Telemedicine in Nepal: a Pilot Project

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Introduction:

Telemedicine is the process of providing medical expertise remotely with the help of telecommunication system particularly in remote areas. This method is useful in Nepal where few specialists are separated from most of the population. In developed countries, usually real time interactive telemedicine is used. This system will be not be applicable in developing country like Nepal because of high cost of bandwidth and low level of infrastructure development in telecommunication.

The alternative technology suitable for developing country is store and forward system. In a store and forward system, the referring doctor enters the clinical information and digital images in a computer. This can be transmitted via dial-up Internet connection as an e-mail attachment to the central computer. The expert doctor can access the data independently, at his/her convenient time. The size of e-mail attachment for image is a potential problem with this technique necessitating some forms of image compression. [1].

This study was designed to assess whether telemedicine based on store and foreword technology is sufficient for the diagnosis of cases sent from remote rural areas in the field of Dermatology, Radiology and Pathology.

The research component of this project is divided into two broad categories: basic research and clinical research [2].

The basic research consisted of two major components. The first component is to define the minimum technical specifications needed to ensure that diagnostically important information is captured through clinical history and digital image. The second component is knowing medical expert's capability to make accurate diagnosis based upon digital images and clinical history.

The purpose of clinical research is to establish whether this technology will improve the process of health care delivery by increasing information flow and reducing professional isolation.

HealthNet Nepal has built HnetTelemedicine with the Visual Basic, PHP programming language and the open source/Free Software approach to ensure widest availability of this tool for the use of developing countries [3]. This software is prepared keeping in view the high cost of software and requiring proprietary standards while using commercial software.

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Materials and Methods

Area covered
For assessing the telemedicine based on store and foreword technology, a pilot project was conducted in the following areas of Nepal:

AMDA, Damak, (Eastern Region)
AMDA, Butwal (Western Region)
Siddhi Memorial Hospital, Bhaktapur (Central Region)

The medical specialties covered were in the following areas: Dermatology, Radiology and Pathology.

Image Acquisition
Images were obtained using Nikon Coolpix 4500. Images can be stored in JPEG format at varying levels of compression. An additional benefit of this camera is that it can be easily mounted in Microscope with the 30 mm Eyepiece adapter due to its small lens size. It has 4.0 megapixel, which is sufficient for medical still image. The compact lightweight swivel design allows this camera to use with binocular microscope.

Image Processing
Once image are stored in the computer, they need to be cropped to minimize file size and annotation has to be given for better description of clinical problem. A graphic package is developed for this and incorporated in the client software of Hnet telemedicine. This graphic package allows cropping, annotation, rotation, brightness, contrast, color balance and conversion to black and white.

Compression
Image compression is used to reduce the amount of memory required to store an image. For example, an image that has a resolution of 640x480 and is in the RGB color space at 8 bits per color requires 900 Kbytes of storage. If this image can be compressed at a compression ratio of 20:1, the amount of storage required is only 45 Kbytes.

HealthNet Nepal has used image compression software called LZ77. This is lossless data compression algorithm that works by keeping a history window of the most recently seen data and comparing the current data being encoded with the data in the history window. What is actually placed into the compressed stream are references to the position in the history window, and the length of the match. If a match cannot be found the character itself is simply encoded into the stream after being flagged as a literal. With LZ77 60-80% image compression ratio is achieved without the significant loss of diagnostic quality.

