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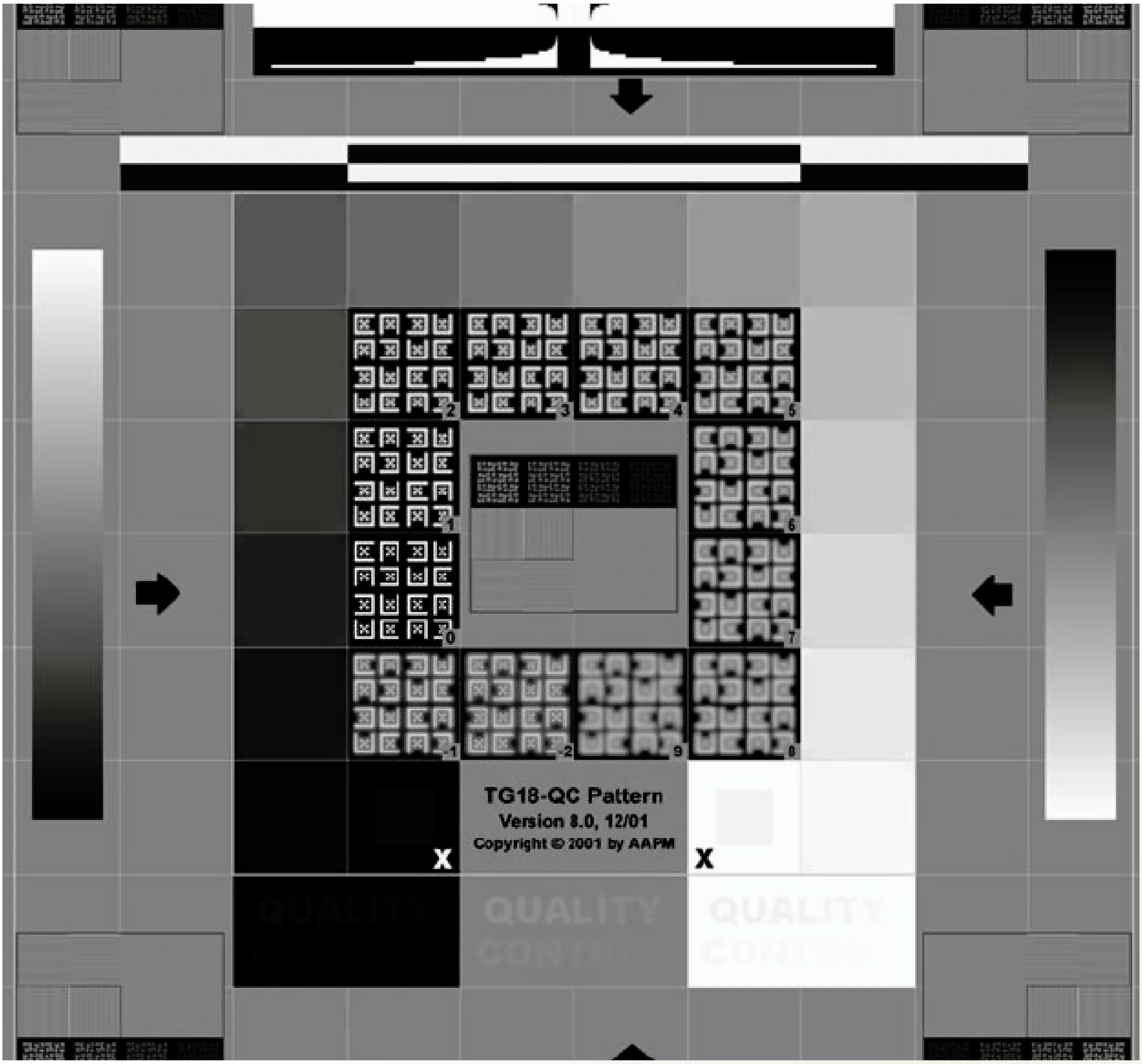
Promontory

Quality in Medical Imaging



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Promontory is a biannual publication that features current updates and issues close to the heart of our profession in Singapore, event highlights and provides a space to showcase achievements and accomplishments of the members of our profession.

President's Message

Written by
MS. DENISE CHOONG,
PRESIDENT

When we think of quality management in radiology departments the first thoughts that commonly come to mind are the terms 'QA/QC' and 'phantom', however that is only one component of the whole quality picture.

In our special feature this issue, we take a deep dive into the many aspects of quality management, in not only general radiography but MRI and Ultrasound as well. In understanding more about quality management in a radiology department as a whole, we can answer the age-old question – is it really my responsibility as a radiographer? Is it not the job of the radiation physicist or the engineer?

While we examine the basics and established methods of quality assurance, in this issue we also explore the new frontier of AI in QA practices. Can it replace our roles in the QA process?

In this issue, We also feature the most recent happenings with SSR before we rounded out 2023.

As we begin 2024, we at SSR wish you a productive and healthy year ahead.
Happy reading!

LTWRAP GALA DINNER

SSR Award Recipients

At the LTWRAP + SSR Gala dinner and World Radiography Day Celebrations, we honoured three distinguished individuals who have helped to shape our profession in Singapore over the years. Here are our SSR Award winners for 2023!

Ms Lim Soh Har
Honorary Membership

Executive Director of the National Healthcare Group Diagnostics (NHGD)

In recognition of the exceptional efforts in developing radiography services and actively supporting advancement of the profession in Singapore.

Mr Francis Ngoi Chong Ling
Life Membership

Senior Manager at National Cancer Centre Singapore (NCCS)

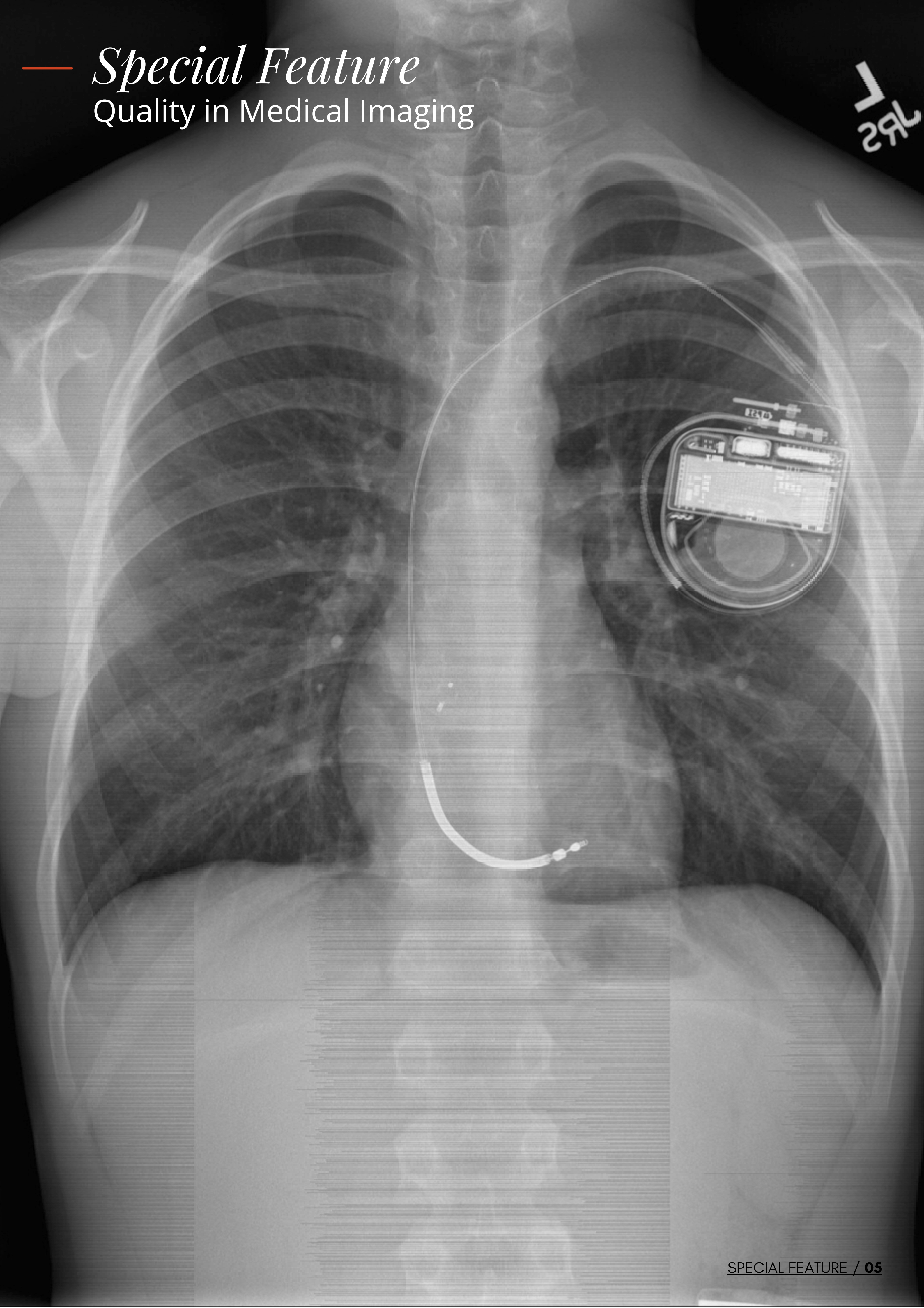
He served in the SSR EXCO as its Publicity Chairperson from 2010-2011 as well as Treasurer from 2013-2015. He has contributed to the profession as an active AHPC committee member and continues to support the society in its professional development goals.

