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Evaluating Adherence to iRefer Guidelines and Barriers to Implementation Among Non-consultant Hospital Doctors in a Model 3 Hospital: A Mixed-Methods Study

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Abstract

Background

The Royal College of Radiologists' (RCR) iRefer guidelines are an established evidence-based clinical decision support tool intended to optimise diagnostic imaging referrals, reduce unnecessary radiation exposure, and improve radiology workflow efficiency. In Ireland, imaging referrals also carry statutory weight: Statutory Instrument (S.I.) No. 256 of 2018 places defined duties on referrers regarding the justification of medical exposures, and Health Service Executive (HSE) guidance requires referrers to have access to iRefer or an equivalent decision support tool. Awareness and use of iRefer among non-consultant hospital doctors (NCHDs) in smaller, high-turnover hospital settings are poorly described.

Aim

To evaluate awareness, utilisation, and accessibility of the iRefer guidelines among NCHDs in a Model 3 hospital and to identify the systemic, technological, and cultural barriers preventing routine use.

Methods

A sequential explanatory mixed-methods design was employed. Phase 1 comprised an in-person, anonymous cross-sectional audit questionnaire developed by the authors for this study, administered to NCHDs to assess awareness, decision-making sources, and guideline concordance across three clinical scenarios. Phase 2 comprised semi-structured, one-to-one interviews with a purposive sample of nine NCHDs across five specialties (emergency medicine, orthopaedics, general surgery, general practice, and general medicine). Interview transcripts were analysed using Braun and Clarke's reflexive thematic analysis framework. Ethical approval was granted by the institutional research ethics committee, and written informed consent was obtained from all interview participants.

Results

Questionnaires were distributed in person to 90 NCHDs, and 70 completed forms were returned (70/90; 77.8%). No awareness of iRefer was reported by 51/70 respondents (72.9%), and only 1/70 (1.4%) reported being fully aware; 44/70 (62.9%) were unaware of their legal responsibilities as referrers under S.I. No. 256 of 2018. When managing a complex case, 49/70 (70.0%) relied on advice from senior colleagues, and only 1/70 (1.4%) consulted iRefer or an equivalent decision support tool directly. Across three clinical scenarios, guideline-concordant responses ranged from 12/70 (17.1%) to 43/70 (61.4%), and only 4/70 (5.7%) answered all three scenarios concordantly. Qualitative analysis of nine interviews identified six major themes: an almost universal absence of awareness of iRefer and any formal induction to it; reliance on alternative, informal, or specialty-specific decision-making sources; time and workload pressure; information technology and systemic access barriers; recurrent interdepartmental conflict with radiology; and a consistent set of participant-generated recommendations.

Conclusions

NCHDs in this Model 3 hospital demonstrated minimal awareness of, and no formal induction to, iRefer, relying instead on clinical judgement and informal or alternative sources. This represents a gap between current practice and both clinical best-practice standards and the referrer duties set out in national radiation protection legislation. The findings support mandatory radiation protection and referrer training at induction, embedding indication-based prompts into the imaging ordering system, and formalising communication pathways between ordering clinicians and radiology.

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Introduction

Diagnostic imaging referral guidelines exist to ensure that patients receive the most clinically appropriate investigation while minimising unnecessary radiation exposure and inefficient use of radiology resources. The Royal College of Radiologists (RCR) has published its iRefer guidelines since 1989, now in their eighth edition, addressing 270 common clinical scenarios and accredited by the National Institute for Health and Care Excellence (NICE) Evidence programme [1,2]. Early evaluations of RCR referral guidance demonstrated measurable reductions in inappropriate referrals following distribution to general practitioners [3], and iRefer is now positioned by the RCR as a clinical decision support tool intended to guide referrers at the point of decision-making [1].

However, the evidence base on the real-world effectiveness of imaging clinical decision support tools is mixed. A large German cluster-randomised trial across 26 hospital departments found that implementation of a comparable clinical decision support system, the European Society of Radiology iGuide, did not significantly reduce the proportion of inappropriate imaging requests, and that few clinicians altered their ordering behaviour even when informed that a request was inappropriate [4,5]. Similarly, embedding predictive-text decision support into an emergency department ordering system added minimal time to the ordering workflow but had only a marginal effect on imaging selection [6]. Conversely, point-of-care decision support tools embedded directly into referrer workflows, rather than accessed via a standalone website, have been shown to meaningfully reduce duplicate imaging and radiation dose [7]. Taken together, these findings point to something simpler than the guidance itself: it is the manner and context of delivery, not the mere existence of a guideline, that appears to determine real-world impact. This is an issue of particular relevance to NCHDs, who rotate frequently between specialties and hospitals and may never receive formal exposure to a given hospital's systems.

Structured clinical audits against RCR referral standards have been shown elsewhere to identify and help close such compliance gaps in radiology departments [8]. A recent cross-sectional survey of 167 referring physicians in the United Arab Emirates found that training participation was significantly associated with better guideline accessibility, and that over half of respondents acknowledged that imaging referrals were sometimes unnecessary, despite high self-reported confidence in assessing imaging necessity [9]. This gap between confidence and guideline-concordant practice, and the role of training and accessibility in closing it, is directly relevant to the present study's focus on NCHDs.