Security and Confidentiality

 This refers to techniques for ensuring that data stored in a computer cannot be read or compromised by unauthorized users. Most security measures involve data encryption and passwords. In server side, Hnet telemedicine application, whenever a user tries to log in the server he/she is authenticated with username and password. The passwords are stored in MD5 encrypted form for security and a user is created in the server through admin part with all essential information. Thus only administrator can create user for this application. Without login no one can get into the application
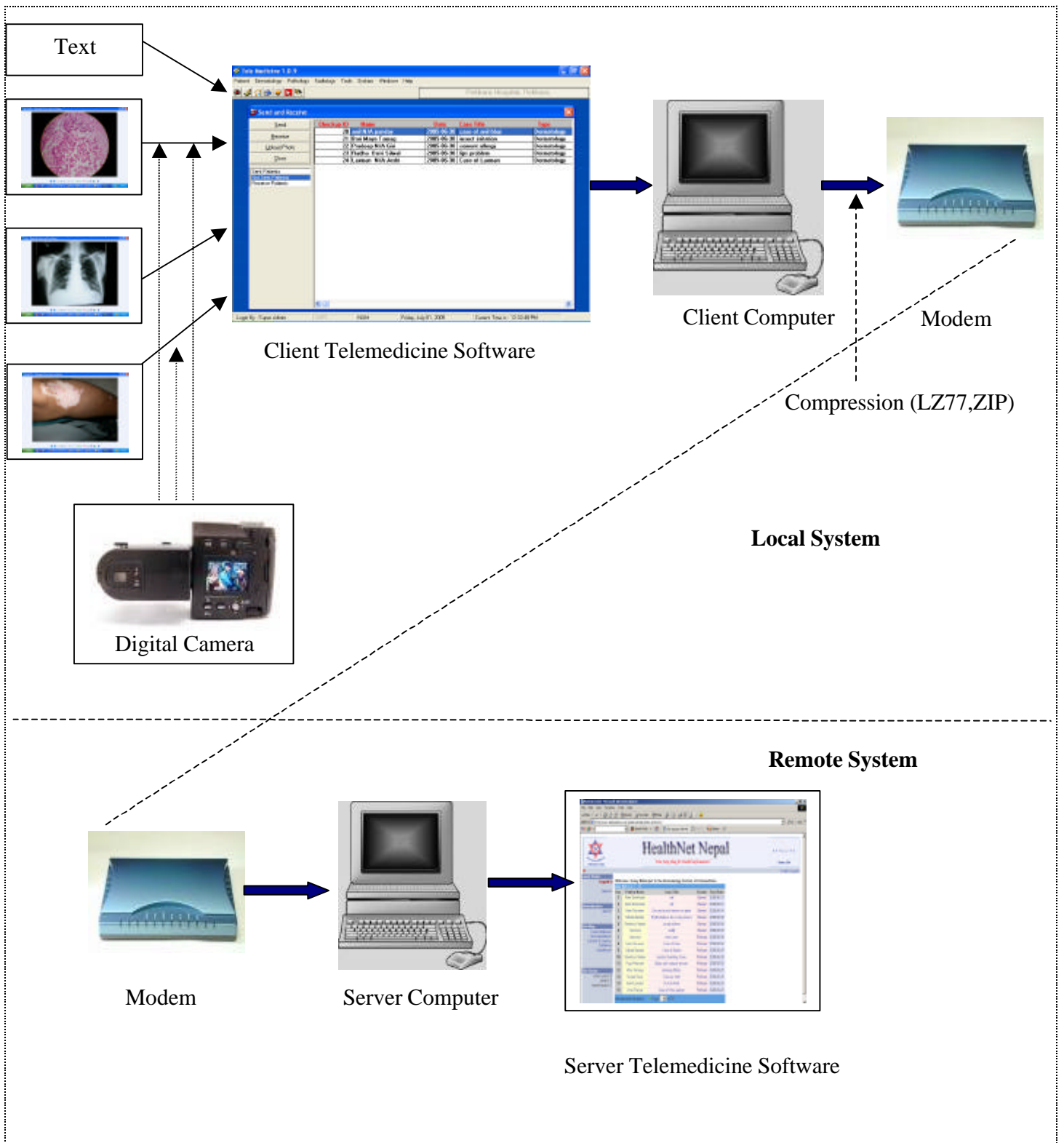
Figure1 : A typical Store and Forward Telemedicine System

