



Teleradiology service for mission hospitals: initial experiences in Ethiopia and Kenya

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Introduction

Throughout their history, mission hospitals have provided high quality and lifesaving medical care to regions of the world where medical care is sparse. These hospitals are generally built and equipped through a combination of governmental and non-governmental sources. As advances in diagnostic medical imaging have progressed and become mainstream in the developed world, mission hospitals have adopted advanced imaging modalities. These modalities provide early diagnosis and treatment options for their patients. In addition to the installation and operation of advanced imaging equipment, the need for professional expert interpretation of these studies remains a challenge for mission hospitals. Historically these hospitals have used either voluntary services on site or paid for interpretations from local radiologists; however, with the introduction of high speed internet, teleradiology has become a possibility. While there have been published accounts of using teleradiology for review of radiography and ultrasonography in the developing world, there is little, if any information published describing the use of teleradiology for Computed Tomography (CT) in similar settings.^{1,2,3} This article describes the teleradiology experience of two mission hospitals in rural Africa.

Soddo Christian Hospital

Soddo Christian Hospital is located in the Southern portion of Ethiopia and serves a regional population of approximately 2 million. Through the generosity of a Norwegian non-profit, a CT scanner was installed at the hospital in 2014. Since its installation, Dr. Karl Roth, a Norwegian radiologist, has worked at the hospital performing CT interpretations. When Dr. Roth returns home to Norway, usually for a few months at a time, the hospital typically does not have on-site radiology coverage; therefore, teleradiology services for interpretation were needed for continued care of their patients. Through a partnership between the University of Alabama at Birmingham (UAB) Hospital Department of Radiology and Soddo Christian Hospital, CT examinations are evaluated when there is no radiologist on site.

This partnership began in early 2015 with a signed memorandum of understanding that outlined the expectations of both institutions. A direct internet Virtual Private Network (VPN) was established between Soddo Christian Hospital and University of Alabama at Birmingham (UAB) Radiology. Through this connection, CT examinations are sent to an onsite archive at UAB. Approximately 8 CT studies are performed each day of the work week. Each day, the CT technologist at Soddo uploads a patient roster to the secure file sharing server. Several subspecialty trained radiologists at UAB then review the CT examinations and produce and upload their report to the secure server that is accessible by the

Soddo Hospital physicians.

Through this partnership, the patients at Soddo Christian Hospital are able to receive quality, sustainable care. At the same time, the faculty, residents, and fellows at UAB are provided the opportunity to evaluate disease processes such as advanced cancers and extra pulmonary tuberculosis that are not commonly seen in the United States but are seen with regularity at Soddo Christian Hospital. This provides a unique learning opportunity for UAB Radiology.

Tenwek Hospital

Tenwek Hospital is located in Bomet, Kenya, 230 km west of Nairobi, near the borders of Uganda and Tanzania. It was founded in 1937 and has since grown to become one of the largest mission hospitals in Africa. Tenwek serves a local population of approximately 800,000. In addition to the local population, Tenwek is also a referral center for 8.5 million people as well as a training facility for African doctors and nurses.

Radiology services at Tenwek had humble origins with an x-ray machine operated by the single doctor on site in 1960. After a consistent power source was established in the late 1980s through the construction of a hydroelectric dam, more advanced technology became feasible. In 2011, Toshiba America Medical systems donated a refurbished CT scanner to Tenwek. At the time, it was the only CT scanner in the region and allowed for significant improvement in patient care.

There is no full-time on-site radiologist at Tenwek Hospital. World Medical Mission (medical arm of Samaritan's Purse) coordinates visiting radiologists. On-site radiologist coverage varies from year to year based on volunteer availability. Typically, 60-70% of the year is covered by on-site volunteer radiologists. When no radiologist is on-site, CT scans need to be read

remotely. Prior to 2014, this was achieved by sending CTs to a Nairobi radiology group, at a cost of approximately \$10 per report.

As of 2014, a group of radiologists who had previously served at Tenwek initiated a coverage system to provide volunteer teleradiology coverage from the United States. Volunteer radiologists who maintain Kenyan medical licenses and are credentialed as staff at Tenwek hospital rotate to provide CT reads during weeks when no radiologist is on-site. Anywhere from 5-15 CT scans are read per day by a team of 5-6 radiologists. Administrative support for medical licensure and hospital credentialing is provided by World Medical Mission.

In the initial phase of teleradiology at Tenwek, CT scan DICOM (Digital Imaging and Communications in Medicine) format files were uploaded manually to a cloud drive and then downloaded onto each volunteer radiologist's personal computer. Radiologists then imported them into a DICOM image viewer. This system encountered numerous technical difficulties on both ends of the workflow. In 2015, teleradiology was transitioned to a web-based secure image exchange service called Radconnect, donated for Tenwek's use by Statrad (San Diego, CA). Following installation of Statrad's image uploading server, CT scan uploads to their secure cloud-based server was automated and radiologists could view images through the Radconnect secure web-based viewer. This has streamlined the process tremendously with a much lower rate of technical issues. The bandwidth at Tenwek was originally 3.5 mbps, but was upgraded to 40 mbps. The images are viewable in the US through the web-based viewer using a standard internet connection, even 4G cellular connections.

Since its inception in May 2014, over 2200 patients' CT scans have been read by U.S.-based volunteer radiologists. Beyond providing quality

CT interpretations and saving Tenwek Hospital valuable monetary resources, teleradiology has also provided a wonderful opportunity to serve in missions for the nearly 40 volunteer radiologists. Many of the volunteer radiologists have served (and continue to serve) on short term missions at Tenwek. Serving with teleradiology throughout the year has also allowed these radiologists to remain connected with Tenwek consistently throughout the year.

Future Direction

Access to the internet is taken for granted in the United States. Most people have high speed internet in their home and on their cellphones. In Africa, the penetration of the internet has been slower, particularly in rural areas; nonetheless, access has improved. This access is the commonality between the teleradiology systems of Soddo Christian Hospital and Tenwek Hospital. The internet allows us to connect patients living in mud huts in remote regions of Africa with radiologists living in the United States. As internet access improves, more opportunities will arise. As more mission hospitals acquire CT

equipment and arrange partnerships with radiologists throughout the developed world, having a group of radiologists provide service would be recommended, as a single radiologist would likely not have the appropriate time to read the typical eight to fifteen exams each day. We are hopeful that the success we have had will encourage other radiologists to come along side as these opportunities open up.

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