

# Distributed Personal Health Information Management System for Dermatology at the Homes for Senior Citizens

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**Abstract:** A distributed Personal Health Information Management System (D-PHIMS) has been tested at a nursing home for the senior citizens (NHSC) in Singapore. The Personal Health Information Management System (PHIMS) from the University of Washington was customized to Singapore's context for teledermatology. A clinical trial commenced in October 2005 is ongoing and the survey results obtained indicate that the participants are satisfied with the D-PHIMS system. The diagnosis and treatment recommendations made by the dermatologists using the D-PHIMS diagnosis module were effective in most cases based on feedback from the nursing staff at the elderly nursing home. The results suggest that a teledermatology system could become a useful tool for the nursing homes and to control increasing healthcare costs for elderly care.

## I. INTRODUCTION

The baby boomer generation in Singapore will reach 65 years in 2012 and the proportion of the elderly will increase rapidly over the next 20 years [1]. In 2003, the healthcare cost in Singapore accounted for 3% of GDP. With the aging population the cost of healthcare has been on the rise [2]. The number of people on rehabilitation from surgery, non-acute chronic diseases (e.g. chronic types of skin diseases, cardiovascular disease, rheumatism, etc.) is expected to increase significantly [3]. This may in turn contribute to a significant increase in healthcare costs for management of chronic diseases, which requires frequent medical attention and visits to the specialist. Considering the above trends associated with the aging of the population and rising healthcare costs, various initiatives are being taken to provide effective and affordable healthcare with the goal of making an improvement in the quality of life for the senior citizens without increasing the overall healthcare costs.

A majority of the elderly population suffers from chronic diseases and frequent visits to the clinics can be difficult and cumbersome. Also, they might need additional assistance to travel to and from clinics, especially if they suffer from paralysis or dementia. To address the current unmet needs in healthcare for the aging population, a D-PHIMS system implementing store-and-forward (S&F) teledermatology was developed [4] to evaluate skincare via teleradiology.

The D-PHIMS was developed as part of our efforts to realize the Distributed Diagnosis and Home Healthcare (D2H2) vision through an international collaboration project

known as Singapore-University of Washington Alliance in Bioengineering (SUWA) funded by Singapore's Agency for Science, Technology and Research (A\*STAR) with the primary objective of improving quality of healthcare and reducing healthcare costs by transforming the delivery of healthcare from a hospital and doctor-based model into a distributed home-based one [5] utilizing a highly interconnected IT infrastructure.

Telemedicine has emerged as a way to expand healthcare access using technologies to deliver care from a distance [3]. Telemedicine has become more clinically accepted, particularly in dermatology [6], [7]. Teledermatology is the practice of dermatology using available information and communication technology. S&F teledermatology describes information sharing in a time- and location-independent manner. The local clinician (e.g. nurse and referring physician) may create the images and then store or e-mail them to the dermatologist. The dermatologist may retrieve the images and review them at a convenient time [8]. Some studies reported that the S&F teledermatology is as clinically effective as a face-to-face consultation, where the face-to-face consultation is less than 100% accurate [9], [10].

The D-PHIMS is based on the PHIMS developed at the University of Washington (UW) [11], [12]. The D-PHIMS system aims at providing a secure and scalable personal electronic health record management and messaging system for the nursing home that implements S&F telemedicine to provide offline diagnosis for various non-acute chronic diseases [4]. The nursing home for senior citizens has residents who are aged 65 and above. Due to the inherent structural changes in aging skin the elderly patients are more vulnerable than the general population to contract significant cutaneous disorders, such as pressure ulcers and skin infections, which may lead to significant morbidity and costly hospitalizations [13]. As per the above reasoning and addressing the needs stated by the local nursing home, the D-PHIMS was customized to suit the functional and technical requirements to implement S&F teledermatology and was deployed at the nursing home for the elderly. This paper provides an overview on the clinical trial conducted, its results, and the usability and efficacy of the D-PHIMS system for the management of healthcare for the senior citizens in skincare.

## II. METHODOLOGY

### A. D-PHIMS Architecture and Process Flow

The PHIMS is a web-based repository of patient health data [5]. The D-PHIMS was adapted from the PHIMS. The PHIMS implemented by the UW uses the client/server architecture whereas the D-PHIMS uses the distributed architecture on the local server side and the client/server architecture on the main server side. This type of distributed architecture makes the system scalable, which would enable the expansion of D-PHIMS to various nursing homes around Singapore [4].