Figure 2: A typical page of the Client Hnet Telemedicine System for collecting clinical information
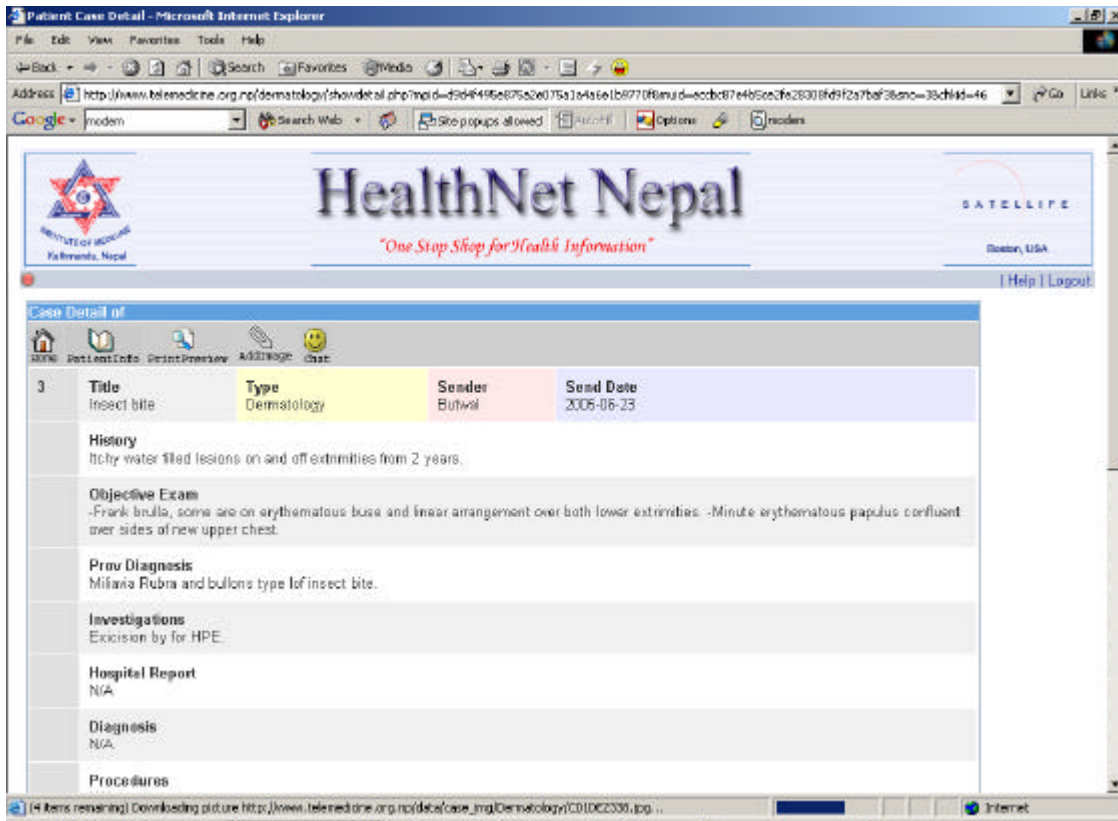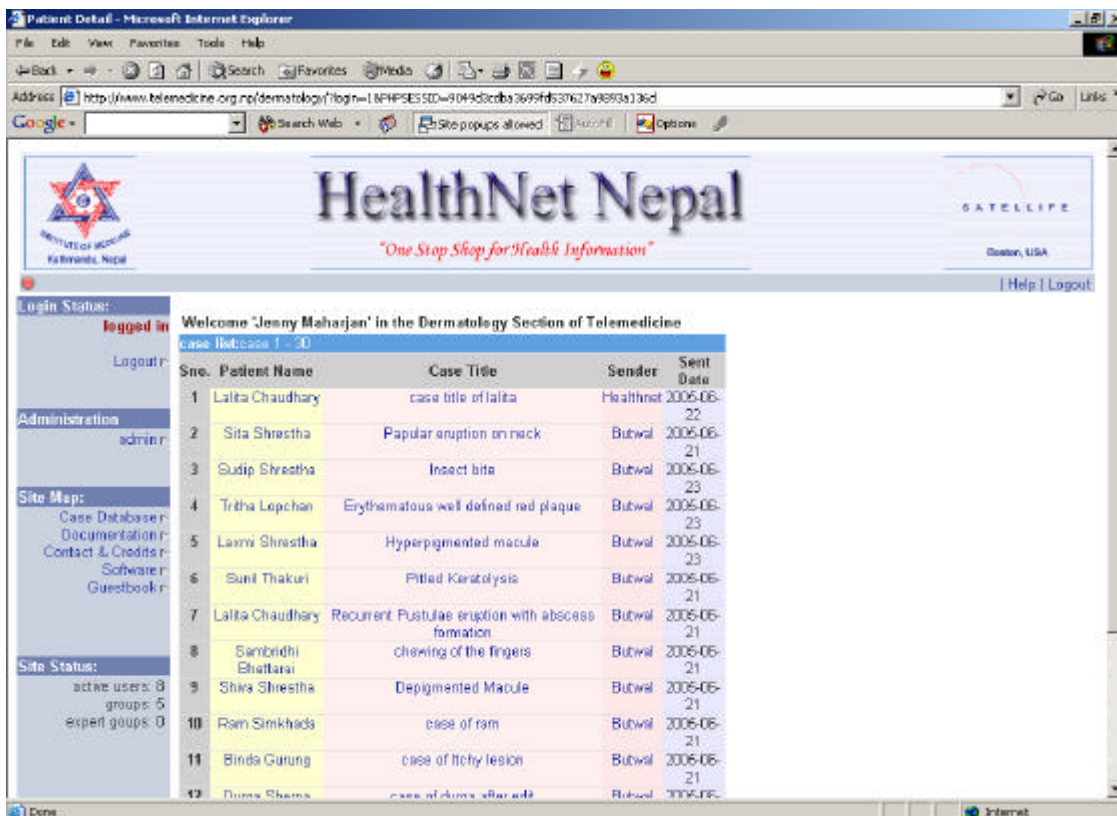
Figure 3: A typical page of the Hnet Telemedicine Server Side

