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FULL PAPER

Consensus survey on pre-procedural safety practices in radiological examinations: a multicenter study in seven Asian regions

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Objective: To understand the status of pre-procedural safety practices in radiological examinations at radiology residency training institutions in various Asian regions.
Methods: A questionnaire based on the Joint Commission International Accreditation Standards was electronically sent to 3 institutions each in 10 geographical regions across 9 Asian countries. Questions addressing 45 practices were divided into 3 categories. A five-tier scale with numerical scores was used to evaluate safety practices in each institution. Responses obtained from three institutions in the United States were used to validate the execution rate of each surveyed safety practice.
Results: The institutional response rate was 70.0% (7 Asian regions, 21 institutions). 44 practices (all those surveyed except for the application of wrist tags for identifying patients with fall risks) were validated using the US participants. Overall, the Asian participants reached a consensus on 89% of the safety practices. Comparatively, most Asian participants did not routinely perform three pre-procedural practices in the examination appropriateness topic.
Conclusion: Based on the responses from 21 participating Asian institutions, most routinely perform standard practices during radiological examinations except when it comes to examination appropriateness. This study can provide direction for safety policymakers scrutinizing and improving regional standards of care.
Advances in knowledge: This is the first multicenter survey study to elucidate pre-procedural safety practices in radiological examinations in seven Asian regions.

INTRODUCTION

According to the Institute of Medicine Committee on Quality of Health Care in America, quality care is described as safe, effective, patient-centered, timely, efficient, and equitable.[1] Among the identified components, safety is the foundation upon which all other aspects of quality care are

built.[1] Nevertheless, the increasing size and age of the population have posed greater challenges in maintaining balance between patient safety and efficiency (or timeliness).[2–4] In diagnostic radiology, overlooked safety issues have resulted in patient harm, for example, when ferromagnetic sandbags were used in MRI scanner suites, when falls occurred during X-ray examinations, and when radiation overexposure occurred during CT examinations.[5] These incidents reflect the importance of establishing and consolidating safety standards used during routine radiological procedures.

Partially attributable to disparities between developing and developed regions in the quality of their education or training programs and their economic strengths, safety standards for medical imaging vary across geographic regions of Asia.[6] The number of clinical medical physicists and support staff must be adequate to meet high standards of service.[7] At various residency training hospitals in certain Asian regions, standardized curricula in diagnostic radiology training programs remain to be developed. In addition, a longstanding problem is the lack of access to quality care because of underdeveloped infrastructures and limited resources. These factors confound objective assessments of safety practices against local standards.

Today, radiologic examinations play important roles in diagnosis, treatment monitoring, and predicting therapeutic outcomes.[8] In Asia, variations in clinical practices, radiology training, and patient volume contribute to the quality of care in radiology. The aim of this multicenter survey was to understand pre-procedural safety practices in radiological examinations in various Asian regions.

PARTICIPANTS AND METHODS

An expert in radiological safety (STQ) designed a multiple-choice questionnaire in English based on the Joint Commission International Accreditation standards.[9] After approval by the Educational Committee of the Asia-Pacific Quality and Safety (APQS) Forum on Medical Imaging in 2015, it was sent electronically to the presidents of 10 Asian radiological societies in China (Shanghai and Hong Kong), Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand. In each nation, three local residency training institutions were chosen by the local radiological society and were requested to complete the questionnaire. When fewer than three institutions in a region responded, the AQPS Educational Committee directly contacted the department heads of the non-responding institutions. If a region persisted without all three institutions responding, it was excluded from the study. As requested by the 2015 APQS Committee, questionnaires were completed by the Department Chair, Chief Radiological Technologist, and/or the Quality Safety Committee chair of each institution and was done so during a 1-year period (2016–2017).

We requested that only those institutions offering accredited radiology residency training programs be selected so that regional standards of care could be represented. Our goal was to elucidate the status of pre-procedural safety practices, and at the regional level, the safety standards were thought to be equally quantifiable when the participants were chosen by the local (regional) radiological societies. The standards of each region were measured against a common reference comprised of US participants, representing their radiology leadership in quality and patient safety in the East (Beth Israel Deaconess Medical Center), South (San Antonio Military Medical Center), and West (University of California San Francisco) regions of the country. Considering that various institutions could have a range of persons qualified to respond to our survey, we requested the most appropriate person to complete our questionnaire so that the execution rates of the questioned practices were considered correct and without variation based on job title.