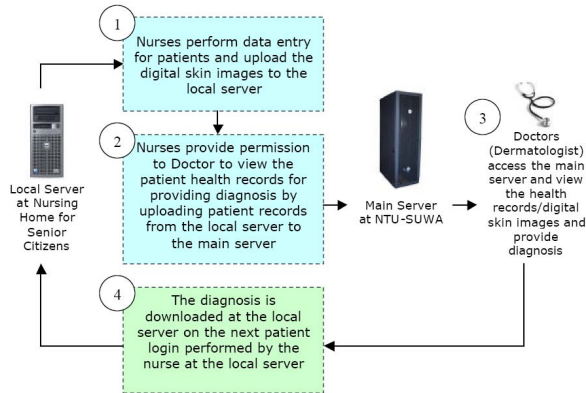


Fig. 1. The process flow model of the D-PHIMS architecture.

The process flow with the D-PHIMS as depicted in Figure 1 can be broken into three parts.

- At the local server side, the nurses perform the data entry/updating of the patient's health records, capturing of images of the patient's skin conditions and uploading the records/images into the main server.
- At the main server side, the specialists access the patient's information and digital images and provide the diagnosis. The uploaded patient data reside in the main server for a short period, after which it is flushed out of the system. This method preserves patient data confidentiality as the patient records reside out of a nursing home for the senior citizens (NHSC) only for a short duration.
- The nurse logs into the patient's profile to trigger an automatic download of the diagnosis from the main server.

In the above model, the nurses perform the data entry/image capture on behalf of the patients as the majority of the residents are aged over 65 years, have poor vision, do not speak English, computer-illiterate and fully dependent on their caregivers. In addition, dermatologists in Singapore prefer medically trained professionals to perform data entry for consistency and reliability.

The system is implemented on a Dell PowerEdge 1750, using the Microsoft Windows 2003 Server with Internet Information Services (IIS) 6, .NET platform with C# and MS-SQL 2000 server technologies. The Microsoft Web Service is used over a Secure Socket Layer (SSL) to transfer data between the local server and main server. Even though the transfer rate is slow for a large amount of encrypted data, it is a secure method for transferring sensitive information. The digital video camera recorder (Sony DCRTRV940) is

used for acquiring the digital skin photographs. An image resolution of 1152 x 864, with a lossy JPEG compression mode with a compression ratio of 3 (the highest image quality offered by the camera) was used. Digital images of the patient's skin conditions were captured using the above camera settings and were sent to the dermatologists to obtain their feedback. Based on the positive feedback obtained from the dermatologist on the quality of the images of the patient's skin conditions for diagnosis [4], the above setting was considered to be acceptable and was used for this clinical trial.

### B. Study Setting and Deployment

The clinical trial started at an NHSC in Singapore in October 2005. The dermatologists from the National Skin Centre (NSC) of Singapore volunteered to use the D-PHIMS and provide free telediagnosis for the residents from the NHSC during the clinical trial period. The nurses from NHSC perform the data entry and capturing of digital images and the dermatologists from the NSC evaluate the digital images and provide the diagnosis/treatments through the D-PHIMS system. The resident doctor at the NHSC then prescribes the medications and/or takes other treatment measures for the patients suggested by the dermatologists via the D-PHIMS system. This study setting is appropriate for the S&F teledermatology to evaluate the need and the value of the D-PHIMS for elderly care in Singapore. A local server was set up at the NHSC with an ADSL Internet connection (512-kbps downlink and 256-kbps uplink) placed in a secure room.

A training session was provided at the start of the clinical trial at the NHSC on teledermatology to the nursing staff and the resident doctor. Then individual training sessions on the hands-on usage of D-PHIMS (one hour per nurse) and on taking digital photographs of patients' skin conditions (30 minutes per nurse) were provided for the nurses. A training session (30 minutes per dermatologist) was also conducted for the dermatologists on the hands-on use of the D-PHIMS system. After the initial training sessions, our project members were assigned to visit the NHSC twice a week to assist the nurses in performing data entry and acquisition of digital images of the patient's skin conditions.

### C. Outcome Evaluation

The nurses and the dermatologists involved in the clinical trial were requested to fill out an online survey form. The survey was organized in the form of questionnaire that covered areas such as overall system satisfaction and user experience gained while using the D-PHIMS system. The response to the questionnaire was given as a multiple choice format and analyzed using a multi-point scale weighted from 0 to 100. In the system utilisation study, the system usage/user activities were monitored by examining the server logging and database access activities since the beginning of the system deployment. The diagnosis module was evaluated based on the effectiveness of the treatment provided through the diagnosis made by the dermatologists using D-PHIMS.