Receiving and Reviewing Cases

The application after logon is point to point email between two physicians using it, typically a remote physician or health worker and a medical specialist in a hospital. Here, the sender simply sends an e-mail by choosing the send button. After uploading a case, server selects a doctor in round robin base listed in the roaster. Server regularly watches the reply from the doctor. If a doctor does not reply a case within 12 hours interval then the case will be automatically assigned to another doctor. For security reason, doctors are categorised in the groups of dermatology, radiology and pathology. These specialists can view only their cases. (Fig 4.).

Figure 4: A typical page of case in the server side
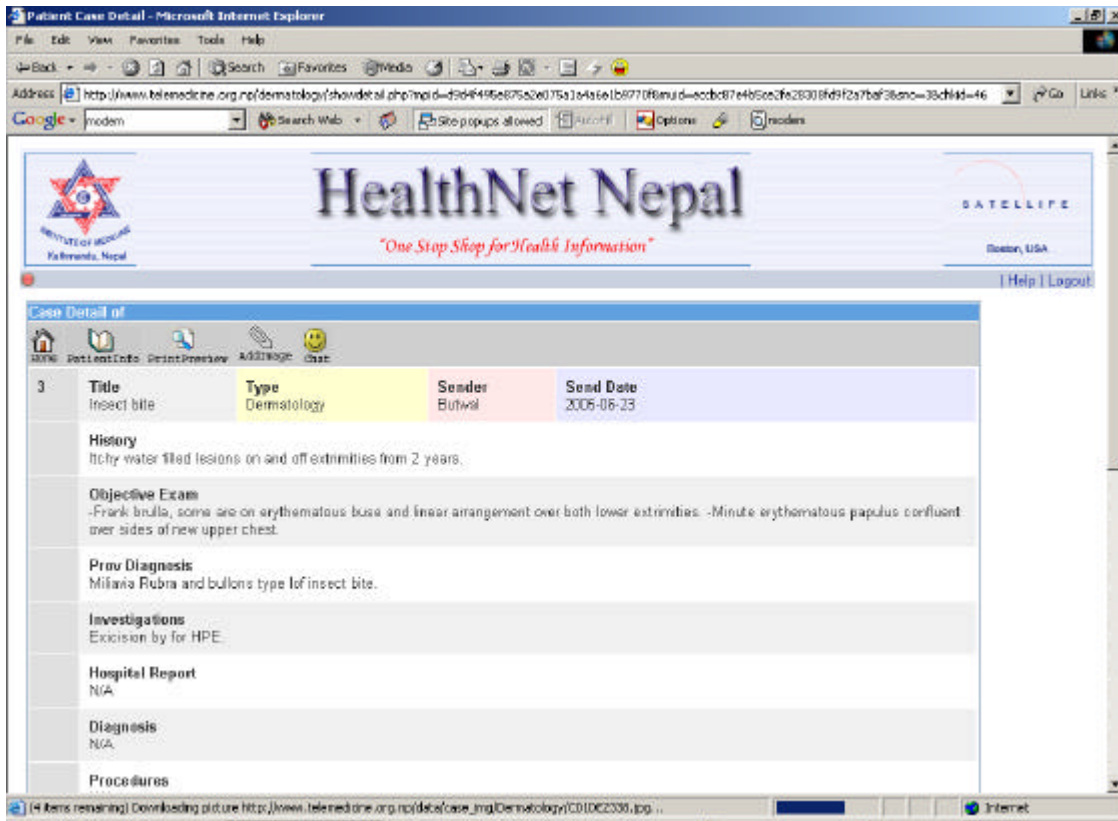
Figure 5: A typical format of case in the server side

