

## Prevalence of unjustified emergency department x-ray examination referrals performed in a regional Queensland hospital: A pilot study

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### Abstract

**Introduction:** The underpinning principles of radiation protection are justification, optimisation and limitation. Each medical imaging referral that uses ionising radiation must balance the justification of exposure to radiation against the benefits of the examination. Scrutiny of justification is the role of radiographers, for general radiography, and is usually performed using the clinical details provided on the referral. International studies report up to 77% of medical imaging examinations are unjustified or inappropriate. In regional Queensland, justification seems to involve a subjective assessment and enforcement is ad hoc. This study aimed to determine the number of unjustified emergency department x-ray examinations performed in a regional Queensland hospital. **Methods:** An audit of the clinical details provided on x-ray referrals and in the medical records was performed on x-ray examinations undertaken within an 11-day period. Justification was determined by compliance with the Government of Western Australia's diagnostic imaging pathways. **Results:** Of the 186 referrals assessed, 75.3% were categorised as not having complied with the imaging pathway and were considered unjustified. When the clinical details in the patient's medical record were reviewed, in conjunction with the referral, the unjustified rate reduced to 49.2% of examinations. **Conclusion:** Results demonstrate a lack of information transfer by referring clinicians and a lack of compliance with justification requirements for imaging by medical imaging staff. Improved communication regarding the need for imaging, and the refusal of referrals that are not justified, will ensure that patients are only exposed to radiation when clear benefit has been demonstrated.

### Introduction

Justification is one of the cornerstones of medical radiation safety and aims to balance the risk of harm and benefit of ionising radiation to the person being imaged.<sup>1–4</sup> Medical radiation practitioners must ensure that an examination is justified before performing it; however, this is made difficult when clinical information on the referral provided does not meet quality standards.<sup>5</sup> Unnecessary or unjustified medical imaging examinations that utilise ionising radiation are a contributor to an individual's radiation burden, health costs and delayed

access to health services by increasing waiting times. Mendelson and Bairstow<sup>6</sup> summarise the issue as “... *risk and cost without benefit*”.

Malone et al.<sup>1</sup> and others report that 30–77% of medical imaging examinations with high-effective dose are considered inappropriate or unnecessary.<sup>7,8</sup> This is in spite of the introduction of referral guidelines in many countries, which aim to support evidence-based decisions for appropriate imaging referrals.<sup>9–11</sup> Use of such evidence-based guidelines can assist to justify examinations that involve ionising radiation and promote the efficient use of healthcare resources. Studies have also

shown that the use of referral guidelines have reduced the number of unjustified examinations without affecting the detection rates of treatable pathology.<sup>1,11</sup>

The process for diagnostic imaging referral involves the transfer of clinical information between the treating clinician and the medical imaging department. Clinical information is used by medical imaging staff to determine the justification of the examination and guides the imaging required to achieve diagnosis. Unfortunately, there is inconsistency between the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the Royal Australian and New Zealand College of Radiologists (RANZCR) recommendations for referral requirements.<sup>5,12</sup> ARPANSA identifies the need for a clinical question and RANZCR requires inclusion of the patient's clinical history.<sup>5,12</sup> Radiographers in Queensland have a medicolegal responsibility to ensure that ionising examinations are justified before they are performed.<sup>5,13–15</sup> Justification is determined by the clinical information provided on the referral, such as a clinical question, differential diagnosis, the mechanism of injury or current signs and symptoms. Assessment of referral justification in our medical imaging department seemed to be subjective, as medical imaging staff differed in opinion on what made an examination appropriate with the same clinical information. It is unclear if referrers and radiographers are using evidence-based guidelines. Guidelines can provide advice on the appropriateness of referrals as well as be used as a single standard against which justification can be determined. In addition, there appeared to be ad hoc enforcement of justification, with staff performing unjustified imaging. This is despite ARPANSA stating that protocols must be in place to ensure that no radiation procedure is undertaken unless it has been justified.<sup>5</sup> Such inconsistency in opinion and in the performance of unjustified imaging led us to question the extent of the problem within our organisation.<sup>16</sup>

RANZCR and the Government of Western Australia have each published imaging referral guidelines.<sup>17,18</sup> The Government of Western Australia's diagnostic imaging pathways (DIPs) are the most comprehensive imaging referral guidelines authored in Australia and provide an evidence-based decision tool to guide the most appropriate examination choices. This study aimed to determine the number of unjustified emergency department x-ray examinations performed in a regional Queensland hospital, using the Government of Western Australia's DIPs to determine justification.