The level of effectiveness was measured based on the feedback from the nurses and resident doctor at the NHSC.

### III. RESULTS

#### A. Registration and Participation

A total of five staff nurses from the NHSC have used the D-PHIMS system. They are full-time nurses whose schedules include different shifts over different weeks. 12 patients out of the 350 residents at NHSC were registered with the system during the period from October to December 2005. Our research project staff were made available twice a week to assist the nurses. Most of the nurses at the NHSC are from countries like India and Myanmar. Among the nurses, only two had a moderate level of computer literacy while the others were not familiar with computer operations other than checking email. They had basic knowledge in English and low-level typing skills.

The two NSC dermatologists also registered with the D-PHIMS system and they used it on a weekly basis.

#### B. System Usage

The system usage was logged from October 2005 to January 2006. The total number of log-ins at the NHSC for updating patient records was 30 where 26 (87%) log-ins were made in the presence of our research project staff and only 4 (13%) log-ins were independent. This result was expected due to the nurses' tight working schedules and limited computer literacy. The 4 logins indicated that they took some initiative to update patient records independently. The total number of log-ins at the NHSC to check if the patient had received their diagnosis was 79. 40 (50.6%) log-ins were made in the presence of research project staff and 39 (49.4%) log-ins without them. The results were encouraging as the follow-up was equally distributed with/without technical staff's support, indicating that the nurses were able to perform this on their own. The average frequency of log-ins by the dermatologist was about 6 times a month mostly on Wednesdays and Thursdays. The average duration for the specialists to provide diagnosis was 4 days after the nurse's referral request while the maximum duration was 1 week.

#### C. Survey Results

A survey was taken from the nurses (sample size of 5) and the dermatologists (sample size of 2) in the month of November 2005. From Figure 2 it can be seen that all the nurses (100%) agreed that they found an overall improvement in the quality of healthcare after using D-PHIMS, but 3 (60%) mentioned that the medical care received using D-PHIMS was not as good as a regular clinical visit. 3 (60%) answered that they would prefer their patients to personally visit the specialist rather than use the D-PHIMS system to obtain diagnosis. 2 (40%) found the system convenient to use whereas 3 (60%) said somewhat convenient to use. 80% were satisfied with the overall concept and performance of D-PHIMS whereas 1 was

somewhat not satisfied.

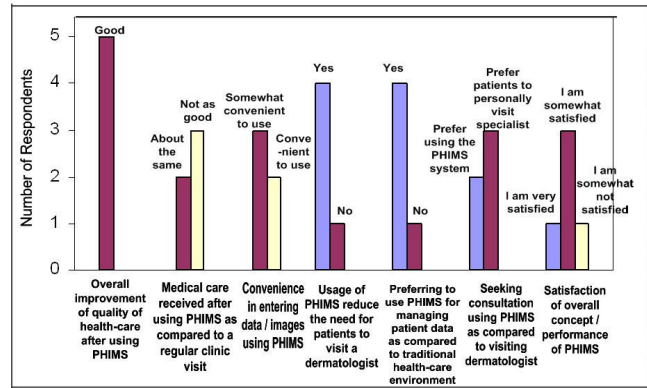


Fig. 2. Nurse survey system satisfaction graph.

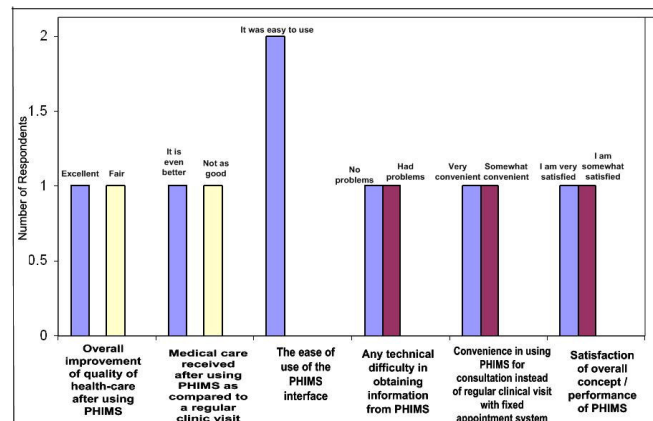


Fig. 3. Specialist survey system satisfaction graph.

