

F R O S T  S U L L I V A N



Market
Insight

Challenges Faced by Australian Radiologists while Working with Conventional Imaging Workflow Solutions

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I. EXECUTIVE SUMMARY

Medical imaging has been a torch-bearer for technological advancements in the healthcare industry. Computerized Tomography (CT) introduced digitization in radiology but the real game-changer was Picture Archiving and Communications System (PACS). With PACS products entering fourth and fifth generations across the world, the traditional film and light box set up are becoming a thing of the past. Medical imaging, in fact, is now showing the effects of Moore's Law, whereby rapid technological advancements and high rate of adoption lead to an acceleration of innovation and swift replacement of technology. To continually evolve with this rapid evolution in medical imaging, GE is working real time and more directly with end users across the globe to design this future. This GE sponsored Frost & Sullivan whitepaper is a part of that process, identifying key issues that impact the day-to-day performance of radiologists in Australia and what are the consequences of these issues.

The most severe obstacle for Australian radiologists is data fragmentation and inefficient information management tools and protocols. Lack of interoperability, differences in file formats and inefficient data communication standards and protocols lead to time pressures for radiologists. Furthermore, medical imaging systems are unable to communicate with other hospital information systems or even the patient's electronic medical record, creating a significant gap in the radiologists' knowledge and understanding. Imaging quality, ability to integrate multiple modalities and system speed and performance were identified as other areas of improvement. With radiology becoming an increasingly important component of emergency care, the above inefficiencies can be critical in delivering quality care. Moreover, evolving government regulations in Australia have attached a cost to the radiology department's performance; thus, addressing these technological issues now becomes a board-room decision.

Improvements in system design and R&D resources should be targeted towards:

- **Seamless workflow integration**
- **Enhances systems interoperability**
- **Advanced imaging analytics**
- **Ubiquitous service delivery**

The end goal of technological advancement and innovation should be improved healthcare delivery at an affordable cost. Medical imaging and informatics solutions need to focus on helping radiologists make timely and informed decisions. While commendable success has been achieved in this field, there is significant room for improvement in workflow optimization, information management and data collaboration.

II. MEDICAL IMAGING AND INFORMATICS IN AUSTRALIA—AN INDUSTRY SUPPORTED BY INNOVATIVE TECHNOLOGIES

Australia enjoys a world-class health system, characterised by the highest per capita healthcare expenditure and the second highest health to GDP ratio in Asia-Pacific. Healthcare expenditure increased at a compound annual growth rate (CAGR) of 6.1% between 2005-06 and 2010-11. The healthcare system is supported by approximately 1,346 hospitals, of which 56% fall in the public sector. However, the number of public sector hospitals is declining while private sector investment is on the rise. While there are several merits of the Australian healthcare system, there are also some challenges such as rising healthcare costs due to a rapidly ageing population as well as uneven distribution of healthcare resources.

The market for diagnostic imaging equipment and medical imaging informatics solutions was estimated at AUD 749.4 million in 2012. The market is dominated by global suppliers such as GE Healthcare, Philips Medical Systems, Siemens Medical Solutions and Toshiba Medical Systems. Patients in Australia have access to state of the art diagnostic imaging technology as seen from the comparatively high number of CT (computed tomography) scanners installed in the country. Australia had 38.7 CT scanners per million population, second-highest among the Organisation for Economic Co-operation and Development (OECD) member countries, as per the OECD Health Data 2011.

Table 1: Diagnostic Imaging Equipment Market: Leading Original Equipment Manufacturers and Suppliers, Australia, 2012

	GE	Philips	Siemens	Toshiba	Shimadzu	Carestream	Agfa
Nuclear Medicine	✓	✓	✓				
CT	✓	✓	✓	✓	✓		
X-ray, CR, DR	✓	✓	✓	✓	✓	✓	✓
Ultrasound	✓	✓	✓	✓			
MRI	✓	✓	✓	✓			
Mammography	✓	✓	✓				
Fluoroscopy	✓	✓	✓	✓	✓		
PACS	✓	✓	✓			✓	✓

The diagnostic imaging services industry in Australia was estimated at AUD 3.1 billion in 2011-12. The market is dominated by private medical imaging groups with I-MED Radiology Network, Sonic Healthcare and Primary Health Care Limited accounting for around 54 percent of the total market.