## Methods

Ethical approval was granted by Townsville Hospital and Health Service's Human Research and Ethics Committee.

This manuscript presents an audit of baseline referral activity conducted as part of a wider pre- and post-intervention research project. This retrospective audit was performed on all eligible examinations, registered on the Radiology Information System (RIS) for x-ray imaging, referred from the emergency department during the audit period of 6–16 May, 2015. This audit period was sufficient to collect enough data to power the statistical analysis.

Audit inclusion criteria required examinations to have: (1) been performed, not just registered on the RIS; (2) been ordered electronically, rather than on a paper referral; (3) been for the initial investigation of a condition or symptom, as opposed to the review of a known condition; (4) been an examination of a single anatomic region; and (5) a relevant diagnostic imaging pathway. Paper referrals were excluded due to the different way in which clinical information is entered and displayed in an electronic format compared to paper. This may have altered the amount of, or type of, clinical information provided. Excluding paper referrals allowed the removal of this variation. Multiple region examination codes that cover more than one anatomic area were excluded, as these could create referrals with one region meeting justification criteria and the other not, leading to difficulty in categorisation.

The principal investigator used the clinical information provided on the referral to determine if a relevant DIP existed for the examination performed. The Government of Western Australia's website contains 173 individual pathways. Referrals were grouped into the following three categories as having: (1) fully met the pathway; (2) partially met the pathway or unclear; and (3) did not meet the pathway; Figure 1 provides a flow chart of referral inclusion criteria and justification categorisation.

Referrals that were not categorised as having fully met the pathway were further investigated by review of the initial clinical attendance notes in the patient's electronic medical record. The clinical notes created by the emergency department referrer were assessed against the available DIPs and the referral was categorised into the same groups as outlined above. Justification rates for examinations as a whole were determined by combining the number of referrals that met a pathway and the number of medical record notes that also met a pathway.

Pathways do not exist for all anatomic regions of the body nor all disease processes. Examinations were included when pathways matched the anatomic region of the injury or a disease-specific pathway matched the clinical details provided by the referrer. The key terms listed in Table 1 were used to identify when a disease-specific pathway could be used.