Measures

The pre-procedural safety survey comprised 45 items divided into 13 safety topics under 3 major categories: General Patient Safety (11 items, 5 topics), Radiation-Related Safety (11 items, 4 topics), and Procedure- or Modality-Specific Safety (23 items, 4 topics). Each item was a multiple-choice question, and the answer set, common across all items, described completion rate ranges for the specific procedure: 0–20%, 21–40%, 41–60%, 61–80%, or 81–100% (see online Supplementary Material 1). To avoid potential biases, the meaning of each multiple-choice answer was reviewed with the participants. The answer set was chosen by a consensus reached at the APQS Forum and was based on the Joint Commission International Accreditation Standards.

Evaluation of general patient safety

First, patient and procedure correctness were evaluated based on whether two patient identifiers were used to confirm the correct patient was being imaged (simplified to "two identifiers") and whether a time-out procedure verified patient informed consent, equipment functionality and correctness of procedure, imaging side, and imaging site (simplified to "time-out"). Second, fall prevention was evaluated based on whether fall risk was appraised for each patient (simplified to "risk clarification") and if found, a special wrist tag was secured in place during examination (simplified to "identifier application"). Third, three cross-infection control practices were evaluated. Specifically assessed were whether patients with infectious or contagious diseases were highlighted (simplified to "informing"), whether protocols were established for cleaning the equipment and room after examining a patient with a contagious disease (simplified to "planning"), and whether proper hand hygiene by patient-facing staff was ensured (simplified to "execution"). Fourth, medication safety was evaluated based on whether policies were developed for identifying, locating, labeling, and storing high-alert medications (simplified to "guidelines") and whether patient medication records and health conditions were checked prior to prescribing, thus avoiding incurred allergies, cross-reactivities, and toxicities (simplified to "record check"). Finally, communication effectiveness was evaluated. Specifically assessed were whether request documents sufficiently described the necessity for the examination and allowed proper performance and interpretation of the study (simplified to 'sufficient information') and whether the system for informing the referring clinician of critical or unexpected but clinically important findings was maintained (simplified to "high risk report").

Evaluation of radiation-related safety

First, examination appropriateness was evaluated based on whether the clinical indication was appropriate (simplified to "clinical indication"), whether modalities without ionizing radiation (ultrasound or MRI) were considered (simplified to "alternative modalities"), and whether the study was verified not to be duplicative or unnecessary (simplified to "duplicate avoidance"). Second, dose optimization was evaluated based on whether the equipment was in good working order through regular servicing and maintenance (simplified to "maintenance assurance") and whether correct protocols were ensured in study planning (simplified to "protocol assurance"). It was also evaluated based on whether errors were minimized to avoid repeat scans and potentially additional radiation (simplified to "error reduction") and whether only properly trained personnel were allowed to handle the equipment (simplified to "trained personnel"). Third, pregnancy exclusion was evaluated based on whether the policies for identifying pregnant patients prior to imaging with ionizing radiation were followed (simplified to "identifying pregnant patients"). Finally, radiation surveillance was evaluated based on whether appropriate protective equipment/shielding was used (simplified to "radiation protection"), whether radiation exposure of healthcare workers was monitored (simplified to "exposure monitor"), and whether dose readings (*e.g.* the dose of a CT examination) were available (simplified to "dose reading").

