

Teleradiology in Singapore – Taking Stock and Looking Ahead

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Abstract

Teleradiology will have a significant impact on the delivery of healthcare and the practice of medicine. In order to ensure a positive outcome, the expected benefits, limitations and potential pitfalls of teleradiology must be carefully considered. For Singapore, teleradiology can be used to facilitate a quantum leap in the standards of radiological services. This can be achieved through the development of an integrated, nationwide, high-speed radiology network which will allow patients to have access to high-quality and responsive subspecialty radiology expertise located throughout the country. If judiciously implemented, teleradiology has the potential to propel Singapore radiology to an unprecedented level of professional quality and service delivery, and will provide the framework for sustainable radiological insourcing from other countries.

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Introduction

Teleradiology is the electronic transmission of radiologic images from one location to another for the purposes of interpretation and/or consultation.¹ The current interest in teleradiology is fuelled mainly by rapid technological advances, a worldwide shortage of radiologists, and cost considerations in developed countries. Today, it is possible to transmit images from the entire range of diagnostic modalities to a remote site for interpretation.

The literature on teleradiology revolves primarily around the provision of after-hours, or ‘Nighthawk’, services. There is escalating demand for such services, beginning in the late 1990s and predominantly from the United States of America.^{2,3} This service has been shown to be feasible and can be safe, provided an active quality assurance programme exists.^{4,5}

However, expansion of telemedicine beyond the boundary of “Nighthawk” services has been met with reservation. *The New England Journal of Medicine* recently published a commentary on the current situation in America.⁶ The author, a specialist in Internal Medicine watching events unfold, worries about a future where patient care “will be provided by anonymous people in cyberspace rather than by local doctors” and that “distinguishing competent

providers from hucksters will become even more difficult.” This paper concluded that “whatever the outcomes... it will be controversial”.

Singapore is presently embarking on offshore teleradiology initiatives for selected primary healthcare facilities. However, to the authors’ knowledge, no comprehensive review of teleradiology in Singapore has recently been published.

This paper aims to review the current status, expected benefits, limitations and potential pitfalls of teleradiology in Singapore. It also provides recommendations on how Singapore can harness teleradiology to maximise local radiology expertise, provide an unparalleled subspecialty level of nationwide radiological services, and establish the framework to participate actively in the global teleradiology arena.

Teleradiology in Singapore – How Far Have We Come?

Teleradiology within Singapore was first explored in the public sector in the 1990s when efforts were made to establish teleradiology consultation between Stanford University and Singapore General Hospital for magnetic resonance imaging (MRI) and computed tomography (CT) studies.⁷ Similar services in the private sector commenced

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in 1992 (personal communication – Kwok R, Hoe J, Lim PS) for teleradiology of plain radiographs and ultrasound. These attempts remained isolated initiatives, mainly due to the prohibitive cost of the infrastructure and the technological limitations in the past.

The most recent local teleradiology initiative was officially announced in early 2006. This involved sending images from selected polyclinics of the National Healthcare Group to an offshore teleradiology service provider in Bangalore, India.⁸ The initial capital investment for this initiative was about S\$2.3 million,⁹ and an exchange of letters in the local press raised other issues for consideration.

Expected Benefits from Teleradiology

The following are potential benefits expected from the implementation of a teleradiology service:

1. Provision of Radiological Interpretation Services Where They are not Readily Available

Teleradiology has been used to facilitate radiological interpretation of images from centres where workload is insufficient to justify a fully staffed radiology department, or where there is a significant shortage of on-site radiologists. In the United States, the radiologist-to-population ratio from 1993 to 2003 ranged from 1:9569 to 1:8105.¹⁰ In spite of this, there continues to be a shortage of radiologists in the United States.^{11,12} This level of staffing is, however, still high compared to a ratio of 1:18,000 in Canada¹³ and 1:17,987 in Australia.¹⁴ Based on local data¹⁵ for the year 2004, the 128 registered diagnostic radiologists (as of 31 December 2004) would equate to a radiologist-to-population ratio of about 1:33,000 in Singapore. These figures support the relative shortage of radiological expertise locally.¹⁶

2. Access to Subspecialty Radiological Input

Modern imaging studies, especially those of complex cases, often require detailed review by radiologists trained in the corresponding subspecialty area (e.g., neuroradiology, cardiac imaging, musculoskeletal radiology, paediatric radiology and head and neck imaging). Through teleradiology, centres without on-site subspecialty radiological capability can benefit from the expert opinion of subspecialised radiologists in a different department.

