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GramHealth: A bottom-up approach to provide preventive healthcare services for unreached community

Ashir Ahmed, Lutfe Kabir, Eiko Kai and Sozo Inoue

Abstract— **Insufficient healthcare facilities and unavailability of medical experts in rural areas are the two major reasons that kept the people unreached to healthcare services. Recent penetration of mobile phone and the demand to basic healthcare services, remote health consultancy over mobile phone became popular in developing countries. In this paper, we introduce two such representative initiatives from Bangladesh and discuss the technical challenges they face to serve a remote patient. To solve these issues, we have prototyped a box with necessary diagnostic tools, we call it a "portable clinic" and a software tool, "GramHealth" for managing the patient information. We carried out experiments in three villages in Bangladesh to observe the usability of the portable clinic and verify the functionality of "GramHealth". We display the qualitative analysis of the results obtained from the experiment. GramHealth DB has a unique combination of structured, semi-structured and un-structured data. We are currently looking at these data to see whether these can be treated as BigData and if yes, how to analyze the data and what to expect from these data to make a better clinical decision support.**

I. Introduction

There are 1 billion people are unreached in terms of accessing to quality healthcare service [1]. About four thousand children die of diarrhea in a day, one pregnant mother dies in every 90 seconds. This scenario can be dramatically changed if we can simply convey few simple medical tips to the target unreached community. Most of the unreached people are from rural areas in developing countries [2]. Healthcare service does not exist there for two major reasons: (1) Doctors do not want to stay in the village as they do not find their livelihood requirements fulfilled (2) Quality hospitals/clinics can not sustain without stable income. Recently, mobile phone became available in each corner of rural areas. Health consultancy over mobile phone became popular in Bangladesh as an alternative solution. One such organization receives 15000 calls per day for health consultancy [3]. Consultancy over mobile phones brought many benefits to the people especially to the remote female patients who can talk to a male doctor keeping themselves anonymous for private diseases. A remote doctor can prescribe medicine, can interpret clinical records and also can introduce a hospital or doctor near the patient's place. However, in order to diagnose a disease properly, doctors need to see the clinical records measured by diagnostic tools. To solve these issues, we have prototyped a box with necessary diagnostic tools, we call it a "portable clinic"[4] and a software tool, "GramHealth" for managing the patient information. We carried out experiments in three villages in Bangladesh to observe the usability of the portable clinic and verify the functionality of "GramHealth". We display the qualitative analysis of the results obtained from the experiment. GramHealth DB has a unique combination of structured, semi-structured and un-structured data. We are currently looking at these data to see whether these can be treated as BigData and if yes, how to analyze the data and what to expect from these data to make a better clinical decision support.

II. Advantages of Mobile-Phone Based Remote Health Consultancy System and Technical Challenges

In a typical mobile phone based healthcare consultancy system, the doctor is located in an urban area in a call center. The doctor has a facility to receive phone calls, a computer based hospital database to support the patients' inquiries. The patient places a call to a hot-line number of a call center [Figure. 1]. The call is usually routed to a doctor in a round-robin fashion. There are exceptions when a female patient prefers to consult with a female doctor or a follow-up patient looks for the previously consulted doctor. The consultancy has the following three major phases- (a) Introduction phase: collects patient basic information (name, age, sex, location etc.). (b) Diagnosis phase: the patient explains the symptom and then the doctor interrogates to find out the cause of the symptom. (c) Advice phase: the doctor then either prescribes medicine or suggests a nearby hospital for further checkup and consultancy. An advanced healthcare service provider keeps the patient-doctor conversation records in a CDR (call details record) and uses special software tool to keep the patient profile details including the list of medicines prescribed.

Ashir Ahmed and Eiko Kai are with the department of advanced information technology in Kyushu University, 744 Moto'oka, Nishi-ku, Fukuoka-819-0352, Japan (phone and fax: +81-92-802-3632 email: ashir@ait.kyushu-u.ac.jp).

Lutfe Kabir is with the global communication center in Grameen Communications, Grameen Bank Bhaban, Mirpur-2, Dhaka, Bangladesh (email:kabir@mail.grameen.com)

Sozo Inoue is with the faculty of Engineering in Kyushu Inistitute of Technology, 1-1 Sensui-cho, Tobata-ku, Kitakyushu, 804-8550, Japan. (email: sozo@mns.kyutech.ac.jp).

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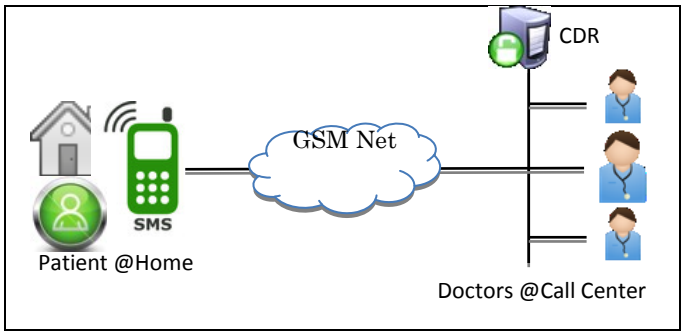

Figure 1. A Typical Mobole-phone based Remote Healthcare System

A. *Amazing facts from patient-doctor conversation*

We analyzed 400 audio records, randomly selected from patient-doctor conversation archived in December, 2009.