Evaluation of procedure- or modality-specific safety issues

First, CT-specific pre-procedural safety was evaluated based on whether policies and protocols for pre-medication strategies and intravenous administration of contrast were developed (simplified to "medication and contrast policies"), whether appropriate history checks and pre-procedural screenings were performed (simplified to "pre-procedural screening"), and whether medication histories and laboratory results were reviewed prior to administering contrast (simplified to "review of medication history prior to contrast administration"). It was also evaluated based on whether adequate venous access was confirmed prior to contrast injection to avoid contrast extravasation (simplified to "venous access assurance"), whether adverse reactions were responded to promptly with well-trained staff that followed established departmental protocols (simplified to "adverse event handling"), and whether clinically significant reactions and their treatments were documented in radiology reports and/or patient medical records. Second, the pre-procedural safety of intervention procedures was evaluated based on whether informed consent for the examination was obtained and documented and the coagulation profile was corrected if abnormal (simplified to "correction of coagulation profile") and whether professional sedation was performed using patient selection for sedation, pre-sedation assessment, and selection of sedation drugs (simplified to "sedation security"). Third, MRI-specific pre-procedural safety was evaluated based on whether patients with ferromagnetic devices or objects were restricted from MRI suites, contraindications to MRI were scrutinized, MRI screening forms were completed by patients and reviewed prior to their entry into the restricted area, and patients were provided with detailed information about MR procedures, schedules, and safety concerns (simplified to "patient information"). It was also evaluated based on whether contraindications to the examination were brought to the attention of the MRI radiologist in charge of the study (simplified to "attention to contraindications"). Finally, the pre-procedural safety of nuclear medicine was evaluated based on whether radiation exposure to personnel was minimized throughout the preparation steps (simplified to "minimizing radiation exposure") and whether radiopharmaceuticals were prepared according to manufacturer's package inserts and quality control testing was performed, particularly for radiopharmaceutical purity (simplified to "quality control for purity"). It was also evaluated based on whether the quantities/doses of radiopharmaceuticals were assayed before administration (simplified to "analyzing doses of radiopharmaceuticals") and whether shielded containers and syringe shields were used in their transport and administration. It was further evaluated based on whether the identities of the radiopharmaceutical, patient, route of administration, and the pregnancy and breastfeeding status of the patient were verified prior to administration of a radiopharmaceutical and whether aseptic handling procedures were used in preparing, administering, and handling radiopharmaceuticals intended to be sterile.

Statistical analysis

The standards for each pre-procedural safety practice (one per item) were estimated using execution rates, which were linearly converted into numerical evaluation scores, then those numerical statistics were used to find the median score and interquartile range (IQR) for each item. The applicability and feasibility of each safety practice was verified when at least two of the three US participants exhibited the highest level (81%–100%) of execution. The level of discrepancy in any one score was described as low (IQR $\leqq$ 0.5), middle (1.0 $\leqq$ IQR $<$ 2.0), or high (IQR $\geqq$ 2.0) for the purposes of discussion. A satisfactory rating across all Asian participants was defined as five or more regions (at least 75% of the seven Asian regions) exhibiting the highest execution rate (81%–100%) for a given practice at two or more institutions. When a practice was executed at the highest level at all participating Asian institutions, statistics were omitted, and descriptive results alone were used.

RESULTS

The overall response rate was 70.0% (Hong Kong, Japan, Malaysia, Shanghai, Singapore, South Korea and Taiwan; n = 21). Lower response rates were associated with lower economic development levels in the regions invited. Of the 45 items, "wrist tags" was the only practice that did not pass verification among the US participants.

Nine (39%) items in the Procedure- and Modality-Specific category were executed at the highest rate in all Asian institutions. Two highly executed CT-specific practices were "adverse event management" and "case log," and one interventional procedure was "patient consent." Among practices specific to MRI, two highly executed practices were "contraindication screening" and "form reviewing," and among practices specific to nuclear medicine, four were found: "radiopharmaceutical preparation," "radiopharmaceutical shielding," "patient safety assurance," and "aseptic processing."