Ms Lui Yin Wah
Life Membership

Senior Lecturer at Parkway College of Nursing and Allied Health

She has supported the society by participating in SSR events and introducing the society to new students to increase visibility and generate interest in being members of the professional society and the SSR student chapter.

Special Feature
Quality in Medical Imaging



Defining And Assessing Quality in Medical imaging

By: Sim Wei Yow
Senior Principal Radiographer II (Clinical),
Singapore General Hospital

In medical imaging, 'quality' often emerges as a focal point in internal and external audits, especially following lapses in practice. However, defining and measuring quality in this context can be elusive. Diverse interpretations in the workplace and literature sometimes obscure its true meaning. Despite these challenges, quality remains foundational in producing images, utilising equipment, and providing services. Yet, the absence of clear guidelines or standards can render 'quality' an ambiguous and subjective term rather than an objective metric.

The International Organisation for Standardisation (ISO) defines quality as "the degree to which a set of inherent characteristics of an object (product, service, process, system) meets stated, implied, or obligatory requirements" (1). Building on this, the World Health Organization (WHO) delineates explicitly six dimensions of quality in healthcare systems (2): effectiveness, efficiency, accessibility, patient-centeredness, equity, and safety.

Acknowledging the significance of quality, measuring, monitoring, and maintaining it effectively becomes crucial. In Singapore, the current regulatory framework, as outlined in the Healthcare Service Act 2021, mandates medical imaging providers to establish a Quality Management (QM) system, conduct Quality Control (QC) tests, and perform regular equipment performance reviews (3). Despite these requirements, a void remains in national standards or published guidelines for Quality Assurance (QA), QC, and clinical audits. This gap often leads clinical departments to adopt foreign guidelines or, in some cases, forego certain quality measures due to resource constraints. The reliance on equipment vendor recommendations, which may not always be impartial, further complicates the pursuit of genuine quality. This situation underscores the need for standardised QA/QC methodologies, identifying best practices, and establishing national standards specific to Singapore's healthcare context.

Concurrently, there is a pressing need for qualified medical physicists (QMP) across various imaging modalities. Although QMPs are prevalent in Radiation Therapy, Nuclear Medicine Imaging, and Magnetic Resonance Imaging, there is a notable global shortage in diagnostic radiology (4). With their deep technical knowledge, these experts are pivotal in conducting equipment tests, overseeing quality measures, and guiding corrective actions. In the absence of comprehensive guidelines, consulting QMPs becomes essential. However, the current shortage encourages radiographers to step forward and actively contribute to quality assurance initiatives.

Collaborative Efforts in Quality Management

The responsibility for QA, QC, and clinical audits extends beyond the medical physicist. This approach is impractical in large healthcare systems, where managing multiple radiology equipment is the norm. As per the International Basic Safety Standards (5), medical physicists can delegate certain equipment performance measurement tasks to radiographers in specific scenarios. This highlights the importance of a collaborative, interdisciplinary effort involving multi-disciplinary teams in designing, executing, and analysing all aspects of QA, QC, and clinical audits (6,7). Ideally, medical physicists, radiographers, radiologists, and physicians should work collaboratively to enhance practice quality. Since QA/QC activities affect all stakeholders in the medical imaging pathway, radiographers bear equal responsibility in ensuring quality and actively participating in relevant QA/QC initiatives and clinical audits.

Quality in medical imaging must not be neglected; it requires ongoing measurement, monitoring, and maintenance through QA, QC, and clinical audits, as depicted in Figure 1.

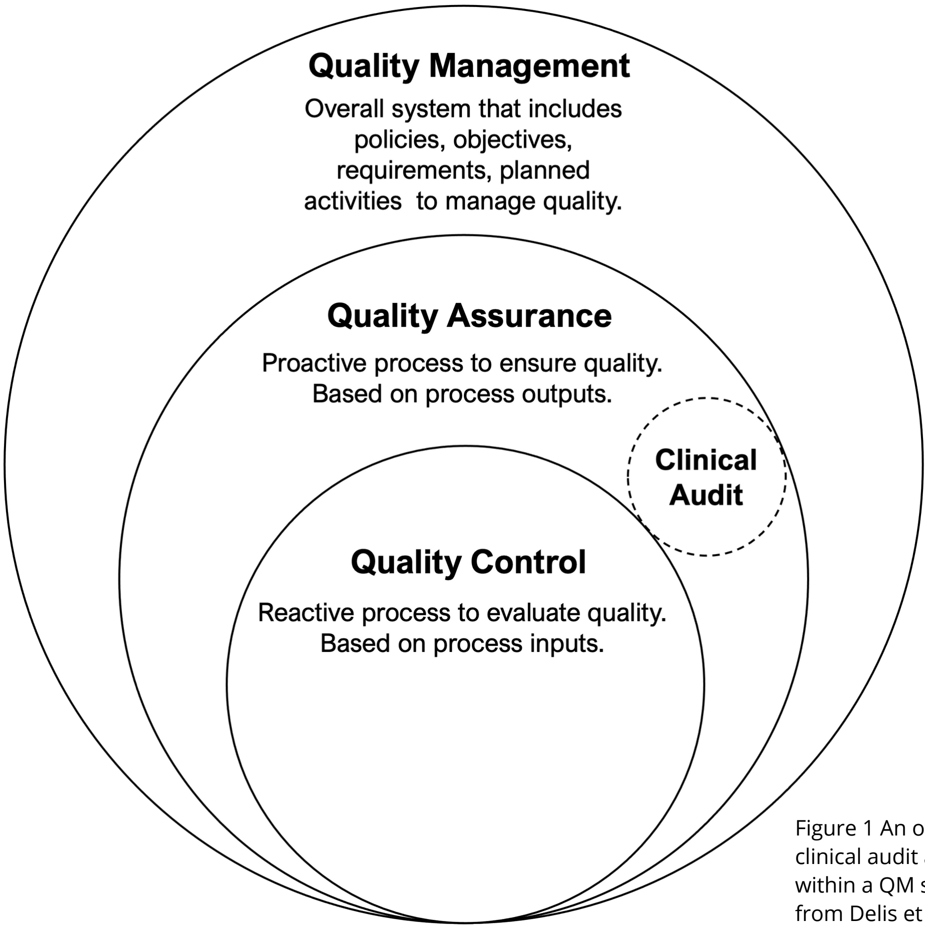


Figure 1 An overview of QA, QC and clinical audit and their relationship within a QM system. Figure adapted from Delis et at., 2017 (7).