There are a good number of female patients making calls (33%) by themselves. This is an amazing observation because a female patient is usually accompanied by the husband or by the parents. In many cases, they feel shy to share private diseases with a male doctor. However, over a mobile phone, they are less hesitant. Table I has the summary of our observation.

Observed Item	Results (n=400)
(a) Caller	Patient: 60%, Relatives: 40%
(b) Age distribution of the patient	0-10 years: 29%, 11-20 years: 15% 21-30 years:24%, 31-40 years:17% 41-50 years: 9%, 50+ years: 7 %
(c) Sex	Male: 67%, Female: 33%
(d) Location	Rural: 30%, Urban: 70%
(e) Call completion	Complete: 68%, Incomplete: 32%
(f) Time of call	Day (8:00-15:30): 57 % Evening (15:30-23:00): 18% Night (23:00-8:00): 25%
(g) Time occupancy of a single call	Introduction phase: 8%, Diagnosis phase: 27%, Advice phase: 67%
(h) Consultancy about	Disease related: 79%, Preventive healthcare related: 21%
(i) Type of advices	Prescribed medicine: 54%, Advice: 28%, Referred to hospital: 17%,
(j) Patients	Follow up: 17%, New: 83%
(k) Patients' satisfaction	Fully satisfied: 71%, unsatisfied: 21%, average: 8%
(l) Major diseases consulted	Gastro-intestinal: 22%, Respiratory: 17%, Reproductive:10%, skin: 10%

TABLE I. SURVEY RESULTS OF A TYPICAL REMOTE HEALTH CONSULTANCY SERVICE

In the followings, we describe the major findings-

(a) Caller: It is not always the case that a patient makes the call by him/herself. Low-literate patients do not feel confident to directly talk with a doctor. Obviously, the kids (<12 years) the older people or very sick patients always depend on a relative to make the call on their behalf (40%).

(d) Location: Not only the rural but the urban unreached and the elite class people also makes calls during emergency period or at unusual time (after midnight) when other hospitals are not open. In our observation, 70% of the calls were made from urban areas. 30% calls from rural areas may seem smaller in compare to the urban areas. Patients are not yet aware of the service.

(e) Call Completion Rate: Not all the calls are complete calls i.e. the doctor-patient conversation do not have always a happy ending. There are more than 32% incomplete calls. The potential reasons are: the poor voice quality, test calls made by curious people to check the service quality etc.

(f) Time of call: 57% of the calls were made in the daytime (8:00-15:30). Normally the clinics in the urban areas start their services in the evening hours. Female patients find this time suitable when they have less household works.

(g) Time occupancy of a single call: We measured the conversation phases to see the pattern how much time is spent for which purpose in a single conversation. The result shows that 67% of the conversation time is spent to advice a medicine and explain the usage.

(h) Consultancy about: 21% people make calls for healthcare issues i.e. to know about the preventive healthcare or seeking for explanation of clinical records.

(j) Follow-up Patients: There was no simple way to identify a follow-up patient from the call audio call records. Only one identifier was the caller phone number. We made assumption from the content of the conversation and found that 17% of the total consulting patients were follow up patients who consulted for the same disease case.

B. *Technical Challenges*

Although our study shows that 71% people are satisfied with the present consultancy service. There is however, a big room for improving the service by introducing simple additional functions into the present system without making any substantial changes in the infrastructure. In this section, we discuss the technical challenges followed by our ideas to address these issues.

(1) Maintaining a patient ID: A patient ID is a key element to maintain individual healthcare records. The present system does not offer a unique ID to their patients. A CDR keeps the mobile phone number of the caller, however there are cases when a patient calls from relatives' phone or uses a family-owned shared phone.

(2) Disease diagnosis process: In the present system, there is no diagnostic tool at the patient side. The doctors are afraid of making inaccurate assumptions from the symptoms expressed by the caller. A physical measurement is necessary to better understand the degree of a symptom and to make an accurate clinical decision.

(3) Patient profile archive: The doctors at the call center are offered and trained to insert the patient profile during the conversation. Many doctors do not feel comfortable to use a computer during the conversation. As a result, the patient profile never gets sufficiently stored. Without past records, it is difficult to take care of the follow-up patients.

(4) Prescription: The medicines in developing countries have English names. The low-literate patients have difficulties to understand the names prescribed by the doctor and take a memo. Some providers use SMS service to send the medicine names. There is a policy that the doctor can only prescribe OTC medicine. Therefore, the doctors have limitations to treat the patients.