NCHDs, comprising interns, senior house officers (SHOs), registrars, and senior registrars, form the backbone of day-to-day clinical care delivery in the Irish hospital system, working under the direct or nominal supervision of a consultant. NCHDs frequently rotate between posts on six- to 12-month contracts, and some specialties, including emergency medicine, are particularly reliant on non-training scheme doctors [10]. Model 3 hospitals, which are general hospitals providing acute medical and surgical care without the full complexity of tertiary (Model 4) centres, have been specifically flagged by the HSE's National Doctors Training and Planning unit as facing workforce and infrastructure challenges that can affect training and guideline implementation [11].

In this context, high NCHD turnover, variable clinical experience, and acute workload pressures may create particular vulnerability to gaps in awareness and use of guidance such as iRefer. While quantitative audits can measure rates of awareness and use, they cannot capture the systemic, technological, and cultural mechanisms underlying non-adherence. A mixed-methods approach was therefore adopted to combine measurable prevalence data with an in-depth understanding of the barriers NCHDs experience in daily practice.

Critically, appropriate imaging referral in Ireland operates simultaneously as a clinical best-practice standard and as a statutory obligation, and the two are mutually reinforcing rather than alternatives. Evidence-based referral guidance such as iRefer represents the professional standard of care, while the legislative framework gives that standard binding force. The European Union (Basic Safety Standards for Protection Against Dangers Arising from Medical Exposure to Ionising Radiation) Regulations 2018 (S.I. No. 256 of 2018) transposed Council Directive 2013/59/Euratom into Irish law and were subsequently amended by S.I. No. 413 of 2019 [12,13,14]. Part 2 of these Regulations establishes requirements in relation to medical exposures, including defined duties for referrers and practitioners, justification of practices, justification of individual medical exposures, and diagnostic reference levels [15]. The Health Information and Quality Authority (HIQA) is the designated competent authority in Ireland, responsible for inspecting and enforcing compliance and for ensuring that medical exposures are both justified and optimised [16].

Distinct duties also fall on the practitioner and the operator involved in a given exposure, roles frequently discharged by radiologists and radiographers, respectively, who are likewise responsible for confirming that an exposure is justified before it proceeds and are professionally and legally entitled to decline to perform an examination they judge unjustified. The referrer, in most acute hospital practice an NCHD, therefore carries

a specific, individual legal duty when requesting an examination involving ionising radiation. Justification is not a formality discharged by the radiology department alone: it requires the referrer to supply sufficient clinical information for the practitioner to justify the exposure and to have regard to referral guidelines in doing so. Guidance issued by the HSE for referrers of radiological procedures sets out a local governance checklist that explicitly includes access to iRefer guidelines or equivalent clinical decision support tools, alongside access to local incident-reporting procedures and the local pregnancy policy for protection of the unborn child. The same guidance identifies expected training routes for referrers, including HSE Learning and Development (HSeLanD) e-learning, seminars, study days, and local in-person training.

This framework has direct implications for the present study. If NCHDs are unaware of iRefer, have not received radiation protection or referrer training at induction, and cannot access a clinical decision support tool at the point of ordering, then the hospital may be falling short not only of good clinical governance but also of the documented expectations placed on referrers under the national framework. Radiation protection training for referrers is available nationally through HSeLanD as well as through in-person hospital-based courses, meaning that the infrastructure to close this gap already exists and is not contingent on the development of new resources. Presenting iRefer awareness as both a professional standard of care and a regulatory and patient-safety obligation, rather than as an optional educational extra, may therefore be a more effective lever for institutional change than either framing used alone.

The primary objective of this study was to evaluate the current levels of awareness, utilisation, and accessibility of the iRefer guidelines among NCHDs across clinical specialties in a Model 3 hospital. The secondary objective was to identify and analyse the specific barriers that impede NCHDs from consulting these guidelines, including time constraints, information technology infrastructure, hierarchical preferences, and interdepartmental communication. The overall aim was to generate actionable insights to improve clinical governance, target induction training, and optimise local radiology ordering workflows.

Materials And Methods

Study design

This study used a sequential explanatory mixed-methods design [17], comprising a quantitative survey phase followed by an explanatory qualitative interview phase, conducted in a single Model 3 hospital.

Participants and recruitment

All NCHDs (interns, SHOs, registrars, and senior registrars) currently employed at the hospital who routinely requested radiological investigations (radiography, CT, MRI, and ultrasound) as part of their clinical duties were eligible for inclusion ($n = 120$). Consultants, non-clinical staff, and clinical staff without ordering privileges were excluded. For the quantitative phase, questionnaires were distributed in person by the investigator to 90 of the eligible NCHDs, and 70 completed forms were returned, giving a response rate of 70/90 (77.8%). For the qualitative phase, participants were invited via institutional email, departmental handovers, and NCHD messaging forums, and participation was voluntary.

