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Abstract

Title (short and descriptive):

Telemedicine Network for Cooperative Medical Decision Making in Balkan Countries

Objective and design (max 1000 characters):

The project, developed by Heart Hospital in Massa, supported by Cuore un Mondo Association and Tuscany Region, was aimed at medical cooperation with Balkan Countries in diagnosis and care of congenital heart diseases. First step was to set up a telemedicine network for multi-center cooperative medical decision making. While echography studies allow to recognize abnormalities in newborns or in fetus, operators are not skilled in many hospitals. Frequently it is necessary to transfer urgently to specialized cardiac units newborns suffering by critical disorders while early care planning, before delivery, would limit risks and costs. Tele-echocardiography was implemented connecting Balkan clinical centres with Heart Hospital in Massa. Initially commercial videoconference equipment was applied but recently a low-cost Open-Source device has been designed, allowing both on-line streaming of video signals for real-time interaction and off-line transmission of diagnostic images (DICOM and not) in addition to conference functions and image storage and management. This device is also challenging for use in remote Countries not able to acquire expensive medical technology.

Methods (max 1000 characters):

Videoconference equipment, commercially available, are useful to transmit on-line over any network video signals provided by imaging equipment. Tele-echocardiography was implemented using such equipment assuring Internet connections with upload transfer rate greater than 512 kbps for limiting degradation of diagnostic accuracy of images. However limiting factors of Internet related to stability and continuity of connections affect the quality of diagnostic images. Store-and-forward is useful in case of low network performances by transmitting off-line image records (DICOM or not) to remote center for cooperative diagnosis. Videoconference equipment are usually expensive, use proprietary technology and have limited functions. To face these limitations developing a low-cost device we adopted Open-Source technologies, following guidelines published by our colleague. Both on-line and off-line tele-consulting, and videoconference are implemented. Basic architecture consists of LAMP frame-work (Linux operating system/Apache web server/MySQL RDBMS database/PHP scripting language), Ekiga (for operator interaction, by H323 and SIP), VLC (media player supporting common audio/video codecs and protocols for streaming over network), DCM4CHE(for storage and distribution of DICOM image studies).

Results (max 2500 characters):

Initially tele-echocardiography was implemented at Pediatric Clinical Centres of both Banja Luka and Rijeka, and later at Gynaecology Hospital in Tirana. Further workstations will be installed within next month in clinical centres of Tuzla, Sarajevo and Mostar.

Commercial videoconference devices (Aethra X3 or X5) was applied for transmitting over Internet sequences of echocardiographic images. Video output signal of echo equipment was connected with videoconference device. Network at hospitals was properly set up to allow use of videoconference transmission protocols. Upload Internet connection bandwidth greater than 512 Kbps was required to limit degradation of diagnostic quality of images across network.

During tele-consulting sessions, usually requested by remote centres, young patients (often neonates) suffering by cardiac disease were studied during echocardiography examination jointly by physicians at remote site and cardiologists at Heart Hospital in Massa. Fetal echocardiography was also performed for allowing early care planning before delivery.

On-line tele-consulting is crucial in case of critical cardiac conditions in order to plan timely care or intervention of patients. Sometimes limitations of public network bandwidth (Internet), not stable in time even if guaranteed by local providers, affect quality of diagnostic images and degradation is too high making it difficult detection of cardiac abnormalities also by expert cardiologists. Store-and-forward is useful in such cases to complete diagnostic examinations.

To cope with these problems a special device, extending functions of videoconference equipment with image storage and distribution, DICOM or not, was designed in our laboratory. Open Source technologies, following guidelines published on web by our colleague (<http://award.altervista.org>), were adopted to limit costs for promoting the diffusion of tele-consulting. The developed system allows both real time and off-line tele-consulting while basic PACS capability is provided.

Mini-ITX low-power motherboard was chosen to achieve small size equipment. As described in methods, the system architecture is based on LAMP frame-work and Ekiga (H323 and SIP compliant) was applied for on-line operator interaction. VLC free media player was used for streaming over network. DCM4CHE (Open Source Clinical Image and Object Management software) was implemented for storage and distribution of DICOM image studies provided by imaging equipment; ovijam was applied to review imaging records by standard web browser . Flash Video was applied to deliver not-DICOM images over Internet, using buffering for limiting loss of information.

The prototype was set up and has been tested in our lab; it will be clinically evaluated during next mission in Bosnia for tele-consulting connecting to Heart Hospital in Massa.

Conclusions (max 500 characters):

While teleconference equipment allowed us to implement tele-echocardiography in Balkan Countries for diagnosis and care planning of congenital heart diseases, this solution is limited in terms of functionality, scalability and cost. Low-cost Open-Source systems, enabling both image management and transmission over public network (Internet), are challenging for the diffusion of tele-consulting for cooperative medical decision making not only in congenital heart diseases but potentially in the study of various medical pathologies, providing specialized medical care virtually anywhere in the world.

Keywords (up to five):

Telemedicine, Tele-echocardiography, Teleconsulting, Cooperative Medical Decision Making