Table 1. Comparisons of execution rates of various safety practices in the General Patient Safety category

Topic	Correctness check		Fall prevention	Cross-infection control			Medication safety		Communication effectiveness	
Practice Region	Two identifiers	Time-out	Risk clarification	Infection notification	Hygiene plan	Hygiene practice	Policy development	Record check	Sufficient information	High risk report
Hong Kong	5.0 ± 0.0	5.0 ± 1.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	4.0 ± 1.0	5.0 ± 0.0
Japan	5.0 ± 2.0	**4.0 ± 2.0**[a]	**5.0 ± 2.0**	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 1.5	5.0 ± 0.0	**4.0 ± 1.0**[a]	5.0 ± 2.0
Malaysia	5.0 ± 0.0	**5.0 ± 2.0**[a]	4.0 ± 2.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.5	**4.0 ± 0.0**[a]
Shanghai	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	**3.0 ± 2.0**[a]	**3.0 ± 2.0**[a]	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 1.0
Singapore	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	4.0 ± 1.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	**4.0 ± 1.0**[a]	**3.0 ± 0.5**[a]	5.0 ± 0.0
South Korea	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 1.0	5.0 ± 0.0
Taiwan	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
USA	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0

Note – One out of 11 safety practices in the General Patient Safety category reached the highest execution rate in all regions and is not shown in this table. The execution rate for each practice in each location is expressed as median ± interquartile range. Due to the extreme diversity in China, Hong Kong and Shanghai are listed separately.
[a]Only one of three hospitals or institutions obtained the highest execution rate.

General patient safety

Overall, three items in the General Patient Safety category were wholly fulfilled in all regions; five practices were not fulfilled in one region, and two in two regions (Table 1). In Japan, three practices were found unsatisfactory: "time-out," "risk clarification," and "sufficient information." Malaysia, Shanghai, and Singapore each were unsatisfactory in two practices: "risk clarification" and "high risk report," "infection notification" and "hygiene plan," and "record check" and "sufficient information," respectively. Together, all safety practices except for "time-out" and "sufficient information" were satisfactorily met by at least 75% of the Asian regions.

Radiation-related safety

Overall, six items in the Radiation-Related Safety category were wholly fulfilled in all regions; two practices were not fulfilled in the majority of institutions in one region, and three in four regions (Table 2).

In Singaporean institutions, four practices were found to be unsatisfactory: "clinical indication," "alternative modalities," "duplicate avoidance," and "error reduction." The first three were also unsatisfactory in Japan. Institutions in both Hong Kong and South Korea were unsatisfactory executing "clinical indication" and "duplicate avoidance." In Taiwan, unsatisfactory performances were found in "alternative modality" and "dose reading." Together, the 75% satisfaction threshold was not reached across the Asian regions for all three items in the examination appropriateness topic.

Procedure- and modality-specific safety

Of the 23 items in this category, the highest execution rates were achieved in 2 CT-specific safety practices, 1 interventional procedure, 2 MRI-specific safety practices, and 4 nuclear medicine-specific safety practices.

Table 2. Comparisons of execution rates of various safety practices in the Radiation-Related Safety category

Topic	Examination appropriateness			Dose optimization				Pregnancy evaluation	Radiation surveillance		
Practice region	Clinical indication	Alternative modalities	Duplicate avoidance	Maintenance assurance	Protocol assurance	Error reduction	Trained personnel	Identifying pregnancy	Exposure monitor	Dose reading	Radiation protection
Hong Kong	**3.0 ± 1.0**[a]	5.0 ± 0.5	**4.0 ± 1.5**[a]	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 1.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5
Japan	**3.0 ± 2.0**[a]	**4.0 ± 2.0**[a]	**3.0 ± 1.5**[a]	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
Malaysia	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 1.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
Shanghai	5.0 ± 0.5	**4.0 ± 2.0**[a]	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	4.0 ± 0.5	5.0 ± 0.0
Singapore	**4.0 ± 0.5**[a]	**4.0 ± 1.0**[a]	**4.0 ± 1.0**[a]	5.0 ± 0.0	4.0 ± 0.5	**4.0 ± 0.5**[a]	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
South Korea	**2.0 ± 1.5**[a]	5.0 ± 2.0	**3.0 ± 1.5**[a]	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.5
Taiwan	5.0 ± 1.0	**4.0 ± 0.5**[a]	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	**4.0 ± 0.5**[a]	5.0 ± 0.0
USA	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0

Note – The execution rate for each practice in each location is expressed as median ± interquartile range. Due to the extreme diversity in China, Hong Kong and Shanghai are listed separately.
[a]Only one of three hospitals or institutions obtained the highest execution rate.