From Figure 3, it can be seen that both dermatologists agreed that there was an overall improvement in the quality of healthcare after using D-PHIMS, but one mentioned that the medical care received using D-PHIMS was not as good as a regular clinical visit. One mentioned that there was some technical difficulty in using D-PHIMS. In general, both found the D-PHIMS interface easy to use and satisfied with the overall concept and system performance.

#### D. Evaluation of the S&F Tele dermatology Diagnosis Module

The E-medicine team asked a few questions to the nurses at the NHSC to evaluate the S&F tele dermatology diagnosis module.

- When asked whether any patient had been pre-diagnosed on their medical condition before the clinical trial began, the response was: "Only one patient currently registered with the D-PHIMS system had been referred to the NSC before the clinical trial and was pre-diagnosed on his/her skin condition."
- When asked whether the patients were referred to the NSC based on the advice of the dermatologist and if not the reasons, the response was: "Most of the patients were not referred to the NSC as we obtained clear and concise diagnosis from the dermatologists over D-PHIMS which led to an improvement in the skin conditions of the patients when the resident doctor prescribed relevant medications for the patient in accordance with the treatments suggested over D-PHIMS." Thus the response indicates that the diagnosis module is adequate

for diagnosing/treating the patient's chronic non-acute skin conditions in most of the cases.

#### IV. DISCUSSION

The survey results show that a majority of the nurses and dermatologists agree that the D-PHIMS system improves the overall quality of healthcare. However, some felt that the medical care received via teledermatology was not as good as a conventional face-to-face visit. In an Asian environment, people are usually conservative and regardless of the convenience offered by D-PHIMS, they believe the best medical care is through a physical clinic visit to the doctor. This mindset could be changed after they become familiar with the system usage in a way that the D-PHIMS concept can function as an integral part of the existing national healthcare system. Apart from the above issues, both the nurses and dermatologists recognize the long-term benefits of the system. The following are some of their comments:

**Nurse 1: "For the patients, it is convenient having in-house dermatologist to consult because they need not to go to the clinic and save the traveling fees ..."**

**Nurse 2: (The D-PHIMS system is) "Available anytime, saves money and manpower; saves time."**

**Nurse 3: "D-PHIMS is excellent in sending data and receiving diagnosis and treatment within 4-7 days."**

**Dermatologists' observation: "A face-to-face consultation will still be the gold standard, but teledermatology will be the next best thing for circumstances of constraint."**

One of the nurses commented **"For the nurses, we have to give much of our time to enter the data of the patients to the D-PHIMS and taking photographs and explaining the overall information to the relatives to get consent from them while we have our routine duty to attend on the other hand. Anyway, this is a good system if we can allocate more time to familiarize with the system usage."** This brings us to the next issue on the outcome of this clinical trial. One of the nurses responded to the survey saying that the D-PHIMS was somewhat not satisfactory. This may be due to various reasons. The computer literacy level and language skills may be a major factor as many of the nurses are from non-English speaking countries. At the nursing home, they operate with limited manpower and resources. In order for the D-PHIMS system to be more widely deployed, they would have to appoint nursing students or part time paramedics to handle the data entry, as it is not practical to expect the elderly patients to update their own health data. In addition, mobile notebooks can be provided to the nurses so that they can perform data entry at their convenience. The D-PHIMS user interface could be optimised to minimize typing by including more list boxes or combo boxes. Providing D-PHIMS in multiple Asian languages would definitely improve the general acceptance of D-PHIMS in Singapore and other Asian countries. The dermatologists found the system very useful even though they were concerned with the aspects of insurance and medico-legal issues involved in providing diagnoses over the Internet. One of them felt that using D-

PHIMS may not be as good as a clinic visit, probably due to the inability to conduct detailed physical examination and lab tests. They commented that the information provided by the D-PHIMS for any patient was comprehensive and the digital images of the patient's skin conditions were sufficient for the diagnosis of chronic skin conditions. With their level of computer literacy, they found the interface user-friendly.

#### V. CONCLUSION

The clinical trial for the D-PHIMS system is ongoing at the nursing home in Singapore. Although the nurses had to overcome language barriers, develop basic computer skills in using D-PHIMS and handle heavy workload, they were able to recognize the advantages and potential of D-PHIMS that can become a foundation for healthcare delivery in the future. The dermatologists as per the outcome of the clinical trial observed that this system could be the next best thing to the gold standard of face-to-face consultations. The D-PHIMS concept can be expanded to include different diseases like stroke, dementia, and cardiovascular to have a wider and more significant impact on the society. The S&F method of disease diagnosis could be useful during epidemics like SARS.

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