

# Application of an XML-Based Store-Forward System to Urban Teledermatology

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## BACKGROUND

The overall question the investigators sought to explore in this study revolves around the role of store-forward teledermatology in an urban primary care/tertiary care spoke/hub setting. The University of Washington Physicians Neighborhood (UWPN) Clinics is a network of primary care clinics closely affiliated with the University of Washington (UW). The UWPN clinics are located primarily in urban settings throughout the greater Seattle area<sup>1</sup>. The bulk of tertiary care services and referrals for these clinics is handled by UW. Access to referral services is good but can be limited by temporal constraints (the long lead time in scheduling appointments with certain subspecialists) and by convenience (time and frustration costs of commuting in a metropolitan area with some of the worst traffic conditions in the Nation).

In designing the store-forward teledermatology study in the context of the Institute of Medicine report on evaluating telemedicine<sup>2</sup>, the investigators identified system requirements specific to a store-forward teleconsultation system being used for an evaluation study. Existing systems at the time of the initiation of the study did not meet the requirements; thus, a decision was made to build a Web-based store-forward system. The system was designed to be easily customizable for different clinical domains and different types of studies, since these requirements did not appear unique to teledermatology and since there were other clinical domains that the UW Telehealth Program<sup>3</sup> was interested in investigating.

## REQUIREMENTS: URBAN TELEDERMATOLOGY STUDY

A key requirement for the dermatologists participating in the study was that the system permit the creation of a UW-specific, store-forward, teledermatology-specific, electronic consult request form. A related requirement was that the data on this form be stored in a database for aggregate analysis of study data. The clinicians at the participating UWPN clinic required that the system integrate into the existing EPIC-based paperless clinic. In addition, the telemedicine investigators required that the system have an acceptable level of security and be scalable to many UWPN sites and potentially to rural sites (those in need of store-forward teledermatology consultation and willing to participate in a study).

Specific to the store-forward study (as opposed to completion of a teleconsult), the dermatologists involved with the study had a number of questions they wanted to answer: What is the impact of teleconsultation on a primary care provider's diagnosis? Treatment? Level of confidence? The telemedicine investigators also had process questions such as How much time is involved in preparing a teleconsultation? What are the technical problems? Is there a contingency plan in the absence of telemedicine services? What is the ultimate disposition of the patient?

## REQUIREMENTS: STORE-FORWARD SYSTEM

Meeting the specific narrow requirements of the urban store-forward teledermatology

study (UW and UWPN) and then generalizing these requirements to other clinical domains, other store-forward teleconsultation studies, and other sites (e.g., non-UW and nonurban) led to the following requirements: (1) a “thin” client with no software installation (especially for heterogeneous rural sites), (2) use of the existing Internet infrastructure as a communication backbone, (3) ability to integrate into an existing clinic/referral workflow, (4) adequate security measures, (5) configurable consultation templates (clinical domain- and/or consultation-type-specific), (6) storage of the data from the consultations in a database for analysis, (7) similar configurable evaluation-study-specific templates (preconsultation/postconsultation for the primary care provider, postconsultation for the consultant), (8) similar storage of the data from the study-specific templates in a database for analysis, and (9) open-source design to permit adaptation of the system for related uses by other telemedicine investigators.

#### RESULTS: IMPLEMENTATION OF SYSTEM

We built a system to meet the requirements outlined above. To minimize the costs of replicating the system, the Windows NT and Microsoft BackOffice software development environment was chosen. The system is secured by applying the latest patches, disabling all nonessential services, restricting privileges to the bare minimum necessary for users and applications, and using Tripwire to monitor for any intrusions. Secure Sockets Layer connections over the standard Internet are used to encrypt data transmission. Authorization and authentication are via encrypted user names and regularly updated passwords as well as monitoring of usage logs. Consultation and evaluation study data are stored without patient identifiers in an SQL Server database. Access to the database is via Active Server Pages (ASPs) along with server side COM objects (third party and locally developed). Primary care

provider, specialty consultant, and system administrator all access the database via the Web. Data extraction for analysis purposes is done on the server side and not via the Web. The ASPs used are compatible with all major browsers, which permits adding rural sites and users with no remote software installation.

The system is designed to be table and form driven. The administrator can add new specialists and/or specialties as well as change who is “on call” for teleconsultations using the system’s Web-based administration tools. Both consultation and study forms are encoded in a simple XML notation that includes tags for free-text entry, “pick one of list,” “pick multiple off list,” and “select value in range.” Any number of images (up to administrator-configurable MAX\_IMAGES) can be attached to a consultation. For maximum flexibility, the system allows images in the common standard image formats, permitting primary care providers to use a variety of digital cameras.

At the UWPN Factoria study site (and subsequently other UWPN sites for an expanded study), the templates were customized to integrate with the EPIC electronic medical record system. Specifically, templates were developed for the EPIC system that used extracted information from the EPIC system for incorporation into the store-forward teledermatology template developed by the dermatologists at UW. The cameras used at the UWPN sites were Sony Mavica cameras, which recorded images on floppy disks for ease of use in the clinic setting (requiring only a standard floppy drive on the EPIC workstation computer rather than a large number of camera interfaces throughout the clinic).

#### RESULTS: URBAN TELEDERMATOLOGY STUDY

At the time of preparation of this abstract, accrual of patients into the evaluation of urban store-forward teledermatology has

been completed, and final analysis of the results is under way. Sixty-five consults were requested by five clinicians (including a physician assistant) over a 22-month period (an average of three consults per month). A preliminary analysis of the data shows that the average time to prepare a teledermatology consultation was 13 minutes. On an 11-point Likert scale (0=Not Necessary to 10=Essential), the primary care providers rated the necessity of the consultation as 7 on average. Prior to the teledermatology consultation, the primary care providers' levels of confidence in their diagnosis and treatment plan were 5.5 and 5.7, respectively, on average on a similar Likert scale. There were issues with familiarity with and experience in taking photographs of dermatological lesions despite training and a "crib sheet," but these issues improved over time as the primary care providers and dermatologists interacted with one another. The preliminary analysis of the dermatologists' assessment of need for additional in-person contact with the patient suggests a bimodal distribution, with approximately 40 percent of the time feeling an in-person visit was necessary despite the teleconsultation. The consultation raised the primary care providers' confidence in the diagnosis and treatment plan to 7.9 and 8.2, respectively. Overall satisfaction with the process was 8.7 on a Likert scale (ranging from 0=Very Dissatisfied to 10=Very Satisfied). On a scale from 0=Much Worse to 10=Much Better, the average quality of the teleconsultation process, compared with an in-person visit, was rated 6.5.

## DISCUSSION

The XML-based, configurable, store-forward telemedicine system developed at UW was successfully applied to a real-world evaluation study of the potential role and utility of store-forward teledermatology as an adjunct to in-person referral in an urban setting. On the basis of the high user acceptance of the tool (by both primary care providers and

dermatologists) and similar preliminary results from users in rural areas, it appears that this model could be extended to evaluation studies of store-forward telemedicine in other clinical domains. Preliminary analysis of the results of the urban store-forward teledermatology study suggests that it plays a role as an adjunct to in-person referral in an urban setting, but in a setting where in-person visits are readily available, it does not obviate the need for a significant number of in-person referrals (approximately 40 percent of the time).

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