122(19.4)	118(23.6)	.086
	19-99/adults	1040(82.6)	887(78.7)		506(80.6)	381(76.4)	
Race	**Hispanic**	565(44.9)	515(45.7)	.001*	282(44.9)	233(46.7)	.533
	Non-Hispanic White	482(38.3)	365(32.4)		213(33.9)	152(30.5)	
	Non-Hispanic Black	103(8.2)	98(8.7)		48(7.7)	50(10.0)	
	Unknown	65(5.2)	94(8.3)		54(8.6)	40(8.0)	
	Other	43(3.4)	55(4.9)		31(4.9)	24(4.8)	
Medical Insurance	**Medicaid**	856(68.1)	800(70.9)	.494	397(63.2)	403(80.8)	.000*
	Medicare	153(12.2)	129(11.4)		80(12.8)	49(9.8)	
	Private	145(11.5)	113(10.1)		100(15.9)	13(2.6)	
	No insurance	71(5.6)	64(5.7)		32(5.1)	31(6.2)	
	ACA and other public	33(2.6)	22(1.9)		19(3.0)	3(0.6)	

Percentages (%) add up in columns not rows
Statistical significance at p < .05
[a] Chi-square test was used to compare gender, age, race and medical insurance
[b] There is one missing value from the gender variable

Table 2. Adult vs pediatric eConsults

	Total eConsults	Face-to-face
Adults	377	67
Pediatric	122	12
Total	499	79





The segment inside the rectangle shows the median days and "whiskers" above and below the box show the minimum and maximum days. Mild outliers are marked with an open circle (o). Extreme outliers are marked with an asterisk (*).

Wait time in pre-eConsult group based on 744 of 744 referrals that received an appointment. No missing values.

Wait time in post-eConsult group based on 311 of 312 that received an appointment. 1 missing value

Wait time in F2F eConsult group based on 66 of 70 that received an appointment. 4 missing values.

Figure 5A & 5B. Median days from referral submission to dermatology consultation

Table 3. Days from referral submission to appointment date

	Historic Controls (n=744)	Traditional Consults (n=311)[a]	eConsults (n=499)	eConsults Face-to-Face (n=66)[b]
Mean	74	93	<1	34
Median	77	104	0[c]	28
Min-Max	0-353	0-300	0-5	7-143
SD[d]	38.5	50.6	1.04	24.03

Abbreviations: SD, standard deviation
Independent samples t-test between means was significant p=.000*
[a] 312 of 628 referrals received an appointment. Missing value for 1 referral.
[b] 70 of 78 eConsults with a F2F recommendation received an appointment. Missing values for 4 referrals.
[c] the value "0" indicates that eConsult referral submission and dermatologist reply was within the same day.