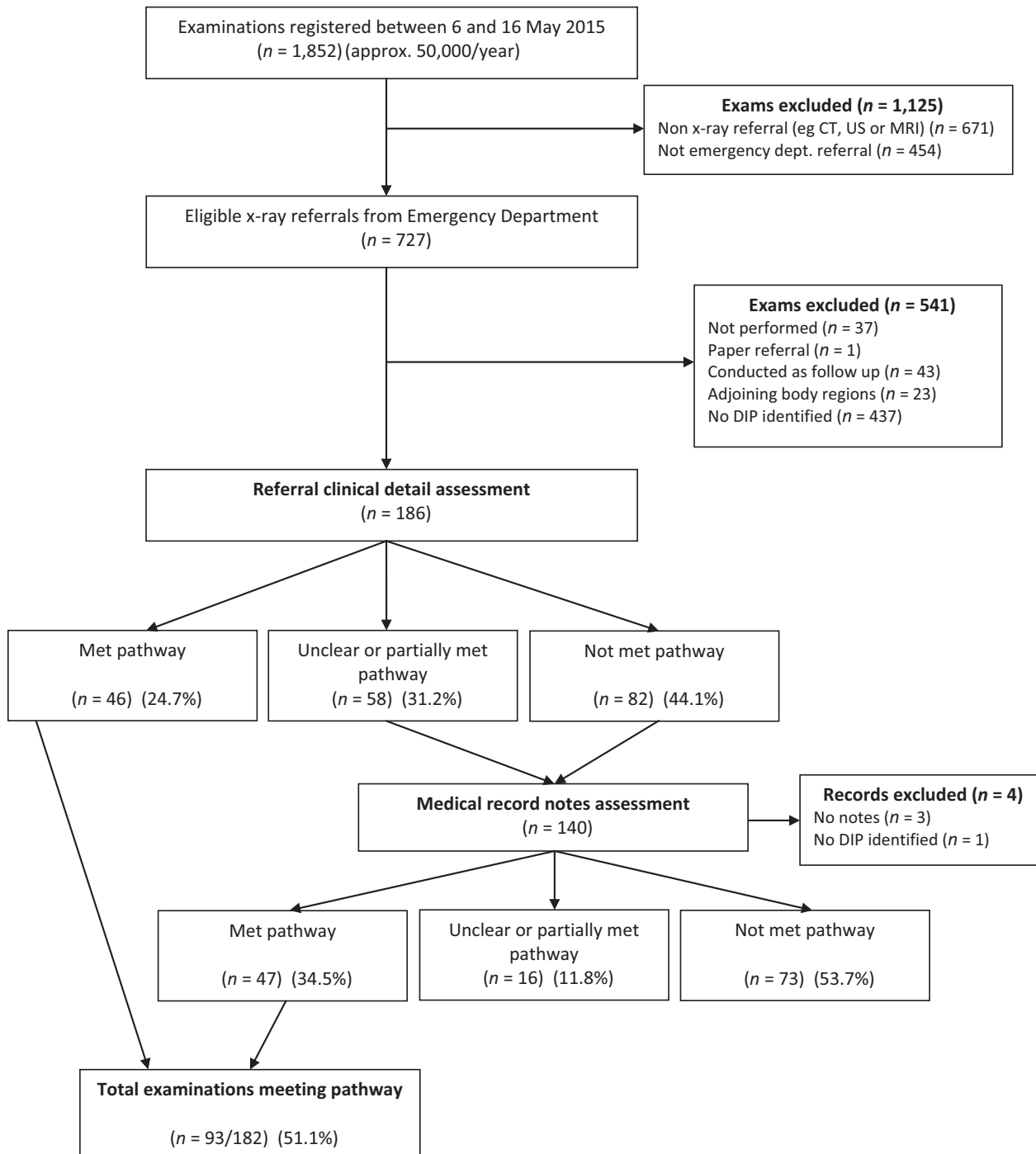


Figure 1. Flow chart of referral inclusion criteria and categorisation.

### Medical imaging report

The final medical imaging report for the examination was reviewed by the principal investigator and the content evaluated for the outcome of the examination. Positive results were considered those examinations for

which the report stated a clinically significant outcome relevant to the clinical details provided on the referral, for example, fracture, dislocation or infection plus findings which were inconclusive of a relevant outcome. Negative results consisted of reports where no abnormality was detected or incidental findings were

**Table 1.** Key terms used to identify specific imaging pathways.

Examination name	Key terms used	Imaging pathway used
XR Hip	'External rotation' '#'	Hip fracture (suspected)
XR Wrist	'Base of thumb'	Scaphoid fracture
XR Hand	'Scaphoid'	
XR Thumb	'Snuff box'	
Any musculoskeletal area	'? Osteomyelitis'	Osteomyelitis (suspected acute)
XR Abdomen	'? Obstruction'	Bowel obstruction (suspected)

XR, x-ray.

reported. In addition, negative results included those reports indicating the presence of swelling but for which no other injury was described.

### Data collection and analysis

Referral clinical details were collected from the enterprise Picture Archiving and Communication System (Agfa ePACS), while the emergency department attendance notes were retrieved from the integrated Electronic Medical Record (ieMR) (Cerner Millennium). Patient and referrer identifier data were supplemented from the Radiology Information System (Agfa RIS). Descriptive statistics and Chi-squared tests for independence were performed on the collected data using Statistical Package for the Social Sciences (SPSS) (IBM, version 22), with *P* values of less than .05 considered statistically significant.