For the qualitative phase, a purposive sample of NCHDs was recruited across five specialties: EM ($n = 2$), orthopaedics ($n = 2$), general surgery ($n = 2$), general practice ($n = 2$), and general medicine ($n = 1$), totalling nine participants. Recruitment and interviewing continued iteratively until thematic saturation was reached, that is, until successive interviews ceased to generate new codes or themes, at which point data collection concluded. The final sample size of nine was therefore a product of this saturation point rather than a predetermined target. Written informed consent was obtained from all nine participants prior to the interviews. The composition of the qualitative sample is summarised in Table 1.

Participant	Specialty	Grade	Prior awareness of iRefer
P1	General medicine	NCHD	No prior awareness
P2	Orthopaedics	NCHD	No prior awareness
P3	General surgery	NCHD	No prior awareness
P4	General surgery	NCHD	No prior awareness
P5	General practice (GP trainee)	NCHD	No prior awareness
P6	Emergency medicine	NCHD	No prior awareness (aware of the study only)
P7	Emergency medicine	NCHD	Aware from a previous post; no local access
P8	Orthopaedics	NCHD	No prior awareness
P9	General practice (GP trainee)	NCHD	No prior awareness

TABLE 1: Qualitative sample by specialty, grade, and prior awareness of iRefer.

NCHD: Non-consultant hospital doctor; GP: General practitioner.

Data collection

For the quantitative phase, an anonymous, paper-based audit questionnaire was administered in person to NCHDs. The questionnaire was developed by the authors specifically for this study, as no previously published and validated instrument assessing iRefer awareness among Irish NCHDs was identified; it is reproduced in full in Appendix 1. The instrument recorded grade, specialty, and weekly volume of radiology requests involving ionising radiation; self-reported awareness of iRefer and of referrers' legal responsibilities under S.I. No. 256 of 2018; the primary source consulted when deciding on imaging for a complex case (advice from senior colleagues, consultation with radiology, iRefer or the European Society of Radiology iGuide, or Google/UpToDate); three clinical scenario questions assessing guideline-concordant decision-making; and an open-text item on the primary perceived barrier to consulting iRefer, subsequently grouped by the investigators into descriptive categories (no knowledge of the guideline, time, access, difference of opinion, and no barriers).

The three clinical scenarios were constructed around published diagnostic and imaging guidance rather than investigator opinion. Scenario 1 concerned suspected pulmonary embolism in a woman at 12 weeks' gestation, for which ventilation/perfusion scanning was taken as the guideline-concordant answer in preference to computed tomography pulmonary angiography, on the basis of the lower maternal breast tissue radiation dose described in the Royal College of Obstetricians and Gynaecologists Green-top Guideline No. 37b [18]. Scenario 2 concerned non-specific low back pain of four weeks' duration without red flag features, for which no imaging was taken as concordant, in line with NICE guideline NG59 [19]. Scenario 3 concerned clinically suspected scaphoid fracture with an initially negative radiograph, for which early MRI was taken as concordant, in line with the NICE recommendation to consider MRI as first-line imaging in suspected scaphoid fracture [20].

For the qualitative phase, one-to-one, semi-structured interviews were conducted with each of the nine participants in person and audio-recorded with consent. Interviews explored how and when participants first became aware of iRefer; participants' typical processes for ordering radiological investigations; the impact of time constraints and workload on guideline consultation; suggestions for making iRefer more seamless and accessible; and any additional workflow challenges. The topic guide was likewise developed by the authors for this study, was not piloted or formally validated, and is reproduced in Appendix 2. It was applied flexibly, with follow-up prompts varying according to each participant's responses. Recordings were transcribed verbatim.

Data analysis

Quantitative questionnaire data were entered into a spreadsheet and analysed using descriptive statistics, with categorical variables summarised as frequencies and percentages and stratified by grade and specialty where relevant. No inferential testing was undertaken, as the study was designed to establish baseline prevalence rather than to test hypotheses. Data compilation and descriptive analysis were performed using Microsoft Excel 365 (Microsoft Corporation, Redmond, Washington, United States).

Qualitative transcripts were analysed using Braun and Clarke's six-phase reflexive thematic analysis framework, comprising familiarisation with the data, generation of initial codes, searching for themes,

reviewing themes, defining and naming themes, and producing the final analysis [21,22,23]. Coding was conducted at a semantic level, focusing on participants' explicitly stated experiences and suggestions, with themes developed inductively from the data rather than mapped onto a pre-existing framework.

Ethical considerations and data management

Ethical approval for this study was obtained from the Mayo University Hospital Ethics Committee, prior to data collection (approval number: 20260701). Written informed consent was obtained from all interview participants in accordance with the ethical principles set out in the Declaration of Helsinki [24]. Survey data were collected entirely anonymously. Interview transcripts were pseudonymised, and no identifiable patient data or specific clinical cases were collected. All digital data, audio recordings, and transcripts were stored on an encrypted, password-protected institutional server accessible only to the primary investigator, in compliance with the General Data Protection Regulation (EU) 2016/679 [25] and institutional data protection policy. There were no clinical interventions and no risk to patients; risk to staff participants was minimal, as responses were confidential and did not affect professional standing or employment.