3. Out-of-hours Radiology Service and Consultation

Teleradiology can allow centres that are not adequately staffed to provide a 24-hour radiological service. Images acquired during odd hours can be sent to a teleradiology reporting centre for review. This has previously been adopted by some centres in the United States through the “Nighthawk” radiological reporting service, where differences in time zones between India and the United States were used to address the shortage of on-call

radiologists in North America.

In the same vein, images can also be transmitted to the home of a local radiologist for interpretation outside of office hours, removing the need for the radiologist to travel back to the hospital. This is especially useful in situations where radiology trainees provide the first line of service during night calls and require a consultant’s opinion.

Non-radiologist clinicians can also benefit from the transmission of images to their homes for review and to facilitate decision-making in complex clinical cases (e.g. review of CT aortogram images of an aortic dissection by a cardiothoracic surgeon).

4. Enhancing Education and Information-sharing Across Centres

Used appropriately, teleradiology can be harnessed to increase the variety of case presentations, learning opportunities and tutorials for radiologists and non-radiologists alike. Images can also be shared across top tertiary centres during multidisciplinary meetings, with the aim of enhancing patient care.

5. Tapping on Previously Unavailable Radiological Resources

Teleradiology can allow private or part-time radiologists to report studies from a remote location, assisting in the clearance of any existing backlog and reducing the workload on radiology departments in hospitals. These radiologists would otherwise have been underutilised in addressing the increasing demand for radiological interpretation.

6. Possible Reduction in Healthcare Cost

As part of the trend of globalisation and in line with efforts to control rising healthcare costs, the use of teleradiology to enable interpretation of images by radiologists in countries where the labour costs are significantly lower has been actively explored by several countries, including Singapore.

Limitations and Potential Pitfalls in Teleradiology

1. Legal Issues

The provision of a teleradiology service outside of a national boundary has legal implications. The Royal College of Radiologists has expressed concern about inadequacies in the current legal framework in the United Kingdom to deal with such matters, especially if the teleradiology provider is located outside of the European Union.¹⁷ Similar concerns about inadequacy of local case law and legislation with regard to these rapidly developing healthcare advances were also raised by a medico-legal adviser in response to queries by the Singapore Medical Association.¹⁸

a. Medical registration. Most users of teleradiology

services require the registration of the reporting radiologist with the regulatory body of the country from which the images originate. The remote service provider should have qualifications at least similar to that of the on-site provider. Any local requirements with regard to recertification, revalidation and continuous professional development should also be applicable to the radiologist in the reporting centre. These are essential requirements to ensure that minimum standards of reporting are maintained, regardless of the location of the teleradiology service provider.

b. Liability. The duty of care must be clearly defined, especially in the contracts between the requesting centre and teleradiology provider, so that there is clarity with regard to the liability of the service provider and reporting radiologist should any error or medical mismanagement arise from an erroneous report. The avenues through which a patient may seek redress for incorrect or inappropriate radiological investigations, especially if this crosses national boundaries, need to be worked out. In the Singapore context, one medico-legal adviser has indicated that any civil litigation brought by patients against offshore teleradiology providers would likely be heard in the patient's own jurisdiction.¹⁸ In the event of erroneous reporting resulting in an adverse outcome, the teleradiology provider must be subject to the same consequences as the on-site provider, i.e., be censured and sued for damages, and possibly even be barred from practising by the local regulatory body.

c. Medical confidentiality. The transmission of data needs to comply with existing local requirements with regard to security and protection of data. Measures should be in place to ensure that images sent to the teleradiology provider are only viewed by authorised personnel, and that the images are not used for other purposes without the prior consent of the patient. Public confidence in the privacy of sensitive information that has potential to cause embarrassment or loss should be maintained. This is especially important in the context of a society that is sensitised to breaches of confidentiality in financial data through identity fraud in internet banking.

d. Radiation safety. Recently, there has been a significant increase in the number of radiological examinations performed, resulting in increased radiation exposure to patients. In the local context, the radiological workload in 2 restructured hospitals increased by about 30% to 66% across various modalities from 2001 to 2005 (personal communication – Tan TY and Tan BS). The risks of medical radiation are real, and the latest report by the National Academy of Science¹⁹ indicates that there may be no safe lower limit. In fact, it is estimated that there could be a 1 in 1000 chance of developing a cancer from a 10mSv radiation dose, which is about the dose seen in a standard

CT scan of the abdomen and pelvis, especially when multiple post-contrast phases are used.²⁰ The risk in children is potentially even higher, with an estimated risk of 1 in 550 developing cancer.^{21, 22}

This highlights the importance of justifying each radiological examination, using appropriate protocols and customising the examination to suit the clinical question. This is usually done by on-site radiologists who vet investigation request forms, and when needed, read through the clinical notes and discuss the case with the requesting physician. Such processes may not be adequately addressed in offshore teleradiology.