Quality Management System (QM)

The QM system functions as the core of internal governance in medical imaging, led by a quality committee comprising medical physicists, radiographers, radiologists, nurses, and managers. This committee is responsible for developing policies, setting objectives, and identifying processes to meet quality standards. It outlines the QM system's structure and framework, delineating roles and responsibilities for staff involved in executing and analysing quality measures. Key components of the QM system include risk analysis, Quality Assurance (QA), Quality Control (QC), staff training, documentation, and continuous improvement processes.

Quality Assurance (QA)

QA, an essential element of QM, aims to instil confidence that quality standards are consistently met (6,8). It involves assessing the output of each process to ensure its correctness and integrating findings from QC activities (spanning equipment, systems, and procedures). The QA process in medical imaging starts from the initial system procurement and extends to the end of its lifespan. Preparing technical specifications, which assure that procured systems meet clinical needs, is a pivotal part of QA. This extends to ensuring safety standards in room layout and design. Overall, QA encompasses the entire lifecycle of medical imaging equipment, from selection and procurement to installation, acceptance testing, commissioning, ongoing maintenance, and eventual disposal.

Quality Control (QC)

QC represents the foundational level of quality-related activities. Far from being confined to periodic equipment tests conducted by medical physicists, QC is a continual process of evaluating both equipment and personnel against established quality standards (6,8). Generally, QC involves process input evaluations to ensure accuracy and identify errors, informing subsequent corrective actions. Forms of QC include checklists, run charts, or procedural timeouts. For example, a radiographer verifying patient identification and the correct side and site before image exposure exemplifies QC in practice. Diagnostic radiology equipment QC testing guidelines are available in publications like AAPM Report No. 74 and IPEM Report No. 91.

Clinical Audit

A clinical audit systematically reviews current practices to enhance patient care quality, comparing these practices against predefined standards to identify necessary modifications (9,10). Clinical audits are most effective when structured and conducted periodically. Depending on the aspect of clinical practice under review, the frequency of audits may vary from monthly for technical parameters and image quality to annual for clinical protocols. The clinical audit could also be reactive as an investigation tool for a clinical issue raised. The audit team should determine the audit's frequency, methodology, objectives, and standards in consultation with the quality review committee.

The clinical audit process in medical imaging is extensive, encompassing every stage of the imaging workflow and patient pathway. Auditable areas range from the appropriateness of clinical requests, imaging protocols, and patient preparation to technical factors, procedural techniques, image quality, processing, radiology reports, and post-care. The specific focus of each audit depends on its objectives. For instance, if the goal is to enhance patient safety during radiography examinations, audits might include patient identification methods, radiographer reject analysis, radiation protection, and infection control measures. To ensure the clinical audit's effectiveness, several critical factors must be addressed:

- **Setting Clear Objectives** Audits should be driven by a desire for enhancement, not just adherence to standards, fostering a culture of continual reflection and improvement.
- **Identifying Quality Standards** The audit should be benchmarked against well-defined quality standards or established organisational guidelines, which can help focus the audit and facilitate a deeper understanding of underlying issues, thereby aiding in the development of corrective action plans.
- **Interprofessional Collaboration** Involving a diverse team in the audit process is crucial. A well-rounded audit team would include medical physicists providing physics input, radiologists offering interpretative insights, physicians overseeing patient management from a pathological perspective, and radiographers contributing imaging/technical expertise.

Beyond Establishing a QM system

Once a Quality Management (QM) system is in place in a department, it's crucial to look beyond the status quo and continually evaluate all processes for potential quality gaps. Reflecting on current practices in Quality Assurance (QA), Quality Control (QC), and clinical audits, especially in the context of Singapore, is vital for ongoing improvement. The following considerations and questions can guide this reflective process: What are the recognised best practices in the field? Is there a practice of sharing findings with peers to work towards national standards? Are QA, QC, and audit data managed in compliance with data security policies? Can artificial intelligence or computer applications be used to enhance quality measurement and analysis?

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Typical General Radiography QMS

GENERAL RADIOGRAPHY

QUALITY MANAGEMENT

- Establish quality policies, objectives, and processes to achieve these quality objectives
- Complies with HCSA, AHPC, WSH, ISO standards and other legislative requirements
- Monitor staff training and competency
- Conducts risk assessment (e.g. equipment, workplace safety etc)

QUALITY ASSURANCE

- **Clinical protocol review:** Done annually to ensure the relevance and appropriateness of current protocols, aligning them with the latest research evidence.
- **Image quality audit**
- **Radiographer reject analysis** - monitoring reject rates as recommended by AAPM task groups 151 and 305
- **Exposure analysis -** Regular review of DAP and EI values, possibly via SQL queries to extract data from PACS DICOM tags, helps identify dose outliers and ensures that the representative doses do not deviate significantly from accepted DRLs.

CLINICAL AUDIT

- **Image quality audit** - Retrospective peer or designated auditor reviews of randomly selected cases based on agreed standards such as exposure parameters and positioning can effectively assess individual radiographers' competence.
- **Radiography practice audit** - Prospective audits through physical observation with timely feedback for practice improvement in areas such as placement of lead anatomical marker, patient positioning, placement of orthopaedic calibration marker, patient breathing instructions during chest radiography, exposure parameter setting, radiation safety and protection, etc.

QUALITY CONTROL

- **Detector uniformity** - To assess the degree and source of artefacts observed in digital radiography images and to confirm that the image is homogeneous.
- **AEC consistency** - To assess if the AEC deliver consistent, reproducible exposures across a wide range of tube potentials. The recorded EI and mAs values should be within ±30% of the baseline values and within ±20% of the mean values.
- **Mechanical inspection of imaging equipment** - To ensure that there are no hazardous, inoperative, out of alignment or improperly operating units.
- **Beam alignment and entering** - To assess the coincidence and alignment of the collimated light field with the X-ray field, as well as the coincidence of the crosshairs of the collimated light beam with the centre of the X-ray beam.
- **Routine inspection of Image display** - To confirm that the image displays reproduce all of the grey scale information in the image accurately.
- **Lead apron test** - Examined under X-ray to check for defects such as holes, cracks, and tears.

Conducting and Sustaining Clinical Audit in MRI

Li Kam Hung, Nurhazwani Bte Roslan, Wang Hsiang-Ya
MRI Team, Singapore General Hospital

Achieving excellence and precision is crucial in healthcare, as each decision directly impacts patient care. The provided service has to be impeccable, as the result could potentially change the course of a patient's treatment. Audit and quality assurance checks are essential to safe practices and service delivery. These checks assess adherence to protocols, image quality, patient safety and overall effectiveness of MRI procedures. The goal is to identify areas for improvement and ensure that service meets established standards, contributing to enhanced patient care and outcomes.

The SGH Radiography Department, MRI Clinical audit can be broadly categorised into the following domains:

1. Staff Training and Competence
2. Protocol Adherence and Image Quality
3. MRI Safety
4. Equipment Performance
5. Infection Control

1. Staff Training and Competence

MRI radiographers must undergo at least two months of training. Their progress and learning curve are recorded in the 'Training Booklet' throughout the period. To assess their competencies and confidence, they must perform various cases independently before being certified as competent. Their performance and training books are reviewed and audited by their trainer and the MRI modality leader.