Data Collection

A non-randomized study was conducted in AMDA, Butwal, AMDA, Damak and Siddhi Memorial Hospital, Bhaktapur for inclusion of cases. First of all, the specialist doctor has to complete their perception of the image exposure and diagnostic quality using a three-point ordinal scale 1. Good; 2. Adequate; and 3 Poor. At the second stage, the specialist doctor recorded their confidence in the presence of each indicator sufficient for diagnosis in the five point ordinal scale: 1. Definitely present; 2. Probably present; 3. Cannot decide; 4. Probably absent; 5. Definitely absent.

Results

The total cases observed in different areas for telemedicine are 150, which is classified as below:
- **Dermatology :** 55 cases
- **Radiology :** 92 cases
- **Histology :** 3 cases

Radiology Cases:	
Preferred Diagnosis	**Number of Preferred Diagnosis**
Pain in Lt. Breast, lump Lt. breast VOR	1
Rt. Shoulder joint pain, B/L knee joint	1
OA knee	1
Al left wrist	1
ACP Parkusanism	1
Anemia	1
B.L Hip Pain	1
B/L max sinus	1
Back pain x 1 ½yrs	1
HTN Pedaledema	1
C/O, pain in the neck	1
c/o b/l nasal discharge	
Chest discomfort under evaluation	1
COAD	1
Cough	3
Cough, Blood stick sputum sometimes	
Dry cough Chest pain	1
Fall injury	1
Fever	1
Forefoot Rt. Foot	1
GHC	2

H/O trauma	1
Haemoptysis	1
Headache	1
Kyphotiz deformity at D-L spine level	1
L59 haemoptysis, fever, x-ray previous infection	1
Lower back pain	2
Neglected dislocation of superior radio ulna join	1
Old PTB Rx	1
Old treated Kochs	1
Pain abdomen wt loss	1
Pain and swelling over shoulder Lt.	1
Pain B/L knee L>R	1
Lump Left breast VOR	2
Pain in neck No Vadicular feature	1
Pain Left flank	1
Pain low back and lt. Leg	1
Pain right lung	1
Pre op	1
Right sided renal calculi	1
Routine	1
Rt. Breast lump .	1
Rt. Renal stone	1
Shortness of breath .	1
SOB , haemophysis, chest pain	2
SOB wt. loss .	1
SOB, Cough	1
Sudden omet SOP .	1
Swelling of both lower leg	1
Torn ACL _ MMT knee Rt.	1

Dermatology	
Preferred Diagnosis	**Number of Preferred Diagnosis**
Acral, lesion on extremities	1
Allergic contact	1
Baby with nodular lesions	1
Chewing of the fingers	1
Chicken pox	1
Coloring effects	1
De-pigmented maculae	1

