International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-6, Issue-7)

Research Article

July 2017

Remote Attention System for Inpatient Care

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***Abstract*:**

ICU management has been daunting task for the hospital administration, doctors are expected to rush back to the hospital on call even after returning home, even if it is middle of night, to inspect critical developments of patient's condition and decide further action immediately. The problem multiplies when doctors are consultants to multiple hospitals. . Hospitals face scarcity of experts who can engage full time, especially when physical presence is required on demand. This paper illustrates an initiative that is driven by collaborating Hospitals as care provider partners and Applied cognition Systems as technology partner to enable virtual presence of remote specialists in collaboration with local doctors as needed in emergency response, remote monitoring and real time consultation for management of patients admitted in wards and ICUs of hospitals.

Keywords: DICOM, RAS, BID, PID

I. INTRODUCTION

The current system affects the quality of life for doctors as well, as they are expected to rush back to the hospital on call even after returning home, even if it is middle of night, to inspect critical developments of patient's condition and decide further action immediately. The problem multiplies when doctors are consultants to multiple hospitals. Hospitals face scarcity of experts who can engage full time, especially when physical presence is required on demand. The shortage of specialist doctors has driven hospitals to look for alternative approaches such as the Tele-ICU, which is expected to reduced cost, increase resource utilization and outreach to a larger group of doctors that can be physically staffed into a hospital [12]. However, proprietary interfaces, protocols and formats of various bio-medical devices and expensive accessories make it significant additional cost and effort to integrate the information and bring it just outside the ICU to a nursing staff room. Although international standards such as DICOM have tried to bring a normalization in device interaction protocols, a majority of vital signs and video streams are not covered by this standard, and the majority of the non-DICOM compatible equipment already in the hospital is not going to be thrown away just to clear way for TeleICU. Another aspect of inconvenience in the Hospitals at India is that the kin of the patient have to wait long hours to get a time slot to visit their patients in WARDs/ICUs turn by turn. Hospitals also want to avoid ICU visitors due to risk of secondary infections, disturbance, and cost of giving them sterilized wear. Hospitals also want to prevent Kin from crowding outside wards and ICUs blocking pathways and creating noise and emotional disturbance to others. Many Kin albeit having anxiety and concern, also find it practically difficult to commute every day in heavy urban traffic to visit the patient for a few minutes or travel from rural areas and stay in hotels and visit to know the status and give company to their patient. In this initiative Applied Cognition Systems has collaborated with hospitals to use their cloud based Remote Attention System (RAS) to addresses all these challenges. RAS enables doctors to remotely inspect and interact with patients, doctors and nurses at more hospitals than feasible by their physical visit. It also enables hospitals to bring specialists located at distant places virtually together as needed for joint assessment in critical situations. RAS facilitates Kin to visit their in-patients from remote places through their mobile phones, by appointment with the nurse/doctor attending to patient. All these virtual sessions can be optionally recorded for medico-legal purposes.

II. METHODS

RAS replicates on an electronic platform, the current manual workflow, dataflow and interactions shown in Fig(1), between the doctors, patients, nurses. The ward/ICU nurses generally maintains a log of medication, diet, diagnosis, treatment, bio-discharge and other health indicators of the patient condition in paper records or in hospital information software and go around watching the patients assigned to them. On a daily schedule, the doctor visits in-patients, inspects the records, visually inspect /talk to the patients to assess the condition and advice for further action. In case of a critical development, the nurse calls the doctor by phone and informs symptoms, reads out vital sign indicators and history for the doctor to infer the situation and advice further action or decide to visit the hospital. If the condition needs multiple specialists together to decide the action, the nurse/duty doctor calls each of them for advice and then decides further action. This process need not change, but come easy and safe through electronic means.