2. Protocol Adherence and Image Quality

The other component that we keep in check is the performance of our radiographers. This is reviewed through:

- Directly Observed Procedure Skills (DOPS)
- Yearly competency assessment
- Yearly MRI safety training and quiz
- Continuous Professional Education (CPE)

a. Directly Observed Procedure Skills (DOPS)

SGH MRI radiographers undergo yearly audits via direct observation of performance (DOPS). DOPS offers a real-time assessment of radiographers' performance during actual patient interactions and imaging procedures, accurately representing their skills and practices in clinical settings. Importantly, DOPS allows for assessing the human aspect of care (radiographers' behaviours, communication skills, and patient interactions) and non-technical skills, such as teamwork and situational awareness, which may not be fully captured through other audit methods. Crucial steps that would be heavily scrutinised are their execution to ensure patient safety, such as identifying the correct patient, confirming the correct site and side, checking for any MRI contraindication, getting gadolinium administration approval for contrast-enhanced cases and lastly, ensuring safe patient transfer.

b. Yearly competency assessment

SGH MRI radiographers must submit three cases from each subspecialty (body, neuro and musculoskeletal) performed independently to their assessor. The assessors will evaluate their ability to acquire images based on the established standards.

c. Yearly MRI safety training and quiz

d. Continuous Professional Education (CPE)

SGH MRI radiographers are encouraged to attend weekly CPE to broaden their knowledge and keep abreast of the latest developments in Radiography. The knowledge acquired during the sharing from other modalities is often applicable to MRI practices. In particular, topics related to clinical diagnosis and its imaging techniques, as well as the treatment plan and outcome. Attendance is monitored each year.

3. MRI Safety

MRI safety is of paramount importance due to its unique imaging technology. Measures are placed to protect both patients and healthcare professionals from potential hazards associated with the strong inherent magnetic fields used. MRI safety training empowers radiographers with the knowledge to identify and mitigate potential risks associated with the strong magnetic field and radiofrequency. It ensures the radiographers can screen patients for contraindications effectively and enables us to safely handle patients with MRI conditional implantations. Apart from using robust pictorial screening questionnaires we developed, the radiographers are trained to utilise equipment such as metal detectors to enhance safety in our MRI practices. Strict adherence to safety protocols and continual education contribute to a safe and effective MRI environment. MRI colleagues undergo yearly refresher MRI safety training.

4. Equipment Performance

In SGH, we take equipment performance audits very seriously to 'guarantee' optimum equipment performance and uptime. Hardware audits are performed via regular quality assurance (QA) checks, with the frequency of checks varying among different equipment. These checks are extended to ancillary equipment, such as MRI conditional physiological monitoring systems, ventilators, and infusion pumps used to care for patients during an MRI procedure.

Helium is a coolant in MRI scanners, and stable levels are necessary to maintain a homogenous magnetic field strength for consistent image quality. Daily MRI scanner QA checks to detect a gradual decrease in helium levels allow for timely intervention and prevent unexpected drops in helium levels, which could lead to quenching. To further mitigate challenges associated with helium, the SGH MRI team has been proactively sourcing alternative technology that uses no or less helium, such as 'helium-less' MRI equipment. Besides eliminating issues related to helium boil-off, this also addresses the worldwide challenges of diminishing helium gas supply.

Quenching: an uncontrolled release of helium that potentially damages the magnet.

Our MRI equipment performance records are reviewed regularly by the clinical audit team to identify missing records, and fault reports will be escalated to the appropriate stakeholders, such as BME, for further intervention. Such audits are important as they ensure the MRI machines are functioning well enough to handle the day's workload and ensure the safe scanning of our patients. It also helps to identify potentially significant issues in our machines if the frequency of faults is abnormally high based on the record.

5. Infection Control

Finally, we also place immense importance on infection control and hygiene. We have established a communication strategy to remind all staff of the importance of infection prevention and control to ensure our patients and staff's health and safety. We appointed Infection Prevention and Control Liaison Officers to actively conduct regular surveillance and enforce compliance with the infection prevention and control guidelines.

Our MRI colleagues are required to complete an annual Hand Hygiene Competency to ensure that they are reminded of the "Dos and Don'ts" when handling patients during an MRI examination. The annual Hand Hygiene Competency is implemented for all hospital staff within Singapore General Hospital (SGH) by the Infection Prevention & Epidemiology (IPE) Department. Any updates on hand hygiene will be promptly updated by the IPE, and the Infection and Prevention Liaison Officers (IPLOs) within the MRI modality will be responsible for updating MRI colleagues accordingly.

In conclusion, clinical audits in MRI play a pivotal role in maintaining quality, safety, and efficiency in healthcare delivery. It serves as a tool for continuous improvement, risk mitigation and ensuring that MRI services align with the best practices and standards in the field. It not only advocates a safer workplace but also allows us to monitor the efficacy of new measures and eliminate superfluous practices to streamline our workflow. As Canadian actor John Novak once said, "In the beginning, internal audits identify opportunities for improvement; at the end, internal audits provide a mechanism for monitoring the implemented improvement in order to sustain its benefits for the long term."

Embracing Clinical Audits

By: Teo Si Min
Principal Radiographer, Singapore General Hospital

Amid your clinical work, you received a simple text message from a peer auditor at your workplace, requesting you to review a case when you have time to spare. Your heart skips a beat as you rush to find the nearest computer at the immediate opportunity. Based on experience, a call like this almost always spells bad news. *What was that case about? What could have gone wrong?*

In another setting, you are attending a regular ultrasound discrepancy round. Although the patient and performing radiographer's details have been omitted, you cannot help but wonder if you had performed any of the cases. When you are called to answer a question during the session, you subconsciously take it as a hint from the presenter that the discrepancy belongs to you.

Clinical audits involve uncovering discrepancies and potential shortcomings in our work. To some, this sometimes evokes a feeling of apprehension. As the ultrasound audit lead, I aim to change this perception because I genuinely believe that clinical audits should be seen as an opportunity for growth rather than one that fosters fear. By embracing the audit processes through the various initiatives introduced for the team, we can take ownership of our work, identify knowledge gaps, and actively contribute to better patient care.

Quarterly Audit Rounds – Fostering Zero-Blame Transparency

Initiated by our ultrasound director, Dr Nanda Kumar, an audit round is conducted every quarterly. Cases rich in learning opportunities are consistently collected through various channels. These include contributions from the ultrasound team, radiologists, clinical audits and clinical rounds conducted by radiologists for clinicians. They are then categorised into specific themes that include (but are not limited to) artifacts, correlation, technique and interpretation errors. Cases may also be themed according to the type of pathologies or the organ involved.

In this zero-blame environment, the radiographers' anonymity is maintained, and auditors concentrate on identifying gaps in knowledge and technique rather than focusing on the individual. We hold in-depth discussions and analysis for up to five discrepancy cases for every session. This zero-blame platform has created a safe space for open dialogue, where our team can candidly discuss cases without fear of judgment.

The success of these audit rounds can be seen from the many snippets of learning points that arose, which led to a continuous improvement cycle in ultrasound practice. These sessions taught us about scanning pitfalls and potential causes of errors, and we eventually generated ideas to overcome those challenges. Some of this knowledge was beyond what textbooks and journals could provide. Instead of finding ways to justify an inevitable mistake, we choose to take a pragmatic approach by focusing on methods to mitigate, if not avoid, the same errors from occurring.

Through this process, we normalise making mistakes and learn from them as part of our journey to improve. When viewed through the lens of learning, errors can inspire and drive progress. As a team, we understand how valuable these sessions are, as without this platform, such learning opportunities would be far more elusive.