Results

Questionnaires were distributed in person to 90 NCHDs, and 70 completed forms were returned, giving a response rate of 70/90 (77.8%). Respondents comprised 47/70 SHOs (67.1%), 17/70 registrars (24.3%), and 6/70 senior registrars (8.6%), drawn from nine specialties, with the largest groups from general medicine (n = 17), orthopaedics (n = 11), and EM (n = 10).

Awareness of iRefer and of referrer legal responsibilities

Self-reported awareness of both iRefer and referrer legal responsibilities is summarised in Table 2. The majority of respondents, 51/70 (72.9%), reported no awareness of iRefer at all, and only 1/70 (1.4%) reported being fully aware. A similar, though somewhat less pronounced, pattern was seen regarding referrer legal responsibilities, with 44/70 (62.9%) unaware of their legal obligations as referrers under S.I. No. 256 of 2018 and 4/70 (5.7%) reporting full awareness. Awareness of iRefer was lowest among SHOs, of whom 38/47 (80.9%) were unaware, compared with 9/17 registrars (52.9%) and 4/6 senior registrars (66.7%). This gradient is consistent with the qualitative finding that awareness, where present, tended to arise later in training or from experience at a previous hospital.

Measure	Fully aware, n (%)	Aware but no details, n (%)	Not aware, n (%)
Awareness of iRefer guidelines	1 (1.4)	18 (25.7)	51 (72.9)
Awareness of referrers' legal responsibilities	4 (5.7)	22 (31.4)	44 (62.9)

TABLE 2: Self-reported awareness of iRefer and referrers' legal responsibilities under S.I. No. 256 of 2018 (n = 70).

Decision-making sources and perceived barriers

When managing a complex case, 49/70 respondents (70.0%) cited advice from senior colleagues as their primary source of guidance, 11/70 (15.7%) consulted radiology directly, 9/70 (12.9%) used Google or UpToDate, and only 1/70 (1.4%) reported consulting iRefer or an equivalent decision support tool. This distribution closely mirrors the qualitative finding that NCHDs default to informal, colleague-mediated decision-making in the absence of accessible guideline resources.

When asked about the primary barrier to consulting iRefer, 45/70 respondents (64.3%) cited a lack of knowledge that the guideline existed, 16/70 (22.9%) cited time constraints, and 7/70 (10.0%) cited access difficulties, while one respondent reported no barriers (1/70; 1.4%) and another reported a difference of opinion with radiology (1/70; 1.4%). This ordering is notable in that, while time pressure featured prominently in the qualitative interviews, the questionnaire suggests that the more fundamental and prevalent barrier is that most NCHDs simply do not know the guideline exists to be consulted in the first place.

Guideline-concordant decision-making in clinical scenarios

Three clinical scenarios assessed whether respondents' stated management aligned with published guideline-recommended practice, as detailed in the Data Collection section. Results are presented in Table 3.

Clinical scenario	Guideline-concordant answer	Concordant, n (%)
1. Suspected pulmonary embolism at 12 weeks' gestation	Ventilation/perfusion (V/Q) scan	33 (47.1)
2. Non-specific low back pain without red flags	No imaging indicated	43 (61.4)
3. Suspected scaphoid fracture with an initially negative radiograph	Early MRI	12 (17.1)
All three scenarios concordant	-	4 (5.7)
No scenarios concordant	-	13 (18.6)

TABLE 3: Guideline-concordant responses across three clinical imaging scenarios (n = 70).

*Guideline-concordant answers were derived from the Royal College of Obstetricians and Gynaecologists Green-top Guideline No. 37b (scenario 1), the National Institute for Health and Care Excellence guideline NG59 (scenario 2), and the National Institute for Health and Care Excellence guideline NG38 (scenario 3).

Concordance ranged from 12/70 (17.1%) for suspected scaphoid fracture with an initially negative radiograph, where early MRI was the guideline-concordant answer [20], to 43/70 (61.4%) for non-specific low back pain without red flags, where current guidance recommends against imaging in the absence of red flag features [19]. For pregnancy-associated suspected pulmonary embolism, 33/70 respondents (47.1%) selected ventilation/perfusion scanning, taken as the guideline-concordant answer in preference to computed tomography pulmonary angiography on the basis of the lower maternal breast tissue radiation dose [18]. For the low back pain scenario, a substantial minority of 23/70 respondents (32.9%) selected lumbar spine radiography despite no imaging being indicated, representing a potential source of unnecessary radiation exposure and low-value imaging. Only 4/70 respondents (5.7%) answered all three scenarios in a guideline-concordant manner, and 13/70 (18.6%) answered none concordantly, indicating considerable variability in imaging decision-making even among respondents who did not identify a specific barrier.

Qualitative phase

Nine semi-structured interviews were conducted and analysed. On average, they lasted approximately four minutes. This brevity did not reflect disengagement but rather the fact that most participants had genuinely little to say about a guideline they had rarely, if ever, encountered before this study, and their answers were correspondingly short, direct, and unrehearsed. Six major themes were identified, summarised in Table 4 and described in detail below.