Furthermore, there may be commercial pressures on the teleradiology service provider to suggest more examinations or perform more complicated studies. They may also be inclined to “cover all bases” just to be medico-legally safe, and protocol multiple additional phases of an examination (e.g., after administration of contrast media). This can be exacerbated by a lack of access to the full medical history of the patient in view of their remote location and unfamiliarity with the requesting physician. This, in turn, can lead to an increase in radiation dose to the patient, which may not be justified.

e. Workload issues. While teleradiology centres need to ensure that standards are maintained in order for them to remain credible, there is also strong pressure on them to remain commercially viable. This can potentially lead to teleradiology centres accepting a workload beyond their capability. This has serious implications for quality of reporting and radiological services, as radiological accuracy has been shown to decrease when the radiologist is overworked and fatigued.^{23, 24}

2. Communication

Clear communication of findings and their implications is a critical aspect of any radiology service. In teleradiology, how the reporting radiologist communicates the study results is a concern that needs to be addressed.

a. Communication with the referring clinician. The radiologist interacts with clinical colleagues in both formal (reports) and informal (telephone calls, corridor consultations, email exchanges, multidisciplinary meetings, etc) settings. The use of teleradiology limits the avenues through which communication can be achieved, and may affect the relationship between radiologist and clinician. Clinico-radiological conferences will probably be difficult to arrange routinely and at low cost, even with modern teleconferencing facilities.¹⁷ Formal and informal exchanges between clinician and radiologist have been shown to change the diagnosis and treatment in at least 50% of cases.²⁵ The American College of Radiologists has also indicated that radiologists need to communicate directly

with the referring physician in the event of any urgent or significant unexpected findings.²⁶ This requirement can be more challenging for a remote provider to fulfill. Concerns have also been raised regarding differences in the idiomatic use of English and local abbreviations between the referring institution and remote teleradiologist, which could adversely affect the interpretation of the radiological findings.¹⁷ This is especially important in the context of modern imaging studies where many minor findings of limited clinical significance are often detected in an otherwise normal study.

b. Communication with the patient. There is a need to clarify whether the patient is required to give consent for images to be transferred to another country for reporting. The reporting radiologist may also be required to communicate scan findings directly to the patient. This situation can arise in outpatient cases where an urgent or significant abnormality is found, necessitating action from the patient to get an earlier follow-up appointment. These include situations where a referring doctor is not clearly specified in the request form, or when the requesting physician is from a practice outside of the institution where the radiological examination is performed (e.g. general practitioner referring cases to the hospital for a CT scan). In such cases, the radiologist must be able to communicate the findings and required follow-up actions to the patient or caregiver in a clear and concise manner.

3. Service Quality

The role of the radiologist in modern medicine extends far beyond merely reporting imaging studies, although remuneration schemes often only take into account the report-generating function. The modern radiologist has been described to play the following imaging consultancy roles, in addition to the writing of reports:²⁷

- a. Advising on optimal imaging or diagnostic work-up
- b. Justification of examinations in individual patients
- c. Optimising and tailoring individual examinations
- d. Ad-hoc problem-solving
- e. Conferencing in multidisciplinary teams
- f. Organising workflow in the radiology department
- g. Quality control

The estimation is that radiologists spend an average of 70% of their working time on the imaging consultancy services detailed above, and only 30% on reading and generating radiology reports.²⁷ Any cost-benefit assessment should also factor in the other key roles that an on-site radiologist plays, as compared to the function of a remote teleradiology provider.

The quality of service provided by a remote teleradiology service may also be hampered by limited or lack of access

to patient casenotes (which are often handwritten), previous investigation results and the inability to directly converse with or examine the patient (which is key in protocoling of certain imaging studies). The remote teleradiology service provider is also unable to cater for the “hands-on” aspects of radiology such as ultrasound (where on-table checking of cases by the reporting radiologist is sometimes necessary) or interventional procedures. Without in-depth knowledge of local variations in disease prevalence, the remote teleradiology provider may be unable to interpret the imaging findings accurately. Radiologists also depend on regular feedback from their clinical colleagues which may be more difficult for a remote teleradiology provider.

4. Impact on Local Radiology Service

The widespread use of remote teleradiology services, especially if driven purely by economic forces, can lead to a loss of local radiological expertise. If a large proportion of imaging studies are sent to an offshore location for reporting, there will be significant implications on the training of junior radiologists and the experience of existing radiologists. This may lead to a decreased attractiveness of the medical subspecialty, thus reducing the number of trainees entering radiology. Such a situation has serious implications for the critical mass required by a small nation such as Singapore, potentially exacerbating the already unfavourable radiologist-to-population ratio. A further depletion of local radiological expertise, which is critical for the delivery of modern healthcare, would be unfavourable for Singapore as it positions itself to be a hub of medical excellence.