Peer Audit - The Strength of Team Collaboration

Peer audit requires auditors to dedicate an hour each day. Regardless, peer reviewers like myself see this as a positive contribution towards maintaining scanning quality, patient care, and safety. Each week, we will audit one case performed by every radiographer in the team using the same set of agreed criteria and guidelines. The audit results are then uploaded and accessible by the entire team. In the event that a potential mistake is detected during the audit, the peer auditor will first discuss it with either the audit lead or clinical lead for consensus before contacting the radiographer. Auditors are also rotated weekly, as this would help the team gain different perspectives.

"...errors can inspire and drive progress"

Factors such as patient condition or challenging scan settings may lead to suboptimal images, varying interpretations and, at times, discrepancies. Auditors may indicate scan setting, patient condition and difficulty level for each case audited to "account for" image quality that is below acceptable standards. However, this approach was not taken because it would give the wrong impression that the intent of peer audit is to give our radiographers a grade for their performance, and over time, it may cause a shift in focus from encouraging improvement to fostering competition. Our peer auditors are not judges but partners in our pursuit of quality patient care.

To date, peer audits have generated positive outcomes such as a reduction in the number of images that mimic pathologies or unwanted artefacts and significant enhancements in report writing. A fringe benefit of peer auditing is fostering shared responsibility and collaborative learning when we communicate feedback and suggestions amongst team members. Peer audit has also made it possible for the ultrasound leads to keep track of and be familiar with the team's performance and progress.

Weekly Self-Audit – Empowering Personal Growth

Weekly self-audit is a reflective practice in which junior radiographers assess their work and identify areas where they excel and where knowledge gaps exist. Every week, each junior will select two of their own cases to audit. A small team of seniors will review these self-audit responses and offer constructive feedback. Besides technical competence, the following factors are evaluated:

- fulfilment of clinical concerns
- application of critical thinking skills
- learning points from the case (where applicable).

Self-audit is a collaborative approach that empowers our juniors to take ownership of their professional growth while being guided by a senior team member. It helps them refine their diagnostic skills through introspection and self-directed learning. This educational process of self-audit offers junior staff more awareness of their clinical practice, leading to practice improvements.

Audit Spotlight - Sharing Bite-Size Knowledge Every Month

In our journey of continuous improvement, our focus tends to naturally gravitate toward junior team members who are in the early stages of their careers. Audit Spotlight serves as an avenue to ensure that learning and knowledge sharing are not confined to a specific experience level.

We present a single, concise learning point from our clinical audits each month. These may include best practices to celebrate achievements or mistakes to help the team identify pitfalls and ways to avoid similar errors in future. It is presented in an interactive manner where team members are requested to provide their ideas or insights at the beginning of the week based on snippet information from the selected case. These responses are submitted online and may be shared in the form of word cloud, polls or open-ended free text. Full case details, including learning points, will be provided at the end of the week. The aim is to provide valuable insights in a bite-size format that can be quickly absorbed and applied. It makes learning and re-learning easy for everyone, from the most junior to the most experienced.

Take, for instance, this month. Our Audit Spotlight featured a case done right, where our radiographer detected a focal round structure in the peri-splenic region. With careful correlation to images from a prior CT procedure, she realised that the finding corresponded to part of the normal pancreatic tail. Provided with a background of the audited study, the team was asked to provide their perspective. The intention was to encourage them to look deeper into the case and reflect. The responses were then collated and shared with the entire team. We also benefitted from having input from our ultrasound director and medical residents on ultrasound rotation. Through this case, the team was reminded that whenever a focal structure is found near the spleen, we should not immediately presume that it is a splenunculus or a pancreatic tail lesion and should correlate to cross-sectional imaging if available. We also learned from radiologists' input that benign congenital variants such as bifid pancreatic tail could cause confusion on ultrasound and that CT arterial phase and T1W sequence of MRI are good starting points for a quick assessment of the pancreas.

Expanding the Reach - Sharing Knowledge Beyond Our Team

Our current audit processes not only support internal learning and improvement but also benefit medical residents who are in the process of refining their skills. Specifically, medical residents are encouraged to participate in preparing and presenting for audit rounds. This hands-on involvement allows them to gain practical experience and receive feedback from various levels that enhance their practice. By presenting audit cases to radiographers from various institutions through conferences, we hope our experiences may also inspire them to implement similar practices in their respective institutions.

Conclusion

The true measure of a team's dedication toward excellence is not the absence of errors but the commitment to learn from them, embrace the lessons, and improve continuously. By making audits a standard part of our work process, we also improve patient care and outcomes.

Acknowledgement

A special acknowledgement goes to the Ultrasound Director, Dr Nanda Kumar, whose proactive encouragement was pivotal in initiating various impactful audit-related projects.

The administrative support and constant presence of my Manager, Ms Soh Qinhui, have been the cornerstone of our current achievements. Without her support and understanding, we would not have the resources to ensure seamless and sustainable audit processes. The unwavering support and consistent involvement from Ms Kho Ying Ying and Ms Ma Voon Chee (Clinical Leads), Ms Denise Lau (Education Lead), as well as Ms Helen Wong (Audit Deputy) have significantly contributed to the success of the various projects.

Lastly, I want to take a moment to express my heartfelt appreciation to our dedicated ultrasound team. Your active participation and willingness to contribute cases have been instrumental in making our audit programme possible.

Artificial Intelligence (AI) in facilitating radiology quality assurance

By: Harris Abdul Razak
Senior Radiographer, National University Hospital

The application of AI within clinical radiology is not a recent phenomenon. Earlier forms of AI application in clinical radiology, such as computerized aided diagnosis (CAD) systems, aid only in detecting abnormalities. Numerous AI applications exist within the radiology context to assist in scheduling, patient screening, and operational analytics, apart from providing a preliminary interpretation of findings. Choy et al. (2018) classify them under two categories: (1) Upstream AI for those related to operational workflows like scheduling and analytics; (2) Downstream AI for those related to using the Downstream AI for those related to using the acquired imaging data like the automated interpretation of findings and image post-processing.

The most overlooked aspect of AI usage in clinical radiology is in quality assurance (QA), where planned and systematic actions are taken to provide adequate confidence that a system performs satisfactorily. The World Health Organization considers radiology QA programs crucial to providing high-quality health care as such programs improve diagnostic information content, reduce exposure, reduce medical costs, and improve departmental management (WHO, 1982).

All imaging departments are expected to establish and maintain an effective QA program. Still, QA programs are partially or seldom implemented. The most commonly cited reasons were the lack of trained professional staff to implement the complex process (Surić Mihić et al., 2008; Willemse et al., 2019; Abdulkadir, 2020), the lack of reliable technology (Strickland, 2015), lack of time (Kaewlai & Abujudeh, 2012; Willemse et al., 2019).

Wismüller, Stockmaster, and Vosoughi (2022) proposed a novel human-hybrid human-machine solution using an AI software that compares AI-based interpretation (using a third-party solution) of acquired images and the radiologist report using natural language processing (NLP). Their solution, Artificial Intelligence (AI)-Based Quality Assurance by Restricted Investigation of Unequal Scores (AQUARIUS), was designed to detect Intracranial Hemorrhage (ICH) in emergency care head Computed Tomography (CT) scans. The discordant study is then re-analyzed by an experienced neuroradiologist. Leaning on the works of Wismüller et al. (2022), this article will guide readers on the possible use of AI as a solution in radiology QA and briefly discuss its risks and ethical concerns.