Theme number and title	Description of theme content
1. Absent awareness and induction gap	Eight of nine participants had never heard of iRefer before this study; none had received formal training or induction on radiology referral guidelines at the hospital.
2. Reliance on alternative decision-making sources	In the absence of iRefer, participants relied on clinical judgement and experience, consultant discussions, or specialty-specific alternatives such as NICE guidance, Ortho Bullets, and IAEM/RCEM guidance.
3. Time and workload pressure	Busy shifts, on-call fatigue, and heavy workloads were repeatedly described as barriers to consulting any guideline, ranging from a lack of time to look up guidance to unconsciously ordering scans without considering guidance at all.
4. Information technology and systemic access barriers	Participants lacked local access to iRefer, and the absence of integrated single sign-on or desktop access was cited as a structural barrier distinct from time pressure.
5. Interdepartmental communication and guideline conflict with radiology	Friction between ordering clinicians and radiology or vetting consultants was a recurring and escalating theme, including delayed vetting, requests for further information, and direct disagreement over which guideline applied.
6. Perceived solutions and improvement opportunities	Participants proposed mandatory HSE e-learning modules, day-one departmental induction, printed guideline handouts, single sign-on or desktop shortcuts, embedded indication prompts within the ordering system, increased staffing, and direct communication channels with radiology.

TABLE 4: Major themes identified through reflexive thematic analysis of nine NCHD interviews.
NCHD: Non-consultant hospital doctor; HSE: Health Service Executive; NICE: National Institute for Health and Care Excellence; IAEM: Irish Association for Emergency Medicine; RCEM: Royal College of Emergency Medicine.

Theme 1: Absent Awareness and Induction Gap

Eight of the nine participants reported having no prior awareness of iRefer before this study. Representative responses included the following:

- "To be honest, I've never really heard of it before. I don't know much about it at all." (Participant 1, general medicine NCHD)
- "I only found it today when you spoke to me about this." (Participant 3, general surgery NCHD)

One participant offered a partial exception. Participant 7, an emergency medicine NCHD, had encountered iRefer approximately three years earlier at a previous hospital during an audit project but reported no access to it at the current site. No participant reported having received formal training, orientation, or induction covering iRefer at the hospital, a point stated directly by one participant:

- "We have not received any formal training or induction in the hospital." (Participant 4, general surgery NCHD)

Theme 2: Reliance on Alternative Decision-Making Sources

In the absence of iRefer, participants described relying on personal clinical judgement, consultant discussion, or alternative guidance specific to their specialty. Participants working in orthopaedics referenced Ortho Bullets and NICE guidance for trauma, while emergency medicine participants referenced Irish Association for Emergency Medicine (IAEM) and Royal College of Emergency Medicine (RCEM) guidance. Notably, these participants were not resistant to structured guidance in principle but were drawing on frameworks other than the one their radiology department expected them to use.

- "We used to refer to Ortho Bullets or American Orthopaedic Society's guidelines for the imaging, but apart from that, I wasn't aware of any other official guideline from HSE." (Participant 6, emergency medicine NCHD)
- "We have the IAEM guideline... there's also the RCEM guidelines... there's a NICE guideline. So we have different sources that we actually base [decisions] on." (Participant 7, emergency medicine NCHD)

Theme 3: Time and Workload Pressure

Time constraints and heavy workload were cited by the majority of participants as direct barriers to consulting any guideline, whether iRefer or an alternative. Accounts ranged from a straightforward lack of time to a more concerning pattern, described by one participant, of ordering investigations without consciously considering guidance at all when fatigued.

"If you are very busy, then you don't really have the time to go through the guidelines." (Participant 2, orthopaedics NCHD)

"When we're on call and we're tired... we're not aware of what we're actually meant to do or follow any guidelines. We just maybe book an X-ray, book a CT without actually following anything through." (Participant 8, orthopaedics NCHD)

Theme 4: Information Technology and Systemic Access Barriers

A distinct sub-theme, articulated most clearly by the participant with prior exposure to iRefer, was a structural lack of access rather than a lack of time. In this account, iRefer was described as effectively unreachable at the point of care, even for a clinician who actively wished to use it. Suggestions to resolve this centred on integration with the existing single sign-on systems already used for laboratory and radiology results, rather than requiring a separate log-in step.

"I knew it was more of a radiologist-targeted website... there's good tools on it, but we don't have access to it." (Participant 7, emergency medicine NCHD)

"If there was a desktop icon or something... automatically logged on, and I can just click and access it really quickly, that would be one way." (Participant 1, general medicine NCHD)

Theme 5: Interdepartmental Communication and Guideline Conflict With Radiology

A recurring theme, which became increasingly explicit in later interviews, concerned friction between ordering NCHDs and radiology, including consultants vetting requests. Accounts ranged from delays while awaiting further information to open disagreement over which guideline should apply to a given request, with participants describing the absence of a shared, mutually accessible guideline as the root of the problem.