It is estimated that the total number of diagnostic imaging services provided in Australia has increased from 21.3 million in 2005-06 to 28.7 million in 2011-12 at a CAGR of 5.1 percent. At present, around 35 to 40 percent of diagnostic imaging services in Australia are provided by public hospitals and the remaining 60 to 65 percent by private hospitals or private imaging practices. Diagnostic radiology, which includes general X-ray, fluoroscopy, dual energy X-ray absorptionmetry (DEXA) and mammography, accounted for over 80 percent of the total number of diagnostic imaging services provided in Australia in 2011-12.

Table 2: Diagnostic Imaging Services Market: Forecast for Diagnostic Imaging Services by Modality, Australia, 2011-2012 - 2014-15¹

Modality	2011-12		2014-15	
	Number of diagnostic imaging services (million)	Proportion of total number of diagnostic imaging services	Number of diagnostic imaging services (million)	Proportion of total number of diagnostic imaging services
Diagnostic X-ray	13.4	46.6%	14.6	43.4%
Ultrasound	10.3	35.8%	12.7	37.8%
CT	3.4	11.7%	4.1	12.1%
MRI	0.9	3.1%	1.2	3.5%
Others	0.7	2.8%	1.0	3.2%
Total	28.7	100%	33.6	100%

Technologies such as e-health, teleradiology, integrated picture archiving and communication system (PACS) and radiology information system (RIS) can assist in overcoming these challenges by improving the productivity of radiologists. The Australian government has undertaken various healthcare information technology initiatives to make delivery of health care more effective and efficient, including the delivery of diagnostic imaging services. For example, the Medical Imaging Program of New South Wales (NSW) Health aims to provide an integrated digital imaging and radiology information system that improves clinical efficiency and gives universal access to images across the state. Private medical imaging groups such as I-MED and Sonic Healthcare have also implemented medical informatics solutions for benefits such as decreased turnaround time for reporting, shorter wait times for diagnosis and treatment, instant display of vital patient information, simultaneous distribution of patient radiology information to multiple locations and increased radiology efficiency.

III. THE EVOLVING ROLE OF RADIOLOGISTS IN AUSTRALIAN HEALTHCARE

A number of industry dynamics have influenced an evolution of the radiologists’ role in Australia. At a granular level, an ageing population, rising threat of chronic diseases and increasing awareness around health and wellness have led to an escalating burden of radiological exams. Increasing volumes require radiologists to be far more efficient, doing more with less. The increasing radiology load needs to be handled by a severely limited workforce. It is estimated that Australia faces a shortage of around 366 radiologists, that is, 18 percent of the total diagnostic radiology workforce by 2025 due to factors such as inadequate training positions at present and shrinking workforce due to ageing population².

Moreover, not only has the average daily radiological exam volume read by a radiologist each day increased about seven-fold in the past 5 years, the number of images taken per scan has also increased exponentially, sometimes by as much as a 100 times as in the case of CT scans. Thus, the amount of information that a radiologist digests each day has multiplied radically in the past few years.

¹ Estimates based on the ‘Review of Funding for Diagnostic Imaging Services: Final Report’ published by the Department of Health and Ageing, Australian Government in 2012

² HealthWorkforce Australia, Health Workforce 2025, 2012

On the other hand, radiological investigations are transitioning from a “good-to-have” to a “must-have” procedure in the healthcare delivery. Radiological exams currently form an important component of the patient’s medical and diagnostic history; and are being increasingly ordered to support critical and emergency care. To further challenge the radiologists’ intellect, a number of specialists in Australia are now resorting to studying the exams they ordered due to which radiologists feel threatened in their role.

Technological advancements in the Australian medical imaging market are keeping pace with developments in almost any other discipline of computer science. Even though there is a general trend towards increasing magnetic resonance imaging (MRI), radiologists in Australia generally work across multiple modalities on a daily basis. Subspecialisation is emerging as an important competitive advantage amongst the workforce.

Australian radiologists work with cutting edge medical imaging, informatics and analytics tools, which require them to have strong IT (information technology) skills as well as contribute to business and organizational decisions regarding radiological IT systems. Increasing healthcare costs along with downward pressures on the prices of radiological exams are constraining margins as well as curbing capital expenditure on equipment and technologies. Mobility of radiological data is expected to be the next big wave in Australia.