Table 3. Comparisons of completion rates of various safety practices in CT- and interventional procedure-specific topics

Topic	Computed tomography					Interventional procedures	
Practice region	Contrast policies	Pre-procedural screening	History review	Venous access assurance	Adverse event management	Coagulation correctness	Sedation security
Hong Kong	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	**4.0 ± 0.5**a	5.0 ± 0.0	5.0 ± 0.5
Japan	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	4.5 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
Malaysia	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
Shanghai	5.0 ± 0.0	**4.0 ± 1.5**a	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.5
Singapore	5.0 ± 0.0	**4.0 ± 0.5**a	**4.0 ± 0.5**a	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0
South Korea	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5
Taiwan	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5
USA	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0

Note – 3 out of 10 safety practices in the CT- and interventional procedure-specific topics reached the highest execution rates in all regions and are not shown in this table. The execution rate for each practice in each location is expressed as median ± interquartile range. Due to the extreme diversity in China, Hong Kong and Shanghai are listed separately.

[a]Only one of three hospitals or institutions obtained the highest execution rate.

Evaluation of CT- and interventional procedure-specific pre-procedural safety

Four practices in this subcategory were wholly fulfilled in all regions; two were not fulfilled by the majority of institutions in one region, and one in two regions (Table 3). On average, Singaporean institutions were unsatisfactory in "pre-procedural screening" and "history review." Hong Kong and Shanghai each were unsatisfactory in one practice: "adverse event management" and "pre-procedural screening," respectively. In contrast, all interventional procedure-specific safety practices were wholly fulfilled by the majority of institutions in seven regions. Together, 75% of the Asian regions satisfactorily fulfilled all CT- and interventional procedure-specific items.

Evaluation of MRI- and nuclear medicine-specific pre-procedural safety

Five practices in this subcategory were wholly fulfilled in all regions; one MRI-specific and one nuclear medicine-specific safety practice were not fulfilled by the majority of institutions in one region each (Table 4). Malaysian institutions were unsatisfactory in "patient education," an MRI-specific safety practice. South Korean institutions were unsatisfactory in "minimizing radiation," a nuclear medicine-specific practice. Together, a 75% satisfaction rate was reached in all regions for all MRI- and nuclear medicine-specific items.

DISCUSSION

Disregarding the development statuses of the surveyed regions, we found that the seven participating regions represented 60.5% of the Asian population. Overall, all participants reached a consensus on 89% of the safety practices evaluated. While various practices assessed in the major category Procedure- or Modality-Specific Safety were satisfactorily applied prior to radiological examinations, several were unsatisfactorily executed in the major category Radiation-Related Safety, indicating potential weaknesses of safety procedures in seven Asia-Pacific regions.

Table 4. Comparisons of completion rates of various safety practices in MRI- and nuclear medicine-specific topics

Topic	Magnetic resonance imaging				Nuclear medicine		
Practice region	Contraindication screening	Screening forms	Patient education	Radiologist attention	Minimizing radiation	Operative control	Radiopharmaceutical check
Hong Kong	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
Japan	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 1.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
Malaysia	5.0 ± 0.0	5.0 ± 1.0	**4.0 ± 0.5**a	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0
Shanghai	5.0 ± 2.0	5.0 ± 1.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.5	5.0 ± 0.0
Singapore	5.0 ± 0.0	5.0 ± 2.0	5.0 ± 1.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
South Korea	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	**4.0 ± 0.5**a	5.0 ± 1.5	5.0 ± 1.0
Taiwan	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0
USA	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.5	5.0 ± 0.0	5.0 ± 0.0	5.0 ± 0.0

Note – 7 out of 13 safety practices in the MRI- and nuclear medicine-specific topics reached the highest execution rates in all regions and are not shown in this table. The execution rate for each practice in each location is expressed as median ± interquartile range. Due to the extreme diversity in China, Hong Kong and Shanghai are listed separately.

[a]Only one of three hospitals or institutions obtained the highest execution rate.