PROBLEM STATEMENT

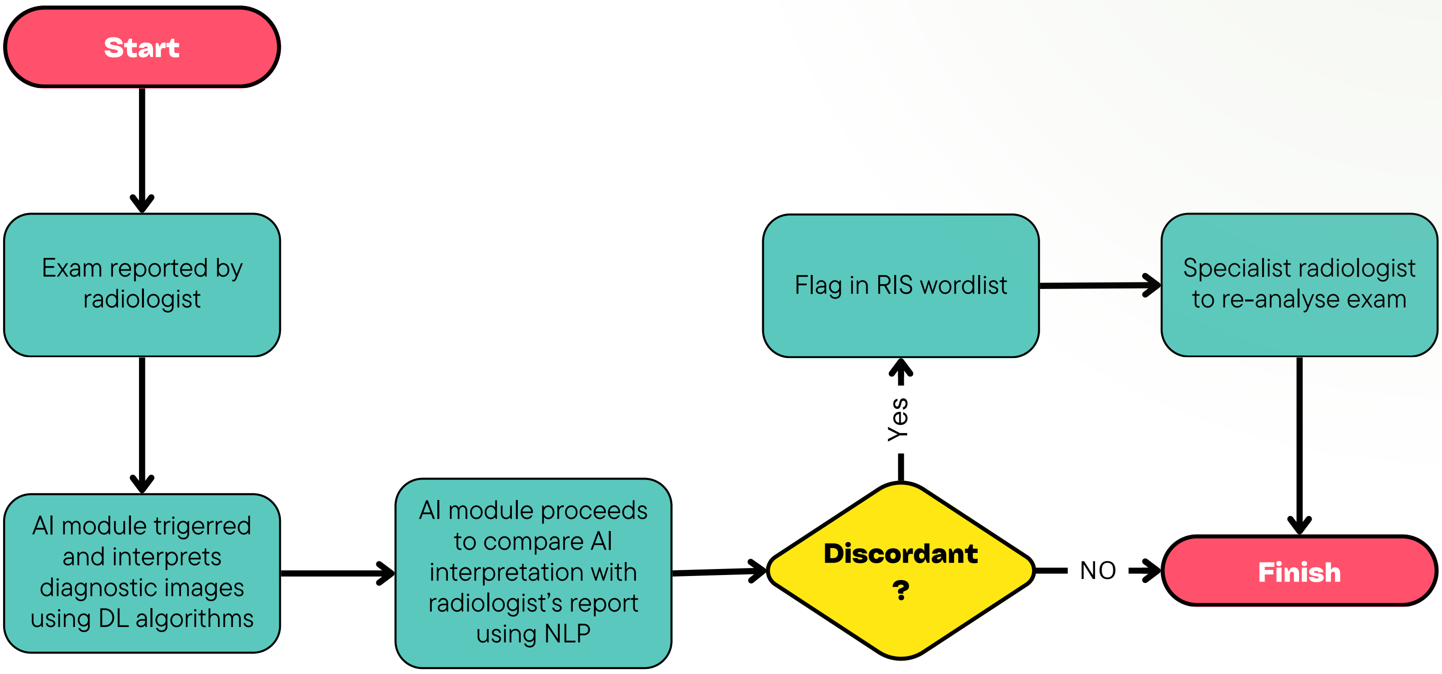
Peer review of reported imaging studies has been considered essential in a radiology department QA program. This necessitates that an independent radiologist reviews the findings of a previously interpreted study and rates it based on the degree of disagreement. Despite this, commitment to continuous peer review is limited due to the shortage of radiologists and high workload (Kaewlai & Abujudeh, 2012; Wismüller et al., 2022).

PROPOSAL

Adoption of AI in radiology peer-review: (1) AI module interprets acquired images and compares them with the radiologist-written report. (2) AI module will automatically flag discordant findings for review by an experienced radiologist.

VALUE PROPOSITION

Introducing AI in the peer-review process can significantly scale up the number of audited exams and reduce the need for human intervention in pre-selecting examinations for review that sometimes may be subjected to human nature, systemic, and statistical bias (Kaewlai & Abujudeh, 2012). Traditionally, peer review in radiology QA only systematically audits 5% of the radiology reports (RCR, 2014). With the AI-first peer review, more exams can be sampled for review, and since the imaging enterprise triggers it, there is no human bias regarding case selection. The obvious benefit will be the reduced manpower needed to review the reported exams. Furthermore, having the AI-first peer review will efficiently identify missed findings in radiology reports and expedite radiology QA programs.



MECHANISM

Immediately after an exam has been reported, an AI module within the imaging enterprise will be triggered automatically query-retrieve the diagnostic images stored in the Picture Archival and Communication Systems (PACS) and provide an AI interpretation using deep-learning algorithms. The AI module will then compare the AI-generated report against the radiologist's report using NLP. Discordant findings will result in the exam being flagged within the Radiology Information System (RIS) worklist of the specialist radiologist for further review. The process is outlined in Figure 1.

POTENTIAL RISKS

There is a general challenge in translating AI systems in healthcare from their proof-of-concept (POC). The abundance of exploratory studies on AI but very clinically validated products also indicates the gap in AI translation in clinical use (Mudgal & Das, 2020). Even though the hype surrounding AI began in 2010, there are currently 190 FDA-approved radiology AI-based applications. Forty-two of these are related to thoracic radiology for the detection and analysis of pulmonary nodules, monitoring placement of endotracheal tubes and indwelling catheters, for detection of emergent findings, and for assessment of pulmonary parenchyma (Milam & Koo, 2023). Hence, a risk is that this proposal will take a considerable time to progress from conception to validation.

The other problem with AI is the model's explainability and transparency. According to Quinn et al. (2022), due to the millions of parameters of the deep neural networks (DNN) and multiple layers that lead to its decision process, DL algorithms operate in a "black box." This means that it is impossible to obtain an audit trail for how a conclusion of a discordant finding is reached because of its convolutional nature (Smith & Bean, 2019). Also, as the selection of exams is performed by the AI embedded within the imaging enterprise, it would be hard to manage how peer-reviewed exams are selected.

ETHICAL CONCERNS

Naik et al. (2022) expressed that AI presents several major ethical concerns, mainly when it is applied in healthcare: (1) data privacy, (2) informed consent to use data, (3) algorithmic bias, and transparency. As elaborated earlier, DL has issues with transparency in decision-making. The medical black box is a risk and an ethical concern in the medical field because it impacts patients. For AI to benefit societies and support the social as well as the common good under the principle of beneficence, the development of AI systems that are transparent, explainable, and free from bias is paramount.

Principally, patients should be aware of the potential use of their data in aggregating data sets for DL algorithms, as the learning process draws from many entities, relationships, and clusters. Also, if their data is going to be accessed or shared for the purpose of building AI models. Enough information should allow patients to decide the consequences of opting in and out in line with the General Data Protection Regulation (GDPR) guidelines.

FUTURE ADVANCES IN TECHNOLOGY TO MAKE IT APPEALING

Presently, AI modules have to be manually activated by the user and are not fully integrated into the existing imaging enterprise. This means that the radiologist needs additional steps to enable the AI module. Also, current AI-based software is not yet optimised with a library of algorithms that could diagnose all abnormalities. Most algorithms were specific to thoracic radiology. AI should be implemented without significant changes to the routine and workflow practices of the end users. As such, this feature should be able to run asynchronously without any user intervention and be integrated with algorithms that are optimised to diagnose based on a wide range of radiological features.

The medical black box is a risk and is a source of bias in decision-making. A safe AI system must be transparent in arriving at a decision and allow for a "human-in-the-loop" to improve patient safety and gain the patient's trust. Human-in-the-loop is a set of strategies that combines human and machine intelligence in applications that use AI to increase the accuracy of the AI model (Monarch & Manning, 2021). Also, explainable AI (XAI) techniques are being developed to make the AI model interpretable and transparent to clinical users. For instance, Rajpurkar et al. (2020) noted that XAI had improved the diagnostic accuracy of 10 out of the 13 participating physicians by providing a visual explanation of tuberculosis in the assessment of chest X-rays than those without XAI. These breakthroughs in AI developments assure that AI systems can be trusted for use in healthcare.