Pigmented lesions	2
Dry and adherer scaly lesions	1
Dry and scaly lesion on palm	1
Erythematosus. scaly plaque over L/L	
Erythematosus dry scaly lesions	1
Erythematosus legions over the scalp congenital.	1
Erythematosus well defined plaque	1
Erythematosus well defined red plaque	1
Erythematosus scaly lesion over trunk and limb	1
Fever from 1 week. Red legions over the limbs	1
Growth on Rt. thumb from 3-4 month	1
H/O fever 4 days back. Macular-Papular rashes	1
H/O jaundice from 8 -9 days with fever. Swelling	1
Halo vorns	1
Hyper-pigmented lesions over the face	1
Hyper-pigmented macula	1
Injury	2
Insect bite	2
Itching	15
PA view	1
Jaundice fever	2
Lichen Planus	1
Multiple, Postural eruption post aspect of trunk	1
Non healing wound over the rt. leg lower region.	1
Palmer psoriasis	2
Papular eruption on neck	1
Papular eruption over the eyelids and neck	1
Papular Nodular lesions all over the body	
Pitled Keratosis	1
Pitled Lesions over the face and trunk	1
Polymorphous light eruption	1
Recurrent pustule eruption with abscess formation	1
Recurrent pustule eruption with abscess formation	1
Scaly, Hyper-pigmented Macular eruption over trunk	1

Scaly, raised, discharging lesion over rt. wrist	1
Seborrheic dermatitis	2
Severe pimples	1
Swelling of the scalp after hair color	
Tinia capitis	1
Viral exanthema	11
Yellowish, greasy, itchy scales on; scalp	1

Histology:	
Preferred Diagnosis	**Number of Preferred Diagnosis**
Swelling & tenderness on the neck	1
Swelling & tenderness of lt. breast	1
Difficulty in vision	1

In no case, did the opinion of medical specialist change, following face to face consultation in case of dermatology, viewing cases through x-ray view and seeing slides through microscope in case of Pathology.

Discussion

In developing our system, we have given consideration to establishing guiding principles for telemedicine services in Dermatology, Radiology and Pathology. However, the gold standard for any specialist referral remains the traditional way of consultation i.e. in case of Radiology viewing through X-ray view, in case of pathology viewing through microscope and in case of dermatology face to face consultation. Technology should be subservient to the requirements of the clinicians.

We have used the "keep it simple" principle by adopting affordable system appropriate to our needs [4]. Compared to real-time system, store and forward system offers a more practical and less expensive solution. Store and forward methods allow the use of low-cost equipment, low bandwidth connectivity, and asynchronous consultation. This approach is successfully used in industrialized countries where high quality images are sent over telemedicine networks for consultation [1].

Recently, digital cameras have emerged as an efficient method of obtaining digital images. Krupinski et al. [5,6] evaluated the effectiveness of digital photography for dermatology and bone trauma diagnoses and found digital camera-generated images to be of sufficient quality. Piccolo et al [7,8] found high diagnostic concordance between telepathology and histopathologic diagnosis. Lim et al [9] and High et al [10] evaluated a digital camera for teledermatology and also found high concordance with face-to-face diagnoses.

The essential question: whether telemedicine in developing country is cost-effective- cannot be answered in advance until pilot project is completed. It has to be evaluated in a properly controlled, scientific manner else the required answer to the question about the appropriate use of resources will not be gathered. [11].

Discussion and future development

Image resolution necessary for a clinical application in the diagnosis process will be determined by the use of Receiver Operating Characteristic (ROC) analysis. This analysis will be done after collecting data in two stages. First of all, medical expert's perception of the image exposure and diagnostic quality will be determined using a three-point ordinal scale: 1. good; 2. adequate and 3. poor. In the second stage, medical expert's degree of confidence in the presence of each indicator sufficient for diagnosis will be recorded using the five point ordinal scale: 1. definitely present; 2. probably present; 3. cannot decide; 4. probably absent; 5. definitely absent.

Conclusion

The medical expert diagnosed with the help of image and compared it with conventional method of diagnosis in order to determine the efficacy of telemedicine in diagnosis process. It was found that there is no difference in diagnosis through image followed by textual information as compared to traditional conventional method of diagnosis in preliminary study. However, ROC analysis has to be done for better understanding the efficacy of this system. The results indicate that compressed image allow readings of sufficient quality for the diagnosis of the cases sent from remote rural areas. Cameras are now available with 8 megapixel resolution, but as the American College of Radiology [12] recommendations call for 4 megapixels for telemedicine. The higher resolution will not be necessary and increase the file size. The health professionals in Nepal have little know-how of information technology, so evaluation has to be performed based on properly controlled and scientific manner in order to success the pilot project.

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