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Tele Nuclear Medicine: Optimizing Delivery of Nuclear Medicine Services

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ABSTRACT

Despite having proven to be greatly useful modality in making early and accurate diagnostic and clinical management decisions among patients from different specialities of modern medicine such as oncology, cardiology, neurology, endocrinology etc., the adoption and utilization of nuclear medicine facilities, particularly in developing countries, has been delayed and slow. The main reasons for this under-utilization are the high costs of the required equipment and lack of specialized trained manpower in nuclear medicine. Tele-nuclear medicine can provide an effective solution to these problems and enable not only an easy, cost effective access and utilization of nuclear medicine for consultation and diagnostic purposes, but also play a great role in furthering the knowledge, skill and training in field of nuclear medicine, especially in developing countries with limited resources. However, for a successful implementation of tele-nuclear medicine, a basic understanding of its requirements, applications, quality control, regulatory and legal issues is required.

Keywords: Tele nuclear medicine, nuclear medicine scans, Telemedicine

INTRODUCTION

Tele-nuclear medicine refers to the transmission of nuclear medicine scans and data, for the purpose of interpretation, diagnosis and consultation by nuclear medicine specialists, at a location distant from where the data are acquired. It incorporates the use of information and communication technology to transmit nuclear medicine scan images, relevant clinical information and laboratory results organized in electronic patient records[(1,2)].

Although, compared to application of tele-medicine in the fields of radiology and pathology, tele-nuclear medicine has often been slow to be applied, it is now being increasingly applied worldwide[(3)]. Tele-nuclear medicine has the potential applications to significantly benefit both clinical practice and academic aspects of nuclear medicine. However, presently there is little literature providing an elaborate description of its applications, basic equipment requirements, quality control and legal aspects associated with its utilization. Hence this article aims to provide relevant details in a relatively elaborate way regarding the understanding, utilization and practice of tele-nuclear medicine.

Need for Tele- nuclear medicine

The incidence and prevalence of various acute and chronic disease including cardiovascular, endocrinological, neurological, oncological and those of other organ systems, is on a rise worldwide. Nuclear medicine has proven to a superior modality in the early diagnosis and management, of both neoplastic and benign diseases of various organs systems, but its utilization has been slower than desired. The main reasons for under-utilization of nuclear medicine modalities are the unavailability of modern, sophisticated equipment due to their high cost especially in countries with limited healthcare budgets and also importantly, as a result of lack of trained nuclear medicine personnel. In developing

countries, many nuclear medicine departments remain inactive several days a month despite having required hardware equipment, typically because of unavailability of required trained specialized manpower or of radioactive tracers such as Molybdenum/Technetium generators or ^{18}F-FDG secondary to financial constraints or management issues[4]. These short comings, especially inadequate number of trained nuclear medicine personnel, limit the utilization of nuclear medicine services in the developing counties and reduce the availability of nuclear medicine facilities to the clinicians[3]. Such issues can be dealt by using tele-nuclear medicine. Tele-nuclear medicine can improve the health care by providing a access to nuclear medicine services not otherwise feasible and allowing for a timely interpretation and consultation. However, it should be remembered that application of tele-nuclear medicines applies only for consultation and diagnostic nuclear medicine, while therapeutic aspect of nuclear medicine is beyond the scope of tele-nuclear medicine.

Essential requirements for practicing tele- nuclear medicine

Equipment requirements

The diagnostic nuclear medicine equipment (gamma camera/ PET-CT) and work station are installed at on-site primary referring centre and the same equipment may be used at remote tele-nuclear medicine centre connected to the primary centre over a network[5,6] or by enabling remote display of nuclear medicine physician workstation, using a remote viewing software[7,8]. Data in form of raw data or processed image scan be transmitted via use of local or extended area networks (LAN, WLAN), or high speed Internet and data compression technologies. VPN, remote server-client/ desktop sharing applications and even transfer of data via CD/DVD ROMS /Pen drives or email attachments are other viable options[2]. PACS and DICOM[9] enable a remote workstation set-up similar to the on-site environment.