(5) Health Data Portability: Some patients have the past clinical records in hard paper format. It is difficult to read out the clinical data over mobile phone. Some hospitals keep the past records in digital format. Currently there is no scheme to transfer the digital data from one hospital to another. The same is true for the developed countries too.

III. Our Preventive Healthcare Approach: Portavle Clinic and GramHealth DB to Support CDSS

In this section, we describe our portable clinic concept and explain how to collect and archive PHR in GramHealth DB of the villagers in an efficient way.

A. *Portable clinic and GramHealth: A proposal to efficiently serve the remote patients*

We considered "disease diagnosis issue" (mentioned in section II(B)) as the primary missing item in the current remote health-consultancy system and proposed an affordable, usable and sustainable concept "portable clinic" to be added in the current initiative for preventive healthcare. A portable clinic is a device equipped with essential diagnostic tools (for temperature, blood, blood pressure, ECG, urine, etc). The clinic is designed to be affordable (<US$300). A prototype of the concept has already been developed and is in the field for our experiment.

The portable clinic box will be owned and operated by a village health assistant. In an ideal situation, she visits the patients' doorstep for regular and on-demand physical checkup. The healthcare data is stored in the portable clinic and a copy is sent to the GramHealth DB. GramHealth is a software tool developed by us considering the needs of the villagers. The call center doctor can access GramHealth. Upon receiving a call from a patient, the doctor asks patients ID number and finds patient's previous records with personal and family profile. This way, the doctor doesn't need to repeatedly ask questions about the patients' personal profile. The doctor time is saved and also the cost burden of the patient will be less. A past record contains previous prescribed medicine and the doctor can easily ask the status for the follow-up patients.

B. *Experimental Environment*

We carried out three series of health camps in three remote villages (basundia village in south-west, rampal village in the southern part and Vomradoho village in northern part) in Bangladesh by using our prototype version of portable clinic and GramHealth. In order to save doctor's precious time, we use our developed "triage" system to consult only with the patients at risk.

In this experiment, we aim to (1) confirm whether he technical challenges mentioned in section II (B) could be efficiently served, (2) monitor whether the system can work with the compromised infrastructure- where unstable bandwidth and regular power-outage is common (3) see whether doctor's precious time can be saved without compromising the healthcare quality.

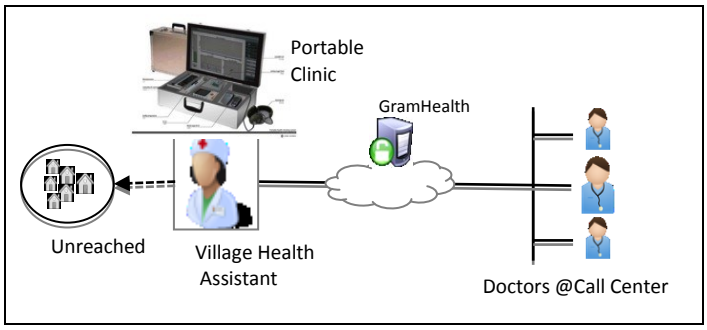

Figure 2. Experimental Environment with Portable Clinic and GramHealth software tool

C. *Results and Discussion*

We setup our portable clinic in a community space in a village. To our surprise there were hundreds of people came to pre-register for our portable clinic based healthcare checkup service. In order to handle the masses, we came up with the concept of "triage" to categorize the people in following four different classes.

We served all the people showed up in the camp. In a three days camp in three villages, we served 462 patients and archived their records. Among them, 33(7%) were identified red, 146(32%) orange, 203(44%) yellow and 80(17%) green. It was observed that not only general people came to take the checkup but people with previous health complaints also visited. Almost 40% people needed consultancy with the remote doctor. At this data collection phase (first phase), we have started collecting another 15000 patients to be finished by March, 2013. The second phase (remote healthcare) has just started. The collected data will be archived as Big-Data to find out location based, age based, family based disease pattern and the effectiveness of treatment. Once the treatment pattern gets mature, GramHealth can be a good source of knowledge base for health education to common people, patients, researchers and family members.

Category	Indication	Action
Red	High risk	Re-check the risky items and consult with doctor for symptom analysis and prescriptions
Orange	Medium risk	
Yellow	Low risk	Provide Health care manual
Green	Healthy	No action

TABLE II. PHR AND TRIAGE

IV. CONCLUSION AND FUTURE WORKS

In this work, we carried out a case study to analyze one-month long patient-doctor voice records logged by a healthcare service center. We reported our findings which reflected the demand and the adoption of technology based on the socio-economic culture of the country. We explained the technical challenges in the highly compromised infrastructure and proposed the affordable and usable "portable clinic" to collect health care data from the patients' door in an efficient way. We also developed a software tool "GramHealth" to collect and store the data for the remote doctor in the call center. The health records are producing a BigData of 15000 villagers to be populated by end of March 2013. As a future work, we will analyze the collected BigData to turn our Database into a knowledgebase so that the patients, researchers and common people find the system more useful as a source of info-medicine.

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