## Results

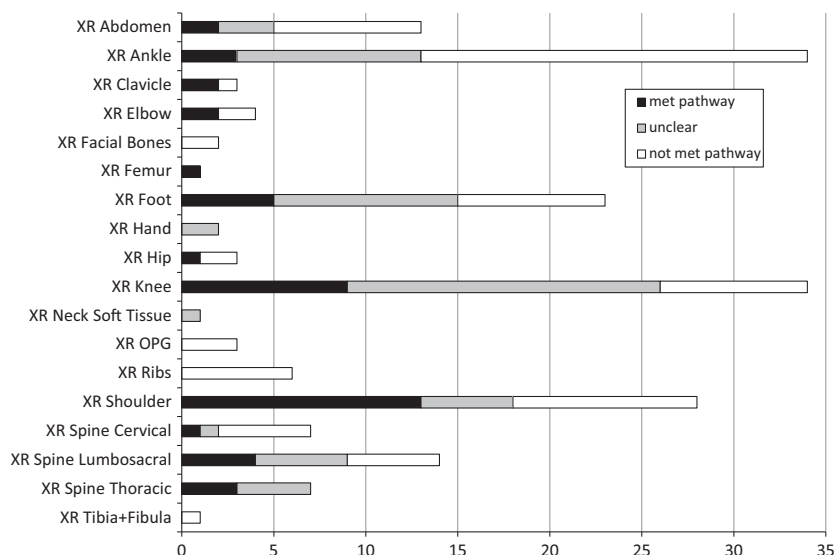
A total of 186 referrals for plain x-ray imaging were identified as eligible as part of the audit. Ankle, knee and shoulder imaging were the three most frequently performed x-ray examinations in the audit period. These examination types varied greatly in their rates of justification with 9% (3/34), 26% (9/34) and 46% (13/28) of referrals meeting the respective imaging pathway (Fig. 2).

### Referral assessment results

Assessment of 186 referrals revealed that 75.3% of examinations reviewed as part of the audit were in the two categories where they did not meet or only partially met an imaging pathway. Figure 1 shows the number of referrals in each justification category.

Of the referrals assessed, 31.7% (59/186) did not include any relevant clinical details regarding the patient's signs or symptoms pertinent to their presenting condition. These referrals commonly provided descriptions of a mechanism of injury sustained by the patient. A statistically significant association was seen between the inclusion of relevant clinical details, that is, more than the mechanism of injury, and the referral meeting the imaging pathway,  $\chi^2(1) = 24.633$ ,  $P < 0.001$ .

When assessing the relationship between referrals meeting an imaging pathway and the medical imaging report outcome, no statistically significant association was demonstrated,  $\chi^2(1) = 1.863$ ,  $P = 0.172$ . Table 2 shows the number of referrals that met a pathway and the medical imaging report outcomes. There was no



**Figure 2.** Breakdown of the number of referrals with a DIP and their pathway agreement.

**Table 2.** Number of referrals in pathway agreement category and medical imaging report outcomes.

	Negative medical imaging report outcome	Positive medical imaging report outcome
Met pathway	29	17
Not met pathway or unclear	103	37
Total	132	54

statistically significant association detected between medical imaging report outcome and signs and symptoms associated with the patient's presenting complaint,  $\chi^2(1) = 0.002, P = 0.964$ .

### Medical record assessment results

Of the 186 imaging examinations reviewed, 140 were unclear or did not meet the referral pathways when using the clinical details provided on the referral. The medical records for these examinations were reviewed. Three patients' medical records contained no initial clinical assessment notes and one had no DIP identified from the clinical information provided and so were excluded from review. Of the remaining records, 65.5% of records did not meet or partially met an imaging pathway justification criteria (89/136) (Fig. 1).