"Sometimes we'll book a scan, radiology will say, 'our guidelines say this'... we don't have access to their guideline... this is a big issue." (Participant 7, emergency medicine NCHD)

"Most of the time, the problem is the conflict between the ordering team and the radiologist. If the departments adhere to this [iRefer], that will help in streamlining ordering scans and prevent delays." (Participant 6, emergency medicine NCHD)

"It would just be easier if there's a way for us to contact them directly and discuss the imaging and the patient, rather than having to go down to X-ray/CT." (Participant 8, orthopaedics NCHD)

Theme 6: Perceived Solutions and Improvement Opportunities

Despite differing specialties and levels of prior exposure, participants converged on a consistent and practical set of suggested improvements. The most frequently proposed measure was formal education at the point of entry to the post, described variously as a day-one induction session or a mandatory HSE e-learning module, and raised independently by participants 2, 5, and 6. Improved digital access was the second recurrent proposal, with participants 1 and 7 both suggesting single sign-on or desktop-integrated access to guidelines so that consultation would not require a separate log-in, and participant 5 proposing that indication prompts be embedded directly within the imaging-ordering system at the point of booking. Lower-technology alternatives were also raised, with participants 8 and 9 suggesting that printed guideline handouts be made available in on-call rooms for settings where digital access is impractical. Beyond access itself, participant 3 identified increased medical staffing as a prerequisite for creating the time needed to consult guidance at all, and participant 8 proposed a direct communication channel between ordering NCHDs and the radiology or vetting consultants responsible for approving requests.

Discussion

The quantitative and qualitative findings of this study triangulate closely. The interview sample's near-total absence of awareness, seen in eight of nine participants, is corroborated at scale by the questionnaire, in which 51/70 respondents (72.9%) reported no awareness of iRefer and only 1/70 (1.4%) reported full awareness. This indicates a substantial and largely unaddressed awareness and induction gap regarding iRefer among NCHDs in this Model 3 hospital, consistent with the broader literature identifying lack of awareness, limited accessibility, and poor workflow integration as recurring barriers to imaging guideline

use internationally [9]. Yet participants were not indifferent to guidance in principle, as several actively used alternative, specialty-specific frameworks in the absence of iRefer, suggesting that the barrier here is one of local awareness and access rather than a general resistance to structured decision-making.

The clinical scenario data extend this picture from stated awareness to actual decision-making behaviour. Guideline-concordant responses ranged from 12/70 (17.1%) to 43/70 (61.4%) across the three scenarios, and only 4/70 respondents (5.7%) answered all three concordantly. Decision-making sources for complex cases were just as revealing, with 49/70 (70.0%) relying on advice from senior colleagues and only 1/70 (1.4%) reporting direct consultation of iRefer or an equivalent tool. In other words, even where a clinical outcome was reasonable, it was often reached through a process largely disconnected from structured, guideline-based decision support, a pattern with clear implications for the consistency and auditability of practice, independent of whether any individual decision happened to be correct. The finding that 23/70 respondents (32.9%) selected lumbar spine radiography for a presentation with no red flags, where no imaging was indicated, is a concrete example of low-value, guideline-discordant imaging with direct radiation and resource implications.

The questionnaire also refines the qualitative account of barriers. While interview participants foregrounded time and workload pressure, the questionnaire found that 45/70 respondents (64.3%) identified a simple lack of knowledge that the guideline existed as their primary barrier, more than double the proportion citing time constraints (16/70; 22.9%). That finding points to awareness-raising, rather than workflow-efficiency measures alone, as the higher-yield initial intervention, with system integration and time-saving measures acting as important secondary reinforcements once basic awareness is established.

The tension between time pressure and structural access barriers identified in this sample mirrors findings from larger studies, in which workload pressures, inadequate staffing, and limited training opportunities are established and generalisable barriers to referral-guideline use [9]. Other work has shown that even where decision support exists, integration into workflow determines whether it is used at all, with a large cluster-randomised trial finding that a comparable European Society of Radiology decision support tool did not meaningfully change ordering behaviour once implemented and that clinicians rarely amended requests even when explicitly told they were inappropriate [4,5]. This raises an important caveat for the present study's recommendations, namely that introducing iRefer alone, without embedding it at the point of ordering, may be insufficient. By contrast, point-of-care decision support integrated directly into the ordering workflow, rather than requiring a separate look-up, has been shown to meaningfully change referral behaviour and reduce radiation dose [7], and predictive-text embedded prompts have been shown to be feasible with minimal added time cost, even if their effect on order selection was modest [6]. This supports participants' own suggestion, expressed in themes 4 and 6, that indication prompts and single sign-on integration are likely to be more effective than a standalone guideline resource.

The interdepartmental conflict identified in theme 5 also points to an underused safeguard. Radiographers, as operators and, in some protocol-defined circumstances, as practitioners under the Regulations, already carry a legal and professional duty to confirm justification before proceeding and are entitled to decline to perform an examination they judge unjustified [12]. Participants described this dynamic as a source of friction rather than a functioning safeguard, largely because disputes were resolved on an ad hoc basis rather than through a defined pathway. Explicitly supporting radiographers to decline unjustified requests, with a clear route of escalation to the on-call radiologist for rapid arbitration, would formalise a check that is already implicit in the legal framework, while giving both ordering NCHDs and radiographers a structured, non-confrontational route to resolve disagreements rather than the informal conflict described in this sample.