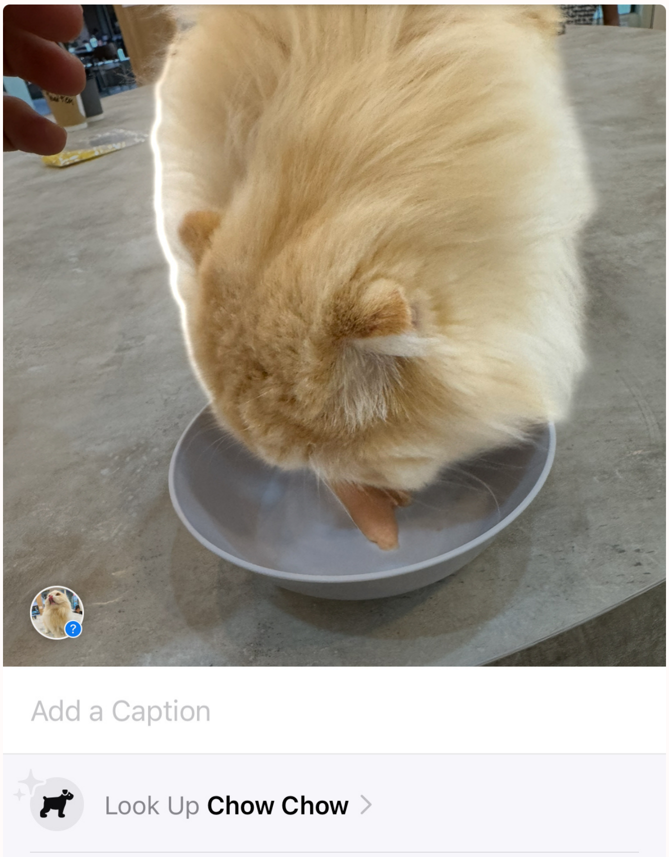
CONCLUSION

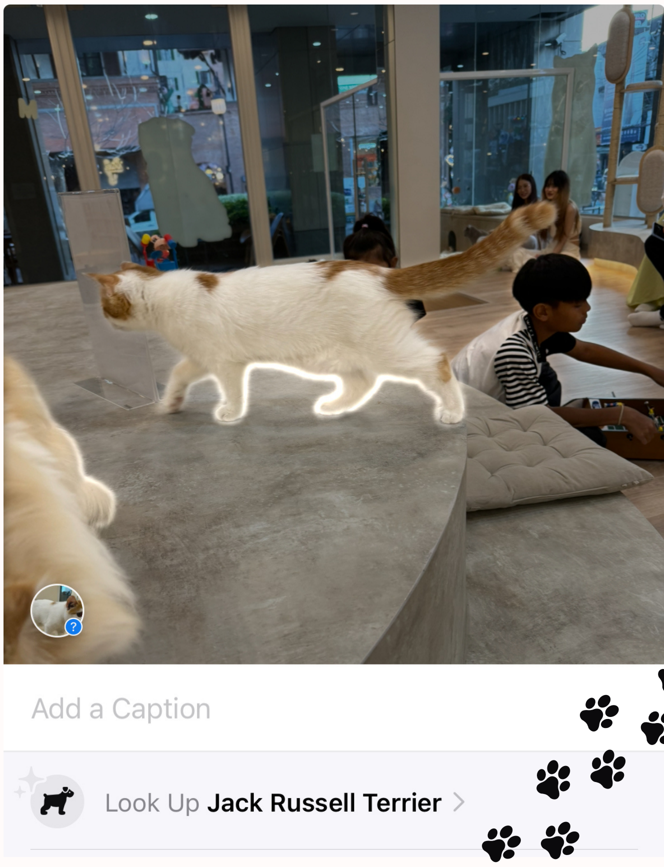
This article demonstrated a possible application of AI to a defined problem in radiology. I suggest that anyone wishing to apply AI solutions also consider the risk and ethical concerns related to AI and not be lulled by the potential value that AI could add to their workflow.

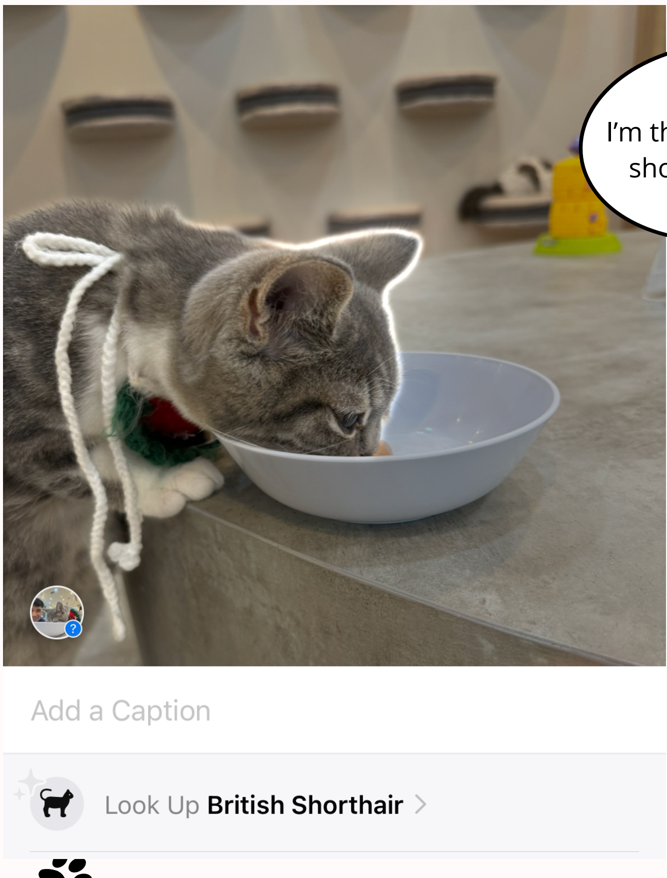
> *"A safe AI system must be transparent in arriving at a decision..."*

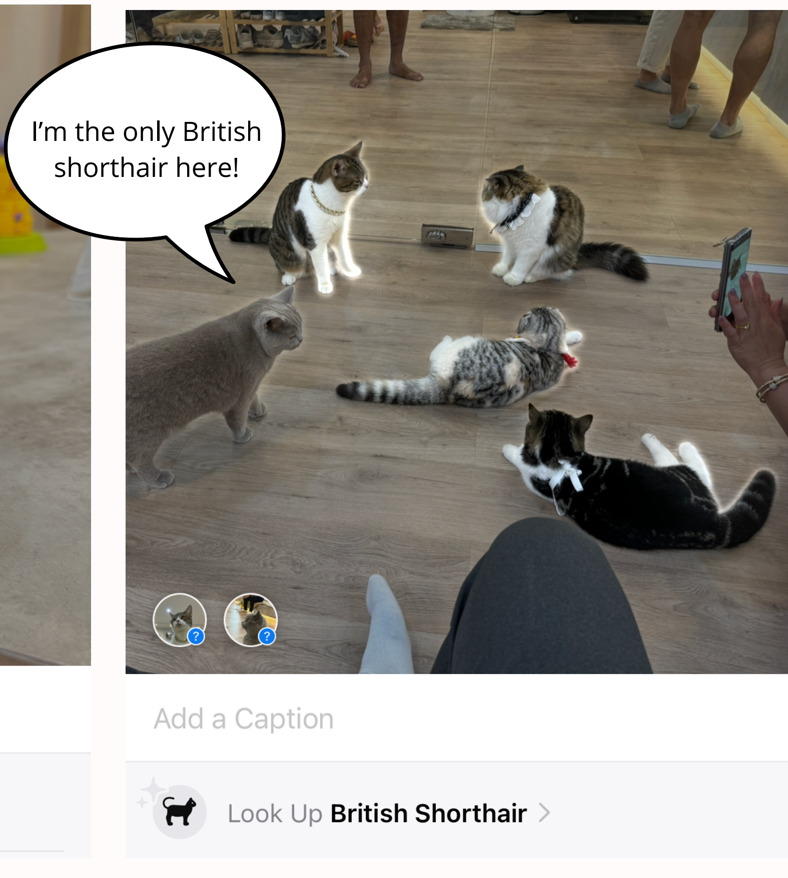
AI has failed to identify cats properly...