### Examination assessment results

Ninety-three of the 182 examinations (51.1%) assessed by referral and medical record clinical details met an identified pathway, 16 examinations (8.8%) remained unclear whether the imaging was appropriate and 73 examinations (40.1%) remained unnecessary due to not meeting an imaging pathway.

### Discussion

This study has demonstrated that only 24.7% of x-ray referrals audited met the Government of Western Australia's diagnostic imaging pathways and could be considered justified. This number of unjustified examinations falls at the higher end of results from other international studies and contributes to the overuse of healthcare resources.<sup>1</sup> Justification rates varied greatly between examination types; however, the highest justification rate was 48% for x-ray shoulder examinations. The reasons for this variation are unclear, but suggestions include patient condition; referrer's level of experience; referrer's skill in clinical assessment; referrer's awareness and use of image referral guidelines.

High numbers of unjustified examinations are suggestive of over irradiation of patients and wasteful use of healthcare resources, which should be of concern to referrers, medical imaging staff and radiation possession licensees. It is the radiographer's responsibility, on behalf of the radiologist, to ensure that justification compliance is achieved for every examination and to act as an advocate for the patient in the assessment of risk versus benefit. If the benefit of the examination has not been demonstrated, then the imaging should not be performed. Inappropriate or unjustified referrals cannot realistically be reduced to zero. Imaging guidelines are suggested pathways based on evidence and best practice but should not eliminate a referrer's clinical judgement. If the referrer has a high suspicion of a condition, it would still be reasonable to refer the patient for imaging. Communication of this clinical suspicion via the referral is still required so that justification can be determined as well as the required imaging projections identified. Table 2 shows 103 examinations that did not meet a pathway, did not detect pathology and could be deemed as a waste of resources. The 37 examinations that did not meet an imaging pathway, but received a positive medical imaging report, suggest that imaging guidelines should be used judiciously and that referral decisions should always incorporate clinical judgement.

The overall examination justification rate of just 50.8%, which was achieved by combining the referral and medical record clinical details, still demonstrates a number of examinations that are not justified in either the referral or medical chart records. The difference between referral (24.7%) and overall examination justification (50.8%) rates reveals that clinical details that provide justification are not being provided by the treating clinician. Clinical details need to be shared with medical imaging staff as they are used to guide the imaging required, such as what region of the body to include and whether any additional views to the minimum set are required. Radiographers use a range of projections to image the body; they are used to demonstrate different anatomic relationships and are guided by the patient's symptoms and the pathology under investigation. If the clinical details on the referral are lacking, then the necessary images may not be acquired. For example, the three routine projections of postero-anterior (PA), oblique and a lateral view of the wrist are not the best images to determine if injury has been sustained to the scaphoid.<sup>19</sup> Additional views of the scaphoid are beneficial and can also improve the accuracy of the medical imaging report.

Reasons for the discrepancy between clinical details provided on the referral and information contained in the medical record may include: (1) a lack of awareness of

what should be included on the referral; (2) a lack of time to complete the referral; (3) a lack of knowledge of the patient, as the task of creating the referral may have been delegated to a different referrer; (4) a lack of training in referral processes; and (5) a lack of knowledge of the availability and use of diagnostic imaging pathways. The reasons as to why clinical details are not provided on medical imaging referrals have not been investigated. Research in this area could also provide insight as to how the discrepancy in clinical details between referrals and medical records could be overcome.

The lack of relevant clinical information on referrals suggests a lack of knowledge about what information is required and used by medical imaging departments. This issue could be solved with referrer education on the type of information required. Studies have shown that improvement in the quality of referral clinical details is achievable; however, they also report that ongoing reinforcement is required for lasting improvement.<sup>16,20</sup> Imaging referral guidelines are an accessible information source for referrers and medical imaging staff; they provide evidence and support for decisions on the justification of an imaging examination.