Fig.1 Typical activity in routine and critical patient management

***Apparatus**:*

As shown in Fig(2), the solution consists of a cloud-based application accessible over internet from mobile phones/tabs of authorized doctors, nurses and RAS terminals. Fitted onto each bed, the RAS terminals capture, record and stream video from cameras focusing on the patient and associated monitoring equipment. Using the backend application, the hospital admin assigns unique bed identification number (BID) for RAS terminals mounted on each bed and binds it to the patient identification number (PID) of patient in that bed, along with staff identification numbers (SIDs) of staff members (doctors, nurses) attending to that patient and the system assigns a virtual conference room for each RAS terminal. When authorized personnel join a conference room from their computer/mobile phone, the RAS terminal automatically streams the video to directly while control synchronization is provided by the cloud server. The implementation uses HTTPS based secure data exchange with access control based on password, role and entity of user and web-real-time-communication protocols for signaling and video transmission with adaptive data compression based on available bandwidth.

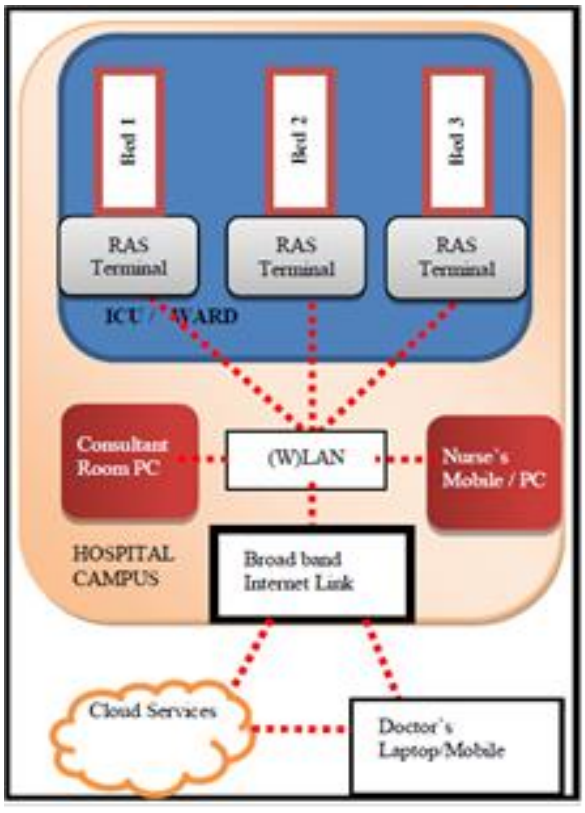

Fig. 2 Remote attention system

Live Session Snapshots

Figure 3 Screens for calling and viewing patients, doctors, nurses

III. TEST AND RESULTS

Pilots runs were conducted with collaborating hospitals and mock patients with RAS terminals was fixed onto corresponding beds. Over 30 staff members (doctors, nurses) were trained to use the system from their smart phones / tabs / Laptops. The nurse logged symptoms with comments in text, image or audio into the system. Various scenarios were tried out; one in which a remote doctor randomly tele-visits a bed without prior notice, another scenario where the nurse raises an alert to the doctor's smart phone, to tele-visit the concerned bed and calls into conference any other doctors as needed. The patient, the vital sign monitor readings, the remote doctor and the nurse were displayed on 4 quadrants as shown in Fig(16), on another webpage doctor could view the log entered by the nurse and during a conference, the nurse could also screen-share the patient's records stored in the hospital's information. The trials were also done with doctors at remote places and at odd hours of the night, and mock patients, with recording of the discussions where successfully played back later.