Below is a set of pictures taken at a Cat Cafe that was later analysed using Apple iPhone's Visual Look Up feature in the Photos app.









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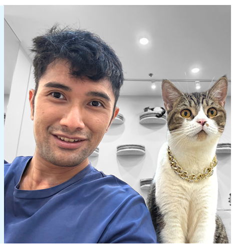
About the author

Harris works as a Senior Radiographer at NUH. Presently, he is doing a doctorate, majoring in technology. His research interests are leadership and teams, as well as health technology. He enjoys visits to cat cafes during his travels overseas.



The 4th Biennial LTWRAP conference was held in Singapore from 17-18 November 2023. LTWRAP is an international radiography and radiation therapy advanced practice conference that aims to bring together Medical Radiation Science thought leaders and Advanced Practitioners (AP) from around the world to build a community of practice and exchange ideas, knowledge, and best practices to promote advancements in our professions and to inspire our next generation. SSR is proud to support the LTWRAP conference.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This seminar was led by Associate Professor Jonathan McNulty, from the School of Medicine at University College Dublin, Ireland, and Editor in Chief of Radiography, the top-ranked journal for our profession. The seminar was well-attended by SSR members and LTWRAP 2023 delegates and those who were currently contemplating a research paper for publication, preparing a paper for submission, considering becoming a peer reviewer for a journal, wishing to improve the reviews they provide, generally interested in scientific writing, or interested in discussing the importance for our profession of scientific writing and engaging with the published literature. The seminar provided top tips for clinical, academic, and research radiographers of all levels who would like to publish and review for esteemed journals including Radiography. There were also contributions by notable international radiographers during the discussions.

International invited guest panel:

Associate Professor Mohamed Abuzaid, Associate Professor of Diagnostic Imaging and Medical Radiation Science at the University of Sharjah (UAE).
Associate Professor Shane Foley, Head of Subject for Radiography and Associate Dean, School of Medicine, University College Dublin.
Dr Rachel Harris, the Head of Professional Practice and Education, Society and College of Radiographers (UK)
Professor Beverly Snaith, Clinical Professor of Radiography, University of Bradford / Consultant Radiographer, Mid Yorkshire Hospitals NHS Trust (UK)
Dr Yat Tsang, Director of Radiation Therapy - Radiation Medicine Programme at Princess Margaret Cancer Centre UHN (Canada)
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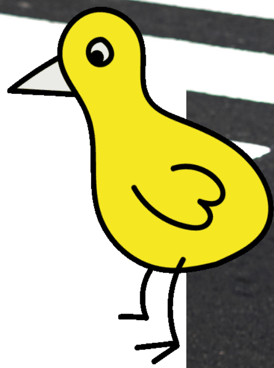

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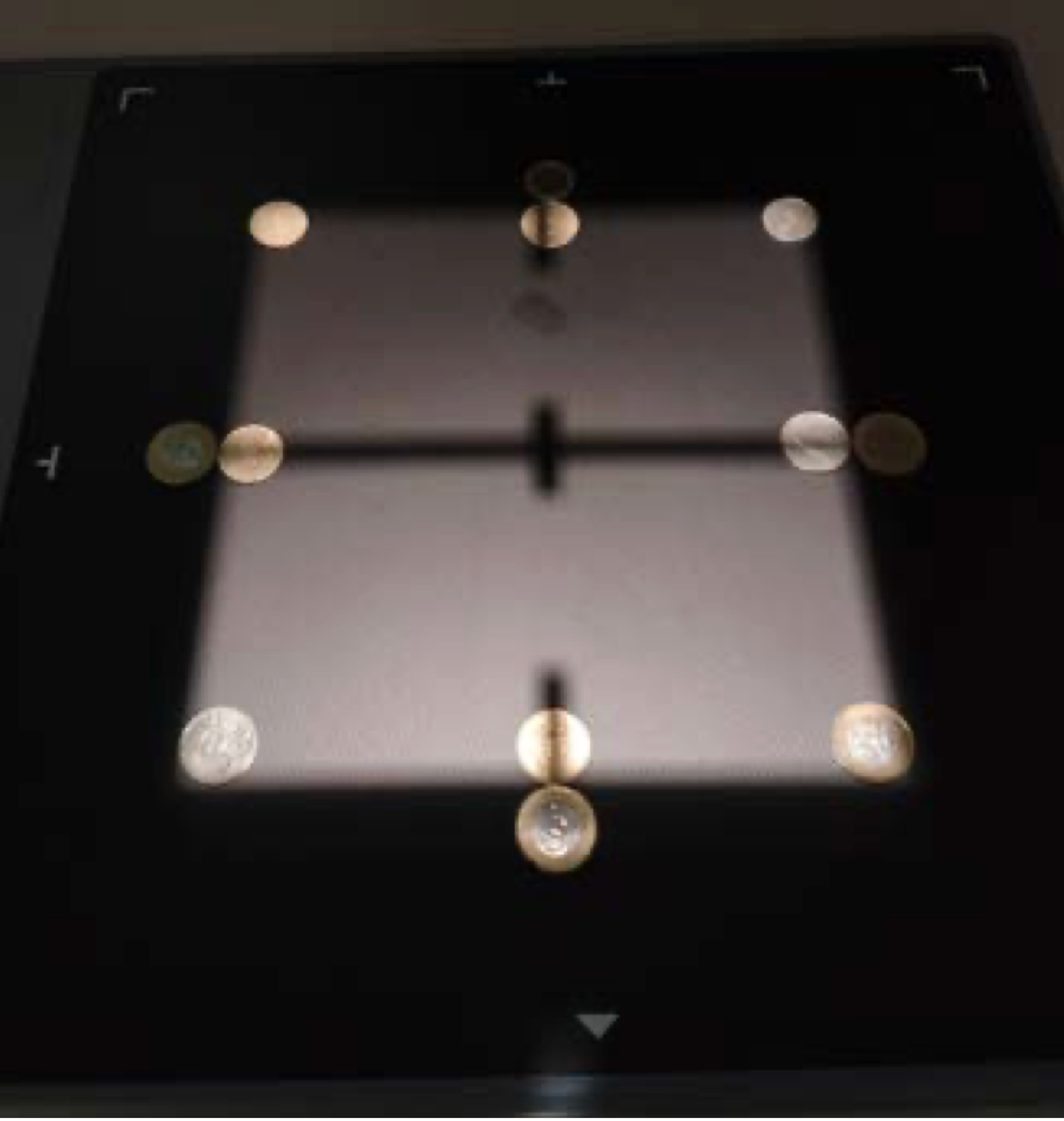
- Answers and winners on IG and FB

Across

3. Mechanical inspection of imaging _ is performed to ensure that there are no hazardous, inoperative, out-of-alignment or improperly operating units.
4. Auditing is an independent and objective review, analysis and evaluation of processes, not a _ exercise.
7. The quality management system is a _ requirement under the Healthcare Services Act (HCSA).
8. Quality _ is a reactive process of evaluating quality.

Down

1. Audit can be a positive tool to drive continuous _.
2. _ is a form of verification activity, such as inspection or examination of a process to ensure compliance with quality system requirements.
5. Quality _ is a proactive process to ensure quality.
6. _ is an acronym for real-time assessment of competence that involves a supervisor observing a trainee conducting a procedural skill.



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