Three (3) of 11 practices were associated with unsatisfactory ratings (less than 5 regions exhibiting the highest execution rates of the practices at two or more institutions). Three examination appropriateness practices, "clinical indication," "alternative modalities," and "duplicate avoidance," received equal amounts of unsatisfactory scores (with low to high levels of discrepancy). These results suggest that proper justification for imaging patients was somewhat insufficient in part of Asia.[10] This unveiled deficiency in examination appropriateness was anticipatively largely attributed to a lack of guidelines.[11] To replenish the missing guidelines that assure examination appropriateness, all radiological societies in the Asia-Pacific region are urged to work together. It is noted that since 1993, the American College of Radiology (ACR) took a leadership role in defining the most beneficial ways of utilizing radiologic services by developing clinical practice guidelines[12] through the ACR Appropriateness Criteria Project. Consensus panels were formed from individuals possessing acknowledged expertise in the fields of diagnostic and therapeutic radiology and other associated specialties.[13] These experts set or modified the criteria for examination appropriateness for various imaging procedures through regular reviews of new scientific evidence and changes in medical practices.

Deficiencies in examination appropriateness can be interpreted as a lack of guidelines, yet consideration should also be given to physician experience, medical customs, reimbursement policies, etc.[14] Additionally, inappropriate use of imaging tools could be represented by either overuse or underuse. The former can be harmful to patients through unnecessary radiation exposure or anxiety from incidental findings and through system inefficiencies such as increased costs and scheduling time. The latter can be harmful through delayed diagnoses and the inefficacy of imaging modalities. However, known valid imaging guidelines do not necessarily reflect the appropriate use of imaging modalities in actual practice. Indications for radiological examinations must be reviewed on a case-by-case basis, and each site must be accredited on a regular basis. Point-of-care deficiencies in examination appropriateness in Asian radiological procedures remain urgent and important issues that must be improved. Our results show that practices in dose optimization, pregnancy evaluation, and radiation surveillance acquired satisfactory evaluation scores (with low or middle levels of discrepancy) across the board. This indicates that clinical practices for radiation monitoring protection and for research teamwork among radiologic technologists and engineers are sufficient for enhancing patient safety.[15,16]

Furthermore, all surveyed practices in CT-specific pre-procedural safety, pre-procedural safety of interventional procedures, and pre-procedural safety of nuclear medicine acquired satisfactory evaluation scores (with low or middle levels of discrepancy). This indicates that quality assurance and quality control processes in the setting of nuclear medicine were performed well and that safety and efficiency in the administration of contrast prior CT and interventional procedures was appropriate. These results will be communicated to each participant so that discussions with their professional societies can take place to facilitate policy development for improving quality and patient safety during radiological examinations.

This study has limitations due to its survey design. Although the number of survey respondents in each region was low and the responses might not represent the average across a larger majority (potential selection bias), this is the first multicenter survey study, to our knowledge, to include seven Asian regions. We utilized consensus thresholds for evaluating the safety statuses of the individual and Asia-Pacific regions with regard to the limited numbers of respondents. Driven by both qualitative (threshold-based verification) and quantitative (numerical statistics) results, the least-executed or unsatisfactory radiological safety practices in each region were identified along with levels of intraregional discrepancy. On the other hand, selection bias is likely to result in an artificially high standard of care because included participants were limited to only those with accredited radiology residency training programs. Finally, survey results were not validated against institutional and regional safety standards, onsite visits, and/or follow-up discussions, through which the purpose of this consensus survey could be strengthened.

In conclusion, this study elucidates the current status of pre-procedural safety practices used in radiology institutions across seven Asian regions.[17] Based on the responses from 21 participating Asian institutions, we found that most standard practices are rountinely performed during radiological examinations, but the examination appropriateness is often deficient. These results represent a baseline for these safety practices and highlight the urgent need for improving pre-procedural safety and patient care. This study can provide direction for safety policymakers when scrutinizing and improving regional standards of care.

AUTHOR CONTRIBUTIONS

Concept and design: Y.H.L., S.T.Q., and W.P.C. Data acquisition: All authors. Analysis and data interpretation: All authors. Manuscript composition: Y.H.L. Study supervision: W.P.C. All authors have reviewed and revised the manuscript for important intellectual content. All authors have approved the version to be published.

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