The final result of all these transformations is that radiology is becoming far more predictive. The practice of radiology in Australia is no longer limited to screening and diagnosis. Preventive radiology and radiological interventions performed to estimate or eliminate the probability of future conditions are gaining acceptance with both physicians and patients. Analytics and intelligence tools, which can derive meaningful insights from disparate data sets in almost real-time, have been a key enabler of this trend.

IV. RESEARCH OBJECTIVE

The objective of this research is to identify and elaborate on the most critical challenges and difficulties faced by radiologists in Australia, and assess the impact of these challenges on the healthcare delivery system at a micro- as well as macro-level.

Insights gained from this research would help uncover market needs which could be addressed through improvements in the technology and system design. Key insights and findings will guide GE Healthcare’s current and future R&D efforts to improve their medical imaging products. The end goal is to improve the day-to-day lives of radiologists by focussing on their most innate professional needs.

V. RESEARCH METHODOLOGY

The research was conducted by the Frost & Sullivan Healthcare team, under the guidance of Ms. Rhenu Bhuller, Senior Vice President, Frost & Sullivan Healthcare, Asia-Pacific. The team consisted of industry analysts and experts in the field of imaging informatics from Australia, Singapore and US. The Frost & Sullivan team collaborated with the GE Healthcare Information Technology (GE HCIT) group to develop an in-depth discussion guide shared with 5 key opinion leaders (KOLs) in the field of radiology across Australia. The research scope was limited to 4 KOLs to reflect the exploratory nature of the study as well as to ensure that crisp, relevant opinions and insights are obtained from the select

few who have extensive knowledge about radiology processes and workflow. The respondents were selected based on the following criteria:

- **Performing clinical work using PACS and/ or diagnostic workstations for at least 3 years since after training**
- **Contribute towards or are interested in designing of improved clinical workstations**
- **Either Thought Leaders in the field of radiology informatics or key decision makers at their institutions within this department.**
- **The respondent group should have representation from both public and private sectors.**

The discussion guide was shared with the respondents in advance. Discussions were held over the telephone and lasted between 30-45 minutes each. While some sections of the discussion were somewhat technical in nature, for the most part respondents were requested to focus on how they would like to improve their day-to-day tasks. The Laddering technique was used to guide discussions as well as to develop a qualitative analysis for the research.

A combination of primary and secondary research was used to understand the medical imaging market landscape in Australia. The Frost & Sullivan Macro-to-Micro approach was used to analyze how megatrends in the healthcare industry translated into more endemic challenges and opportunities in the Australian medical imaging and informatics market with a focus on the evolving role of radiologists in the healthcare sector. Simultaneously, a current state assessment of imaging informatics and workflow tools was conducted so as to develop an objective analyst opinion on the level of market and technology development.

VI. CHALLENGES AND DIFFICULTIES WITH CURRENT IMAGING SOLUTIONS AND THEIR IMPACT

A common thread that emerged from all our conversations with respondents was the lack of efficiency at the workplace caused by the limitation of the PACS solutions in use. All respondents stated that their current PACS solution did not meet performance expectations, such as, speed of response and the ability to pull relevant radiological data in the correct format from disparate sources. This problem is further compounded when imaging procedures are performed to support Emergency Departments where time could be critical. Radiologists currently rely on teleradiology to expedite emergency exams; however, setting up the teleradiology services requires a significant monetary investment as well as developing partnerships across the border. On the other hand, having a patient occupy an emergency ward while waiting for a CT scan is not only a material cost to the patient, it is also an opportunity cost to the care provider, who can potentially use that ward for an Emergency Department case. With the implementation of the National Emergency Access Target program by most state governments, there is now an actual cost attached to the productivity of radiology department when supporting critical care. Patients need to be attended to within 4 hours; this means that imaging and reporting needs to be completed within that timeframe. Once this practice is implemented for the Emergency Department, it gets adopted quickly across other hospital areas. Therefore, in a number even on a routine basis, long queues of patients outside the radiology department are becoming a negative performance indicator for many healthcare providers.