Lack of adherence to imaging referral guidelines by referrers is a well-researched area; improvements have been achieved by different intervention methods including the integration of referral guidelines into the electronic referral process, and reminders on medical imaging reports but all have failed to sustain change without ongoing reinforcement of the intervention.<sup>10,21</sup> Cabana and colleagues<sup>22</sup> reviewed the literature on the barriers to clinician adherence to guidelines. The following are some of the barriers that were identified in the review: (1) a lack of awareness, familiarity or agreement with guidelines; (2) a lack of outcome expectancy where a physician believes the guideline will not result in an improved outcome; (3) inertia of previous practice or a lack of motivation to change; and (4) a mismatch between the guideline recommendation and patient expectations. It would be prudent to consider these barriers when looking at the use of imaging referral guidelines in an effort to reduce unnecessary imaging.

Use of imaging referral guidelines to support medical imaging staff in deciding not to perform x-ray examinations has not been discussed in the literature to date. Medical imaging staff can be seen as a roadblock to imaging examinations by referrers when they question the necessity of a referral. The variation in opinion on justification and the resulting conflict between referrer and the medical imaging department could be reduced through the use of such a single tool. Examination types that do not have an identified imaging pathway still need to be justified, however against what standard, and by

whom, will justification be measured when such a standard does not exist. Justification discrepancies could be difficult to resolve without a single tool in which justification could be objectively measured and jointly agreed upon. Medical malpractice, if imaging is not performed, is argued by referrers as a reason to perform unjustified studies, although over irradiation of patients provides similar negative consequences for the health service. Involving the patient in imaging decisions may mitigate the risk in choosing whether or not to carry out a seemingly unjustified examination.

## Limitations

The small sample size is a limitation of this study, as is short timeframe in which the data were collected. These limitations may have affected the study outcomes due to the referrals potentially coming from a limited number of referrers; as such, a repeated audit at a different or extended timeframe, with a larger data set may reveal different results. This audit, however, was performed as a pilot for a larger study and the outcomes are still of value to the radiography community as a snapshot of activity.

The accuracy of the name of the examination recorded in the Radiology Information System (RIS) and which images were acquired was not confirmed as part of this study. It was assumed that the examination name on the RIS was that of the examination performed and, thus, related to the clinical details provided. If the examination performed, or images taken, were different to that recorded on the RIS, the results of this study may be affected.

A single reviewer with 13 years' experience in general radiography identified whether an imaging pathway existed for each examinations and determined whether studies were justified, based on the clinical details on the referral or in the medical record. The reviewer's experience in justification practices and/or level of agreement with the pathways may have biased their interpretation and affected the results of this study. Study outcomes may have been different if a radiologist, a referrer or a more/less experienced radiographer was used. Although as it is within the scope of a radiographer's role to assess the justification of an examination, it was considered the most appropriate choice. Research into the differences between professions in the determination of justification may provide interesting insight into the appropriateness of imaging by professions that refer and perform x-ray examinations.

The number of unjustified referrals may be even higher than those depicted in this study. We only assessed examinations that were actually performed; it was not within the scope of this study to assess referrals that were refused by the medical imaging staff.

Since this was a retrospective study, it was not possible to collect additional information from the patient or referrer which diminishes the ability to interpret outcomes following radiographic examinations. Acquisition of additional information, beyond that provided on the referral, to determine justification is time-consuming and should not be considered routine practice for medical imaging referrals.

## Conclusion

Referrals to perform unjustified or inappropriate x-ray examinations pose a problem for medical imaging departments. Both referrers and medical imaging staff are responsible for reducing unnecessary examinations and should modify their practice accordingly. Referrers must provide justification on examination referrals, and medical imaging staff should refuse to perform examinations where clear justification, or reasonable clinical suspicion of pathology, is not evident. This study has demonstrated that imaging referral guidelines are not being followed and unjustified examinations are routinely performed. Further research should focus on an improvement in the justification of imaging referrals with clinical details demonstrating the need of the examination, with an aim of achieving sustained changes in practice. Ensuring that referrals are justified will reduce unnecessary imaging; health care costs; ionising radiation exposure; and increase efficiency through reduced patient turnaround times in medical imaging services.

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## Conflict of Interest

The authors declare no conflict of interest.

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