Work station, data visualization and processing at the remote station

The remote work station should have similar display and processing capabilities as the on-site nuclear medicine workstation. All relevant functions needed to interpret or consult on particular clinical studies of interest should be available[1].

The remote work station should allow display and processing of the raw image data or display the already processed images. Processing abilities should provide the ability to measure the value of a pixel from a region of interest and quantitative data as are available on-site work stations (e.g., re-framing the cine data, measuring SUVmax or SUV mean values, measuring size/volume of a lesion or organ etc.[1] .

The work station and monitor should have ability to display data in grey scale or colour and to scale the images. It should be able to display the planar images in matrix sizes ranging from 64 x 64 to 1,024 x1,024 pixels and cine dynamic sequences with up to a 256 x 256 matrix size. For SPECT/CT, PET/CT, PET/MR imaging, work station should have ability to display and fuse both anatomic and molecular images; generate images in multi-axis display (coronal, sagittal, or oblique planes) from a trans-axial data set; cine them; and allow ability to navigate them with automatic tri-angulation of one plane to corresponding position on other two planes[1]. Further capabilities may be added via upgrading the software as required depending of the type of study undertaken for interpretation.

Data completeness

All clinically relevant information required for consultation or interpretation of nuclear medicine scans should be available to the nuclear medicine physician at the remote location. This information includes indication for the study, patient's accurate clinical history, results of other relevant investigations including laboratory and imaging data, prior procedure and treatment details, and any technical problems or potential sources of error. All imaging data

should have patient identifier and appropriate label information[1].

Data protection and privacy

Protection of the privacy of the patient data can be ensured through restriction and traceability of their access to only authorized personnel, anonymization and encryption of data by means of passwords, and their confidential handling by the human users[1,2].

Addressing the Quality control

Quality control, and safety related standards and procedures should be implemented in accordance with the ACR policy on quality control.

The performance of equipment, both at the primary examination site and remote tele-reporting/consultation site should be monitored in accordance with ACR technical standards for medical nuclear physics performance monitoring of CT and nuclear medicine equipment, as well as according to the NEMA and IEC standards described in EANM guidelines on routine quality control[10] and acceptance testing[11] for nuclear medicine instrumentation.

It is important that remote monitor settings are as per nuclear medicine display requirements, and are not altered by non-nuclear medicine applications[12,13]. A test pattern such as the Society of Motion Picture and Television Engineers (SMPTE) medical diagnostic imaging test pattern may be used to check the spatial resolution and linearity of a monitor[14].

In addition, Physician quality control should also be done regularly via ensuring certification/ re-certification process of the reporting physician at the remote centre to ensure that physicians are capable to interpret the results consistently and accurately.

Applications and Uses of tele- nuclear medicine

Clinical nuclear medicine

Nuclear medicine studies can play an important role in assessment and decision making in both urgent and chronic clinical conditions. If local reporting is not feasible because of lack of trained nuclear medicine physician, tele-nuclear medicine can provide an effective solution in such a scenario.

An example of utility of tele-nuclear medicine in emergency setting includes patients with symptoms of angina and a normal or equivocal ECG. Here, nuclear medicine scans like resting myocardial perfusion imaging can be useful to improve important decision making such as whether to admit the patient to critical or cardiac care units[15,16,17,18].

Other examples of applications in emergency settings include testicular torsion, where radionuclide testicular scintigraphy may help prevent unnecessary surgery when colour Doppler ultrasound shows equivocal flow [19,20] and Orthopaedics conditions such as fractures of scaphoid, pelvic ,femoral neck and stress fractures where bone scintigraphy is particularly useful when the diagnosis of a fracture is in doubt on clinical and/or radiographic grounds.[21,22]

Tele-nuclear medicine can also play an important role in many non-emergency room situations. For example, nuclear myocardial perfusion scans are known to more accurate than stress echocardiography in diabetic patients having silent myocardial ischemia. Tele-nuclear medicine could reduce morbidity and mortality by disseminating knowledge, instructions, and allowing increased utilisation of nuclear cardiology in such patients [23,24]. Furthermore, a report from India mentions successful use of telemedicine network via different hospitals to ‘disseminate knowledge, educate doctors and paramedical staff, improve and also develop their consultation and patient management using tele-follow up clinics for various departments such as surgery, radiology, nuclear medicine and rheumatology [25].