Time inefficiencies are further pronounced when senior radiologists are required to spend their valuable time on developing detailed reports and board room presentations. Developing reports manually by capturing data and images of different formats from various modalities requires

significant effort. Further, radiologists often find themselves troubleshooting bugs and system breakdowns with the IT department. Technical issues range from overexposure, workstations slowing down or hanging while working across multiple applications, to complete breakdown in the hardware or software of the imaging modality.

The above stated inefficiencies are estimated to consume 25% of the radiologist's practice time in Australia. As per the Royal Australian and New Zealand College of Radiologists (RANZCR) 2010 Workforce survey, median hours spent by radiologists at the workplace were 44 hours per week. Not all of these 44 hours are spent on clinical practice; radiologists also spend time on other tasks, such as, teaching, training and administrative functions. Further, as the radiologists' workforce in Australia ages, working hours per week are expected to decrease over the next five years. Under these circumstances, it becomes critical to improve the efficiency of PACS systems so that radiologists, particularly senior members of the community, can spend more time on their personal and professional development.

Radiologists are severely impacted by the inability of information systems to communicate amongst each other. None of the respondents was satisfied with the level of interoperability amongst imaging systems as well as other software installed at their facilities. Current imaging systems require radiologists to either manually extract or at least call information from other software, such as, electronic medical records (EMR) and HIS. More often than not, the data outputs are incompatible and need to be viewed, processed and analyzed using different software. Firewalls and data protection protocols hamper image sharing across and within a number of public practices. Not only is this a waste of time, it also leads to significant loss of knowledge, which could have otherwise assisted in better decision making and diagnosis.

While all respondents had worked extensively with multi-modality systems, the use and prevalence of such systems is not as extensive in Australia as they would like. Most facilities operate single modality workstations and those that do support multi-modality solutions are not seamlessly connected and do require radiologists to move between stations. Working across multiple workstations translates into loss of time and energy and is known to cause fatigue as well as medical problems, such as, back pain amongst radiologists. While senior radiologists are adept across various modalities and solutions from different vendors, trainees and new employees tend to show a steep learning curve while adapting to different workstations. Another challenge with multi-modality systems is the storage of data on local desktops. This data then gets locked on the workstation and may not be readily available when needed.

A key challenge with currently available systems is that they do not support 2 dimensional (2D) and 3 dimensional (3D) images simultaneously. This means that not only is the radiologist unable to view 2D and 3D on a single screen, one cannot even perform rich analysis by combining the two images because they are being sourced and viewed through different applications. The ability to slice through coregistered data from different modalities is believed to be the next step towards personalized, preventive medicine. Moreover, respondents are not satisfied with their current image viewers because the display and background colours for most are not optimum for reading. This puts strain on the radiologist's eyes. Also, current viewers require radiologists to position images and other medical information into a format of their choice each time a new exam is presented before them. This leads to an unnecessary number of mouse clicks and too much time spent on post processing, which makes the radiologist feel like he is working at the level of a laboratory technician.

The most preferred method of communication amongst radiologists is via e-mail. Mobile phones are the second best option but are used only in the case of an emergency. The risk with e-mailing is that it is asynchronous and delay in responding to an e-mail could have long-term consequences on the patient's health. Moreover, none of the respondents mentioned a structured information flow process at their facilities. The lack of a robust information dissemination system or a breakdown of

communication tools can result in adverse consequences for patients as well as malpractice suits for radiologists.

The relation between physicians and radiologists has evolved from a referrer-referee partnership to one of deeper collaboration. Radiologists are considered an associate of the physician, such that, they advise physicians on the most appropriate scans required, provide critical insights and diagnosis on patient data, and participate in organizational decisions impacting both public and private sectors. On the other hand, patients are becoming far more aware too and have access to a lot more information than before. All respondents agreed that due to these industry changes the intellectual needs of their role had evolved significantly over the past 5 years. Radiology experience adds substantial value while at the same time, access to case studies, patient histories and other internal and external sources of information becomes vital towards improving performance at the workplace.