This interdepartmental communication and guideline-conflict theme is, to the authors' knowledge, a less commonly foregrounded finding in the existing literature on imaging referral barriers, which more often centres on the referring clinician in isolation. Participants in this study described the absence of a shared, mutually accessible guideline as a direct source of conflict with radiology, rather than simply a referrer-side knowledge gap. Improving iRefer access for NCHDs may therefore carry a secondary benefit beyond its primary aim of improving referral appropriateness, namely a reduction in interdepartmental friction and request delays.

A further implication of these findings is regulatory as well as educational. Under S.I. No. 256 of 2018, the referrer carries a defined statutory duty in the justification of every medical exposure involving ionising radiation, and HIQA inspects and enforces compliance with these Regulations [12,16]. HSE guidance for referrers sets out a governance checklist that explicitly includes access to iRefer or an equivalent clinical decision support tool and identifies HSeLanD e-learning, seminars, study days, and local training as expected training routes. In this sample, no participant had received radiation protection or referrer-specific induction at the hospital, and those who wanted to use iRefer could not access it. Participants themselves independently proposed a mandatory HSeLanD module as the solution, apparently unaware that radiation protection training for referrers is already delivered through precisely that channel nationally, representing an awareness gap about the training infrastructure itself and not merely about the guideline.

One further observation concerns what did not arise. Radiation protection and radiation dose did not feature spontaneously as considerations in any participant's account of how they decide to order imaging, with participants framing their reasoning almost exclusively around diagnostic utility, clinical judgement, and departmental logistics. While the interview topic guide did not prompt specifically on radiation risk, the absence of any unprompted reference to dose or justification across nine interviews spanning five specialties is itself worth flagging, particularly when set against the questionnaire finding that only 4/70 respondents (5.7%) were fully aware of their legal responsibilities regarding justification.

Taken together, these findings point towards several practical priorities. Foremost is incorporating iRefer awareness and practical navigation into mandatory NCHD induction on commencement of a post, given that no participant in this sample had received any formal training on it. This could be delivered through the existing HSeLanD radiation protection modules supplemented by in-person hospital-based sessions, with completion recorded centrally and iRefer use framed explicitly within the referrer's statutory obligations under S.I. No. 256 of 2018 rather than as optional guidance. Structural access barriers warrant equal attention: providing single sign-on or desktop-integrated access to iRefer alongside existing laboratory and radiology results systems and embedding indication-based prompts directly within the electronic imaging-ordering system at the point of booking are both supported by evidence that point-of-care integration is more effective than a standalone guideline resource [6,7]. Where digital access is impractical, low-technology fallback options such as printed summary guidance in on-call rooms, as suggested directly by participants, offer a pragmatic interim measure.

A further set of priorities follows from the interdepartmental friction identified in theme 5. Establishing a clear, direct communication pathway between ordering NCHDs and radiology or vetting consultants would reduce delays and resolve guideline discrepancies without requiring in-person attendance at the radiology department. In parallel, explicitly supporting radiographers in exercising their existing duty as operators under S.I. No. 256 of 2018 to decline unjustified imaging requests, with a defined and rapid escalation pathway to the on-call radiologist for arbitration when the requesting team disagrees, would formalise the resolution of the guideline conflicts identified in this study. The hospital should also audit its practice against the HSE local governance checklist for referrers of radiological procedures, particularly the requirement for referrer access to iRefer or an equivalent clinical decision support tool. Given that lack of knowledge of iRefer's existence was reported far more frequently than time constraints as the primary barrier, awareness campaigns should be prioritised ahead of, or alongside, system-integration measures, with a re-audit of awareness, decision-making sources, and scenario concordance following implementation completing the quality improvement cycle.

Strengths and limitations

Strengths of this study include its mixed-methods design, allowing quantitative prevalence data and qualitative depth to be triangulated; a questionnaire response rate of 70/90 (77.8%); a qualitative sample spanning five clinical specialties with differing imaging referral patterns; and a principled, saturation-driven approach to qualitative recruitment, whereby interviewing continued until no new codes or themes were emerging rather than stopping at an arbitrary or predetermined number, supporting the adequacy of the final sample for the depth of analysis presented. The brevity of the interviews, while initially apparent as a limitation, captured honest and unrehearsed reactions rather than rehearsed answers, consistent with how little exposure most participants had to the guideline beforehand.

Several limitations should be acknowledged. Both the qualitative and quantitative samples were drawn from a single Model 3 hospital, which limits generalisability to other hospitals or healthcare systems. The semi-structured interview format, while enabling rich data, may be subject to social desirability bias despite assurances of confidentiality, and the paper-based, investigator-administered questionnaire format may be similarly affected despite anonymity, given the in-person distribution. The questionnaire was developed by the authors for this study and has not undergone formal validation, and the single-best-answer format of the clinical scenarios necessarily simplifies decisions that, in practice, depend on local availability, patient factors, and clinical context. Finally, awareness and decision-making sources were self-reported rather than observed, and actual ordering behaviour was not independently verified against radiology records.