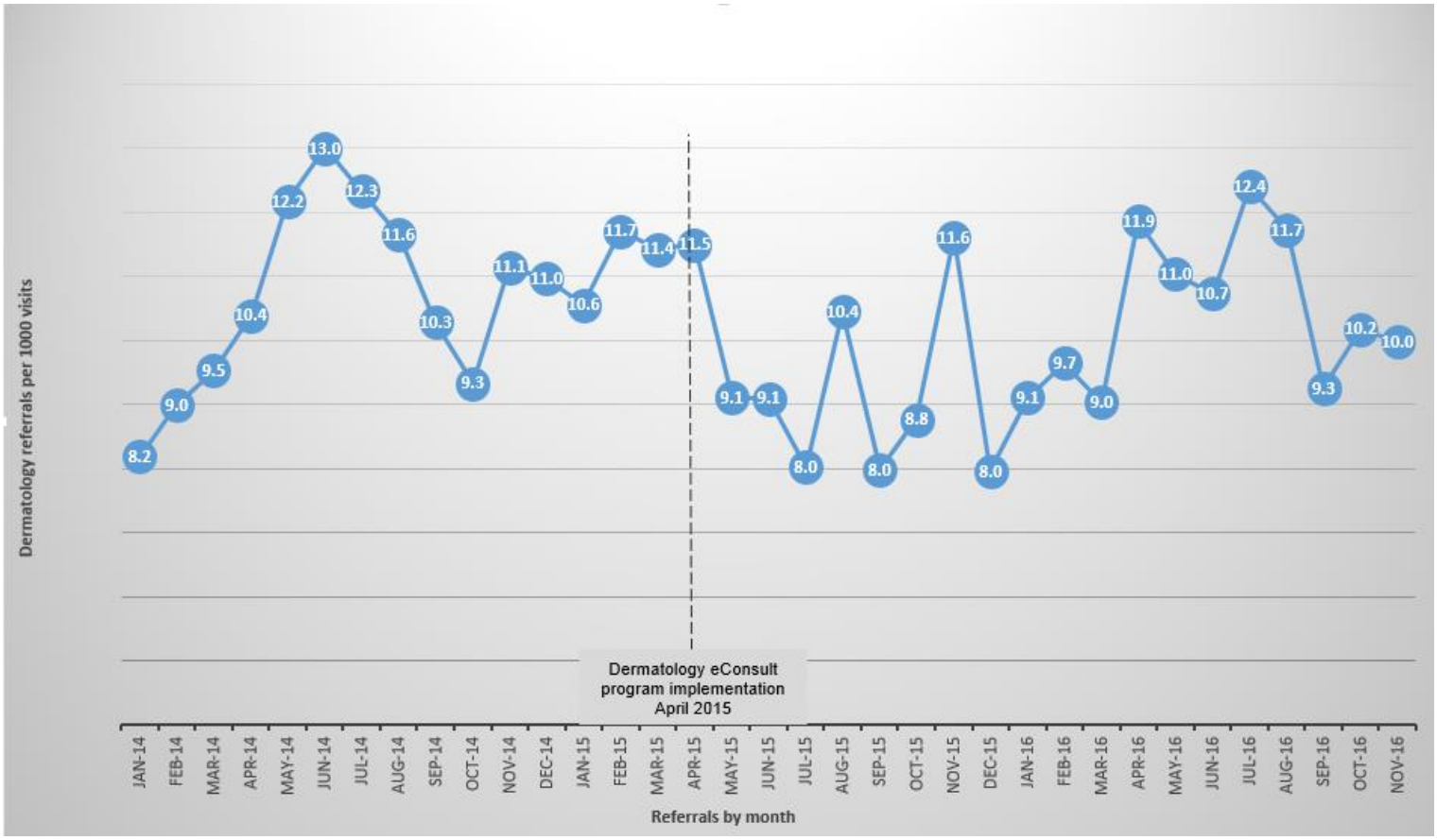


Figure 6. Monthly dermatology referrals by all CHC sites per one thousand patients from 2014-2016

Table 4A.
Dermatologist eConsult diagnostic categories

	N (%)
Dermatitis	**141 (28.3)**
Atopic dermatitis	34
Neurodermatitis	22
Contact/Allergic dermatitis	20
Seborrheic dermatitis	15
Nummular dermatitis	12
Pityriasis Alba	7
Unspecified/other	31
Benign neoplasms	**101 (20.2)**
Nevi	40
Unspecified/other	61
Infectious disorders	**67 (13.4)**
Fungal	29
Bacterial	22
Viral	13
Unspecified/other	3
Other	**37 (7.4)**
Acne/Rosacea	**33 (6.6)**
Acne	22
Rosacea	11
Suspicious neoplasms	**29 (5.8)**
Basal Cell Carcinoma	11
Squamous Cell Carcinoma	5
Melanoma	4
Spitz Nevus	1
Unspecified/other	9
Pigmentation disorders	**22 (4.4)**
PIH	12
Melasma	5
Vitiligo	2
Unspecified/other	3
Psoriasis	**21 (4.2)**
Other inflammatory diseases	**18 (3.6)**
Diagnostic uncertainty	**12 (2.4)**
Alopecia	**11 (2.2)**
Alopecia areata	5
Non-scarring	4
Scarring	1
Unspecified/other	1
Multiple diagnosis	**7 (1.4)**

Table 4B.
PCP eConsult diagnostic categories

	N (%)
Rash	**143 (28.7)**
Neoplasm/Skin growth	**75 (15.0)**
Nevi	7
Unspecified/other	68
Dermatitis	**70 (14.0)**
Atopic dermatitis	11
Seborrheic dermatitis	5
Contact/Allergic dermatitis	1
Unspecified/other	53
Unspecified skin disorder	**64 (12.8)**
Infectious disorders	**41 (8.2)**
Fungal	21
Viral	14
Bacterial	6
Other	**34 (6.8)**
Acne/Rosacea	**23 (4.6)**
Acne	19
Rosacea	4
Pigmentation disorders	**21 (4.2)**
Vitiligo	2
Unspecified/other	19
Psoriasis	**16 (3.2)**
Alopecia	**12 (2.4)**