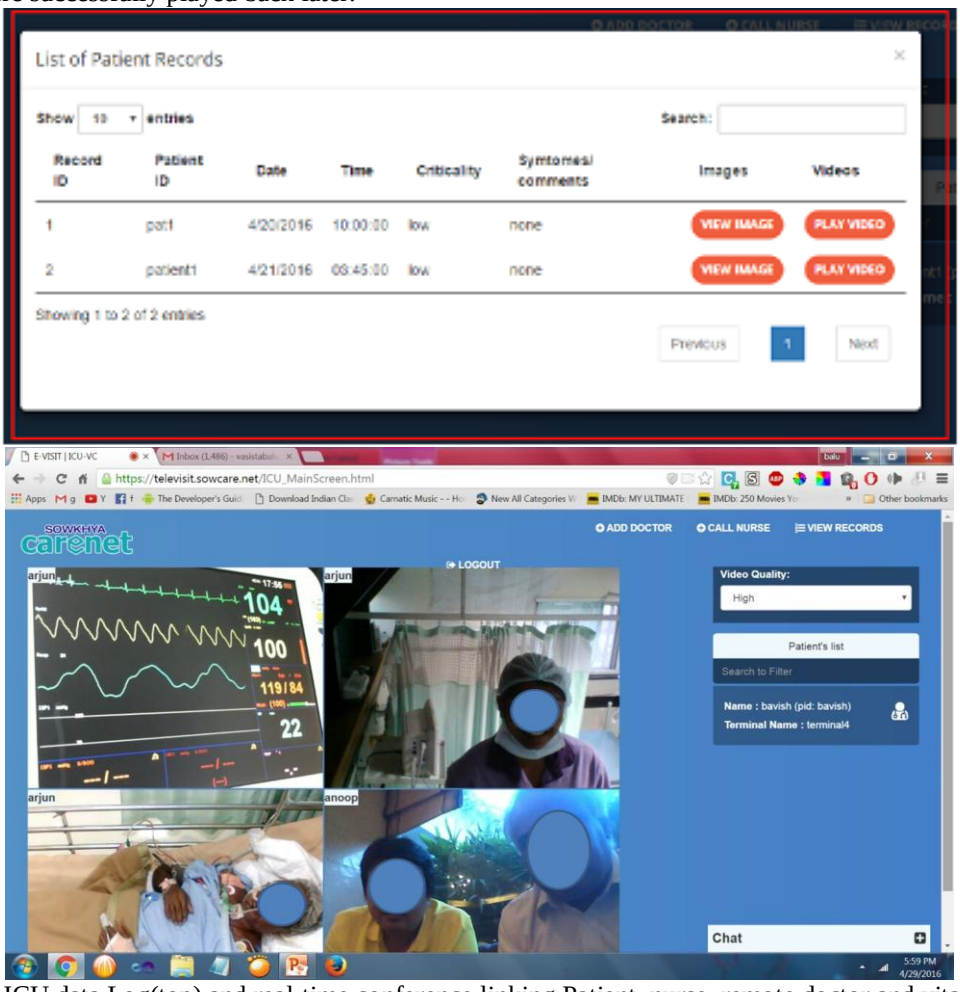

Figure 4: ICU data Log(top) and real-time conference linking Patient, nurse, remote doctor and vital monitor

The system was also tested for tele-visit from Kin through appointment booking by electronic payment of a visit-fee. Automatic alerts on smart phones of ICU nurse and Kin at appointment time connected kin to attending doctor and see (and talk if feasible), to the patient. HD quality conference with jitter free streaming of image and video at latency <10secs was achieved at 256KBPs per channel, and scaled linearly with number of concurrent sessions on different beds. However, since all beds are not engaged in conference concurrently, the bandwidth does not scale linearly with number of beds. The system was also tested by creating link-outage scenarios wherein the systems rejoin an existing session once connectivity was restored, while local recording of RAS terminal continued during the outage. Doctor's feedback was found welcoming the convenience, comfort, timely access to doctors and reduction of visitors in ICUs the system could enable without compromising care or affecting current processes in the hospital or demanding steep learning curve to use the system. Some doctors got clarifications on privacy and security of the data. Hospitals wanted to ensure recording was optional and enabled only on RAS terminals and not on any other user's machines. Patients and Kin were found readily acceptable to use this alternative as it helped reduce their anxiety and enabled them to give company to patients remotely. The proposed system has demonstrated bridging the gaps mentioned It definitely provides a highly scalable and rapidly deployable means to enhance reach and relationship between doctors, hospitals, patients and their kin in moving from reactive to proactive care.

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