Tele-education in nuclear medicine

Tele-nuclear medicine allows the participants, located at remote receiving sites, to benefit from tele-education sessions, such as live or recorded lectures, demonstrations, case presentations, webinars, or conference content. The International atomic energy agency (IAEA) provides distance-learning web-based content in basic as well as some advanced studies in nuclear medicine[(26)]. Recently some web-based educational nuclear medicine webinars has also recently been held by the IAEA[(26)]. The society for nuclear medicine and molecular imaging (SNMMI, USA), also provides educational webinars, live workshops and lectures for nuclear medicine professionals[(27)]. Besides these, there are other societies such as the European society of hybrid imaging (ESHI) and Indian college of nuclear medicine (ICNM) that have been continuously providing content via live webinars, to users for continued medical education and up to date information in the field of nuclear medicine. However, to ensure proper preparation and adequate motivation of the participants, and to utilize tele-nuclear medicine as an effective and useful learning tool, a proactive participation of a tele-nuclear medicine course coordinator is essential[(28)].

Regulatory and legal issues in practice of tele-nuclear medicine

On part of the patient:

The patient is expected to be compliant to and follow the instructions issued to him/her. He or she should consent to the practice of telemedicine. The patient is entitled to a guarantee of the quality of the service in terms of the qualifications and certification of the nuclear medicine physician, the transparency of the procedure and confidential handling of data[(2)].

On part of the tele-nuclear medicine team:

Both the referring centre, and the nuclear medicine physician at remote station share responsibility in the selection and any resultant side-effects of the examination. A doctor should be present at the place of examination to attend the patient in case any complication or emergency situation crops up during the examination session. In event of an accident, law specifies that the jurisdiction of the place of the accident is applicable. The reporting nuclear medicine specialist should be registered in the country of practice and possibly accredited with the hospital where the examination takes place. It has also to be strictly emphasized that both, centre providing the examination data and the remote interpreting nuclear medicine physician, must comply to their respective national tele-medicine guidelines. Tele-medicine should be practiced only by registered physicians who have passed the official training or examination, and have been licensed regarding their practice of telemedicine[(2)].

CONCLUSIONS

World- wide, the role of tele-nuclear medicine is gradually increasing in the improving the accessibility and practice of clinical nuclear medicine. The advantages of tele-nuclear medicine include rapid and efficient transmission of complex medical data, without significant loss of resolution, enabling availability of nuclear medicine services to the patients regardless of the distance between the nuclear medicine scanning equipment and participating nuclear medicine physician. The second advantage is the power of tele-nuclear medicine allowing a cost-effective access to continued education as well as updated training using distance learning at all levels. Therefore with a good adherence to prescribed tele-nuclear medicine guidelines, it can provide an effective solution to address the limiting issues of financial as well as man power constraints which otherwise lead to non-availability or under-utilization of nuclear medicine facilities especially in developing countries.

Conflicts of interest: Nil.

Abbreviations used

PACS: Picture archiving and communication system
DICOM: Digital Imaging and Communications in Medicine
IAEA: International atomic energy agency
SNMMI: Society of nuclear medicine and molecular imaging
ICNM: Indian college of nuclear medicine
EANM: European association of nuclear medicine
ACR: American college of radiology
NEMA: National Electrical Manufacturers Association
IEC: International Electrotechnical Commission
LAN/WLAN: Local/(wireless) area network
WLAN: Wireless Local area network
VPN: Virtual private network
^{18}F- FDG: Fluoride 18-fluorodeoxyglucose
SPECT: Single photon emission computerized tomography
PET: Positron emission tomography
CT: Computed tomography
SUV: Standardized uptake value

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