Table 4C.
eConsult diagnosis that received a F2F visit recommendation

Diagnostic categories	F2F Recomm.* (n=78)	F2F Appt.* (n=68)
Suspicious neoplasms	29(100)	29(100)
Benign neoplasms	10(9.9)	6(60)
Other	6(16.2)	5(83.3)
Other inflammatory diseases	6(33.3)	5(83.3)
Infectious diseases	5(7.5)	3(60)
Diagnostic Uncertainty	4(33.3)	4(100)
Acne/Rosacea	4(12.1)	3(75)
Dermatitis	4(2.8)	4(100)
Pigmentation disorders	4(18.2)	3(75)
Psoriasis	4(19.0)	4(100)
Multiple diagnosis	2(28.6)	2(100)
Alopecia	0	n/a

Data shown as number (percentage) of patients. Frequency represents the number of times each diagnostic category showed up. Percentages are ranked according to highest percentage found. In table 2A and 2B, the percentages add up in column. In table 2C, F2F recommendation column represents the percentage of each diagnostic category from the total number of F2F recommendations (n=78). F2F appointment column represents what percentage of that diagnostic category received a F2F appointment with the dermatologist (n=68).

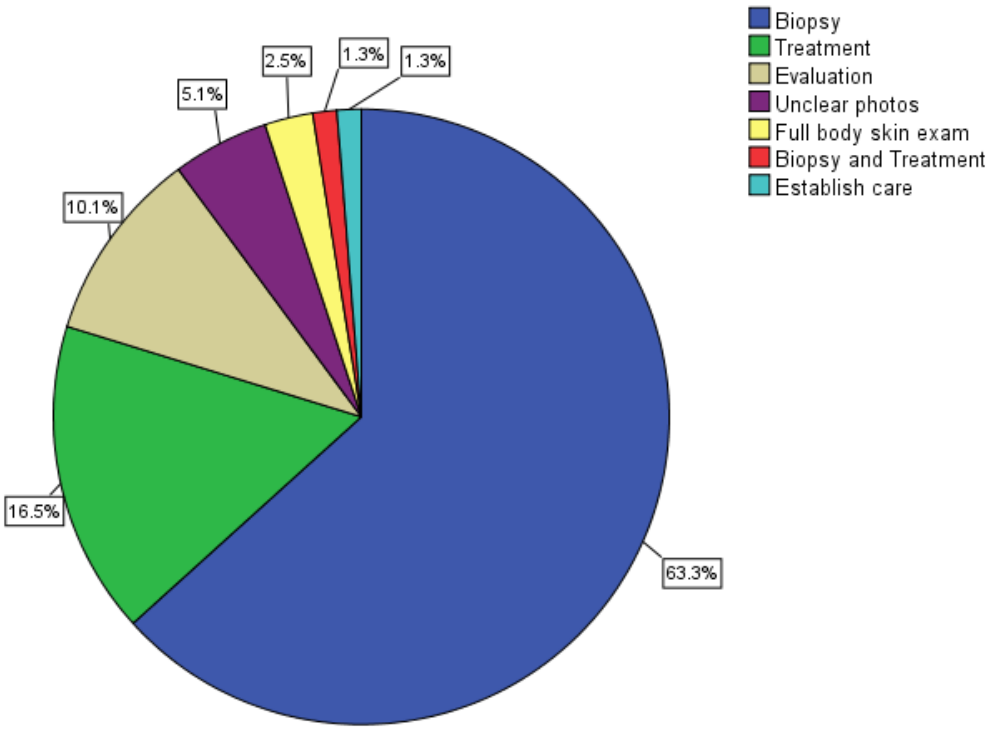