Conclusions

Among NCHDs in this Model 3 hospital, awareness of the RCR's iRefer guidelines was low, with 51/70 questionnaire respondents (72.9%) reporting no awareness, corroborating the near-total absence of awareness observed in eight of nine interview participants, none of whom had received formal induction on iRefer. In the absence of the guideline, NCHDs relied overwhelmingly on informal, colleague-mediated decision-making, reported by 49/70 respondents (70.0%), rather than on structured guidance. Guideline-concordant responses to clinical scenarios ranged from 12/70 (17.1%) to 43/70 (61.4%), with only 4/70 (5.7%) answering all three scenarios concordantly. Time pressure, information technology and access barriers, and interdepartmental friction with radiology were identified as distinct, compounding barriers to guideline-concordant imaging referral, although questionnaire data suggest that a basic lack of awareness of the guideline's existence, cited by 45/70 respondents (64.3%), is a more prevalent barrier than time constraints, cited by 16/70 (22.9%). Because referrers carry defined statutory duties in the justification of medical

exposures under S.I. No. 256 of 2018, and because HSE guidance requires referrers to have access to iRefer or an equivalent decision support tool, these gaps carry regulatory as well as clinical significance. The necessary training infrastructure already exists nationally through HSeLand and local hospital courses. These triangulated findings support mandatory radiation protection and referrer training at induction, point-of-care system integration, and formalised radiology communication pathways, including explicitly supporting radiographers in declining unjustified requests, with a clear escalation route to the on-call radiologist, as priority interventions.

Appendices

Appendix 1

Audit Questionnaire

The following questionnaire was developed by the authors for this study and administered in paper form. It has not been previously published and has not undergone formal psychometric validation.

1. What is your current grade?

Intern / Senior house officer / Registrar / Senior registrar or fellow

2. What is your current specialty?

Free-text response

3. In an average week, how many radiology requests involving ionising radiation do you submit?

0-5 / 6-15 / 16-30 / More than 30

4. How familiar are you with the Royal College of Radiologists (RCR) iRefer (Making the Best Use of Clinical Radiology) guidelines?

Yes, fully aware / Aware but do not know the details / Not aware of these guidelines

5. Are you aware of your legal responsibilities as a referrer regarding the justification of scans under Irish legislation S.I. No. 256 of 2018?

Yes, fully aware / Aware but do not know the details / Not aware of this legislation

6. How do you currently decide which is the most appropriate imaging modality for a complex case?

Advice from a senior colleague / Consult radiology / Search iRefer or ESR iGuide / Google or UpToDate

7. Clinical scenario: A 28-year-old woman, 12 weeks pregnant, with suspected pulmonary embolism and an elevated D-dimer. What is the recommended first-line investigation?

- A) Computed tomography pulmonary angiography
- B) Ventilation/perfusion scan
- C) Chest radiograph
- D) Leg vein ultrasound

8. Clinical scenario: A 45-year-old man with four weeks of non-specific low back pain, no red flags, and no history of trauma. What is the recommended imaging?

- A) Radiograph of the lumbar spine
- B) MRI of the lumbar spine
- C) CT of the lumbar spine
- D) No imaging indicated

9. Clinical scenario: Persistent anatomical snuffbox tenderness following a fall, with initial radiographs negative. What is the recommended next step?

- A) Repeat radiograph at 10-14 days
- B) Early MRI
- C) Early CT
- D) Discharge

10. What is the primary barrier to consulting iRefer guidelines during your clinical shift?

Free-text response

Appendix 2

Semi-structured Interview Topic Guide

The following topic guide was developed by the authors for this study and was not piloted or formally psychometrically validated. Interviews were conducted one-to-one and audio-recorded with written consent. The guide was applied flexibly: questions were asked in a broadly consistent order, but follow-up prompts varied according to each participant's responses, and participants were free to raise issues not covered by the guide.

Opening

Confirmation of consent, specialty, and grade; reassurance regarding anonymity and that responses would not affect professional standing.

1. Awareness and prior exposure: Are you familiar with the RCR iRefer (Making the Best Use of Clinical Radiology) guidelines?

Prompts: If so, how and when did you first become aware of them? Was this during undergraduate training, at induction, in a previous post, or through a colleague? Have you received any formal training or induction covering iRefer at this hospital?

2. Current decision-making process: When you need to decide which imaging investigation is most appropriate for a patient, what do you do?

Prompts: Do you consult a senior colleague, contact radiology directly, use an online resource, or rely on your own clinical judgement? Which specific guidelines or resources, if any, do you use? Does this differ between routine and out-of-hours work?

3. Time and workload: How do time constraints and workload affect your ability to consult guidance before ordering imaging?

Prompts: Can you describe a situation in which you did not have time to look something up? What happens when you are on call or fatigued?

4. Access and barriers: What would make it easier or harder for you to use iRefer at the point of care?

Prompts: Do you have access to it at this hospital? Are there practical, technical, or system barriers? How does the log-in or access process compare with other systems you use for laboratory or radiology results?

5. Suggestions for improvement: What changes would make iRefer more seamless and accessible for NCHDs in your position?

Prompts: Induction or training? Integration with the imaging-ordering system? Printed materials? Any other measures?

6. Additional workflow challenges: Are there any other challenges in the imaging referral process that have not been covered?

Prompts: Interactions with the radiology department? Vetting or rejection of requests? Delays?

Closing

Opportunity for any further comments; thanks and confirmation of contact arrangements.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Mayo University Hospital Ethics Committee issued approval 20260701. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following:

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