VII. THE “IDEAL” MEDICAL IMAGING WORKSTATION

Technology in radiology is a victim of its own success. Customers, that is, radiologists are demanding advanced tools and software because they expect the industry to keep pace with innovation in other sectors. All the respondents provided very detailed insights on what features they would like to see in their “ideal” workstation. These have been categorised as below:

Seamless Workflow Integration

The guiding principle for developing the “Ideal” medical imaging workstation would be efficient and reliable informatics delivered within budget constraints. Improved enterprise content management and medical informatics, which includes better integration and interoperability with other clinical and administrative software as well as EMR, was the most desired improvement in current systems. In an “ideal” system, the radiologist would be able to view a blown-up version of the patient’s EMR alongside the radiological data with just the click of a button. The aim is to be able to tag and retrieve patient information to images rapidly; gain insights on the patient’s full medical history without having to toggle between applications, and push analysis and results into the healthcare information systems and patient records with minimal number of mouse clicks. To support enterprise content management, the radiology department produces and also requires significant amount of data, case studies and reference material. The information, however, currently is pushed into the network through conventional communication tools, such as, e-mails or hospital portals. Radiologists would like to see a customized medical imaging communication system which can be linked to other channels when required. Improved enterprise content management would also indirectly make radiology more useful to doctors and patients. There is room for improvement in the reporting process as well. A dictation system which records radiologists’ understanding and analysis in real-time in a universal language and format would drastically save reporting time as well as improve knowledge capture, especially during meetings which discuss critical or complicated cases.

Enhanced Systems Interoperability

In addition to systems integration and interoperability, radiologists perceive significant room for improvement in core image viewing and analysis functions as well. Radiologists are comfortable working with multi-modality systems provided they do not need to access and sign-in to a plethora of applications. They would like a unified view of all the patient’s exams as well as his medical history.

Added advantages would be the ability to perform rich analysis on merged data from various modalities. User interfaces need to be more intuitive so that the learning curve is shortened. There is an increasing demand for voice recognition software and touch-screen functionalities which allow radiologists to toggle with 3D images. Animated and dynamic images are far better received than static, non-interactive images. However, none of the respondents touched upon the aspect of machine learning, which greatly supports individualized hanging protocols, thus potentially reducing post-processing time and effort. This could be because the respondents had not come across such systems.

Advanced Imaging Analytics

Molecular imaging is fast making its way into Australia. A combination of conventional as well as molecular imaging techniques could provide insights into both the structure as well as the metabolic functions of organs through multi-modality image fusion. This, however, would again require integration amongst varied modalities which collect 2D and 3D images in different formats. Quality assurance is also a key area of improvement for current systems.

Ubiquitous Service Delivery

Radiologists are also seeking platform agnostic solutions not only for their enhanced data aggregation and interoperability, but also for their potential to aid mobility. Radiologists want tools that allow them to work just as efficiently on their iPads and other mobile devices as at their workstation. Cloud storage and computing technologies are also helping advance mobility. For a radiologist, the greatest benefit of mobility is the ability to access and deliver results, especially in emergency situations, almost anytime, anywhere. While data security is a concern, the benefits of mobility in radiology far outweigh the challenges. Cloud technologies and zero footprint clients also help reduce capital expenditure and improve information storage and handling.

Mobility directly leads us to the larger desire for radiologists to decentralize information. To give a simple example, the radiologist does not want imaging data to be locked up at the workstation. Data and images should be accessible at a bedside monitor in the patient's ward and preferably also be able to make changes to the record. This vision can then be extended to radiological images being transmitted to designated PDAs (personal device assistants) in real-time so that when the radiologist is performing the exam, patients and care-givers can view the images as they are being captured. This could significantly enhance patient experience and be extremely rewarding in instances, such as, when family members are looking at ultrasound images of an unborn child. Flexibility in information sharing and mobilization of data could also improve the teaching experience as well as make board-room conversations more interactive. A diagnostic-grade multi-modality image viewer, which is "de-coupled" from a particular workstation or PACS archive, helps meet the need for data access and mobility.

To conclude, while the medical imaging and informatics industry in Australia has achieved commendable success, there is still ample opportunity for innovation. Medical imaging companies are a victim of their own success. Soaring technological advancements have only left consumers demanding for more. There is growing acknowledgement that IT is not enough to transform our fragmented and "broken" healthcare system; medical device manufacturers must re-engineer and optimize workflow processes to ensure high quality imaging, improved information exchange and seamless collaboration.

VIII. APPENDIX

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