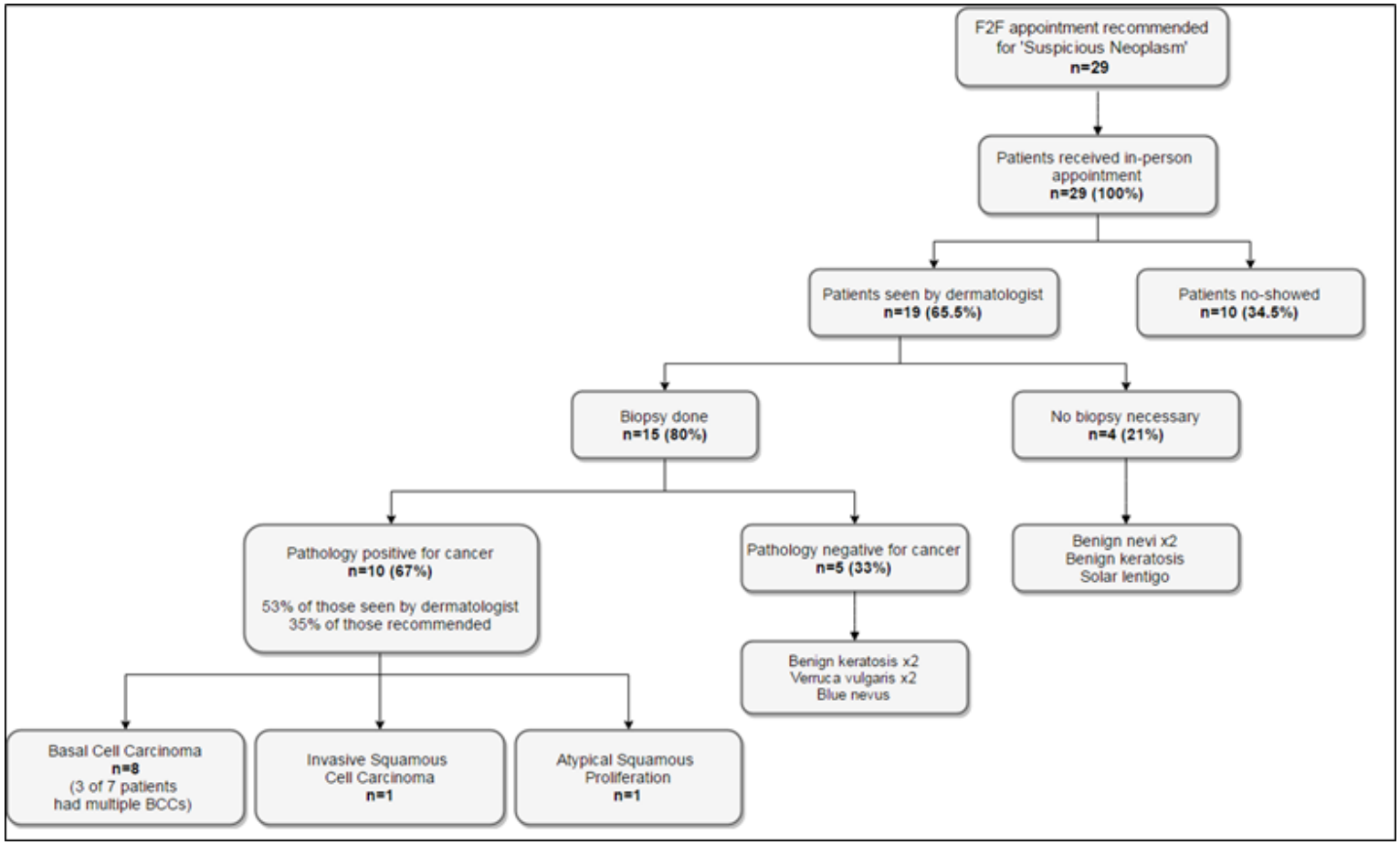


Figure 7. Teledermatologist reasons for F2F recommendations



'Suspicious neoplasm' (n=29) was the top diagnoses send for a F2F consultation by teledermatologist (n=78); total patients seen via eConsults (n=499).
All confirmed cases of skin cancer had a positive pathology report.
No-show patients had several missed appointments.

Figure 8. Flow diagram of eConsult referrals recommending F2F evaluation for suspicious neoplasm

Table 5. Detection of skin cancer in the intervention group

	Traditional consults (n=51)[a]	F2F eConsults (n=46)[b]	P-value
Skin cancer [c]	7 (13.7%)	10 (21.7%)	0.299[d]
Type	4 BCCs 3 SCCs	8 BCCs 2 SCCs	

[a] total patients seen out of 628 patients referred
[b] total patients seen out of 78 patients recommended for a F2F appointment after eConsult (n=499)
[c] all confirmed cases of skin cancer had a positive pathology report
[d] chi-squared tests performed. Significance based on $p < 0.5$.

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