Discussion

As can be seen, teleradiology is a complex issue that can potentially be used to either the benefit or detriment of the patient. Taking all the points into consideration, the authors recommend the following strategies to capitalise on the benefits of teleradiology and position Singapore as a world-class radiology and medical hub:

1. Create a Nationwide Teleradiology Grid

A high-speed national radiology grid linking all radiologists in Singapore should be developed to allow studies to be interpreted across various departments and institutions. By crossing the boundaries between the government and private sectors, full-time and part-time radiologists, this network will help alleviate the current shortage of radiologists and allow for better distribution of radiological workload. With standardised hardware and software, the digitised workload can be rapidly pushed or pulled from one site to another. This will result in a shorter turnaround time for reports and help establish similar standards of radiology services across the nation. The

issues of accreditation and legal liability are already established for all local radiologists, and do not need to be re-examined. In time, this national teleradiology grid can be extended beyond the hospitals, to include primary healthcare facilities, so that the demand for radiological services across the country can be properly addressed.

2. Make Subspecialty Level Reporting the New Standard

Singapore has an established range of qualified radiology subspecialists in fields ranging from musculoskeletal, breast, neurological, chest and abdominal imaging to vascular and interventional radiology. Subspecialty level reporting is already the norm in reputable tertiary hospitals around the world. However, to date, no country has been able to make such subspecialty services routinely available as the national standard. By establishing a national teleradiology grid, Singapore will be able to tap into the economies of scale inherent in the national resource of subspecialty radiologists and make high-quality, sub-specialist interpretation of imaging studies available to every patient. This would be a quantum leap in radiological service delivery standards. The patient and managing physicians will benefit from improved customisation and interpretation of studies, which will enhance patient care. This, in turn, can mitigate rising healthcare costs by reducing the number of unnecessary repeat investigations and ensuring the appropriate use of high-end and costly radiological examinations in the correct clinical scenario.

3. Establish Singapore as a Respected Brand Name for Quality Radiology Services

Singapore has the capability to provide high-end radiological services to countries in the region and beyond. However, this should only be done on a significant scale *after* the establishment of a national teleradiology grid to address the current shortage of radiologists and raise the overall national service delivery standards. This progressive approach is critical in order to ensure that the delivery of radiology services to the local population is not compromised. It would be difficult for any country to justify a major push for insourcing while its own resources are unable to cope with local demand. Only when the internal issues have been addressed can Singapore position itself as a major player in the global teleradiology market.

Making the 3 key recommendations listed above a reality will require concerted efforts within the radiology community, along with strong support from major healthcare providers and policy makers in Singapore.

Why Singapore Can Play a Significant Role in the Regional and Global Teleradiology Network

There are already several players in the field of global teleradiology. However, if our recommendations are

adopted, we feel that Singapore can become a reputable and sought-after provider of teleradiology services in view of the following:

1. The quality and reliability of Singapore radiology is well established, and the subspecialty expertise is already in place. Most Singapore radiologists have post-graduate qualifications from the United Kingdom, while a smaller proportion has qualifications from the United States and Australia. There are regular exchanges between radiologists in Singapore and top institutions around the world through fellowship programmes and conferences. Singapore is already an active participant in the training of subspecialty radiologists in the region. Furthermore, the recent successful showcase of Singapore radiology at the European Congress of Radiology 2006 is a recognition of the quality radiological expertise currently available in Singapore.²⁸
2. Through the establishment of a national teleradiology grid, Singapore can be among the first few countries in the world to successfully overcome internal radiology staffing shortages and provide routine subspecialty radiological services to patients. With the radiology network in place and continued efforts to recruit more radiologists, there will be a sizeable pool of radiological expertise for any healthcare provider, both local and international, to tap on.
3. Singapore is fortunate that it has a combination of a world-class judicial system which can tackle teleradiology-related legal issues, appropriate technological expertise to enable reliable data exchange and security, and strong government commitment to ensure the delivery of quality medical services.

Conclusion

Teleradiology is a double-edged sword which must be carefully wielded to ensure that the quality of radiological services is not compromised. Singapore is in a unique position to harness the benefits of teleradiology to address the current shortage of radiologists and become a key player in the global teleradiology arena. It is our view that the establishment of an integrated, nationwide, high-speed teleradiology network can facilitate the provision of responsive subspecialty radiology services for all our patients, and provide the framework for teleradiology insourcing from other countries. This, in turn, can propel Singapore radiology to an unparalleled level of quality and service delivery.

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