

INTERPRETING COMPLEXITY: HOW SENIOR CLINICAL FELLOWS APPROACH CHALLENGING CARDIOTHORACIC IMAGING CASES - A QUALITATIVE STUDY

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ABSTRACT

OBJECTIVES

To explore how senior clinical fellows in cardiothoracic radiology approach complex imaging cases in routine clinical practice, with secondary objectives of understanding how they manage diagnostic uncertainty, the factors influencing their decision-making, and the development of confidence and independence during fellowship.

METHODOLOGY

A qualitative descriptive study was conducted involving seven senior clinical fellows in cardiothoracic radiology at Liverpool Heart and Chest Hospital, Liverpool, UK, between January 2026 and March 2026. Participants were selected using purposive sampling based on relevant clinical experience. Data were collected through face-to-face interviews using a structured questionnaire containing open-ended and Likert-scale questions. Qualitative interview data were analysed using Braun and Clarke's six-phase thematic analysis framework.

RESULTS

Five major themes emerged, including supportive environment in decision-making, importance of clinical details, diagnostic uncertainty, decision-making under stress, and experiential learning. Fellows reported that consultant supervision, support and multidisciplinary discussions were essential for managing uncertainty. Limited clinical information and ambiguous imaging findings increased diagnostic difficulty. Clinical demands, particularly in unstable patients, influenced decision-making. Furthermore, experience and literature review improved confidence over time.

CONCLUSION

Decision-making in complex cardiothoracic imaging involves managing uncertainty through senior Consultant support, mentorship, adequate clinical information, and experience, which together improve confidence in interpretation and patient care.

KEYWORDS: Cardiothoracic Imaging, Clinical Decision-Making, Diagnostic Uncertainty, Radiology Training, Qualitative Research, Medical Education

INTRODUCTION

Cardiothoracic imaging at a dedicated tertiary care cardiothoracic centre usually involves complex cases for specialist opinion. The findings may be subtle or too complex for a general radiologist. Accurate interpretation of these complex or subtle imaging findings is of utmost importance, as it may alter the management and outcomes of the patient. Discrepancies in these special studies are expected to be higher than normal. The usual approximate discrepancy rate of radiological reports is 3–5% of studies reported.¹ There is rapid change in teaching methods, and importance is given to competency-based training and learning in medical education. The newer teaching methods and approaches, including flipped classroom, are being employed in daily practice. This has led to changes in the assessment of trainees and fellows. There is use of higher

cognitive-based assessment models and decision-making tools, which include entrustable professional activities. The newer models are replacing the traditional methods of teaching and assessment.^{2,3} It is evident that traditional teaching and learning models do not fully help students understand how clinical decisions are made in real-world scenarios. Hence, clinicians with good reasoning skills are developed through better knowledge structures through repeated and variable real-world clinical exposure using newer teaching methods.⁴ Clinical decision-making in real life is influenced not only by basic medical knowledge and technical skills but also by factors such as uncertainty, time pressure, workload and access to clinical support systems.^{5,6} These themes and challenges are especially relevant in cardiothoracic imaging, where the reporting radiologists encounter multiple possible diagnoses and incomplete clinical and surgical information is common. Senior

clinical fellows are at an important stage of training and learning. They are expected to make some degree of independent decisions during their training while still counting on guidance from senior colleagues. The level of independent decision-making depends upon the stage of training and experience. Understanding how they approach and diagnose complex cardiothoracic cases can provide useful information for training, supervision, clinical practice and help improve radiology training programs. Therefore, the primary objective of this study was to explore how senior clinical fellows in cardiothoracic radiology approach the interpretation of complex imaging cases in routine clinical practice. The secondary objectives were to understand how fellows recognise and manage diagnostic uncertainty, to explore the factors that influence their decision-making when interpreting complex imaging cases, and to understand how they develop confidence and independence during their fellowship.

METHODOLOGY

A qualitative descriptive study was conducted at Liverpool Heart and Chest Hospital, UK, between January 2026 and March 2026, involving seven senior clinical fellows in cardiothoracic radiology. A qualitative descriptive design was selected because the study aimed to explore and describe fellows' experiences and approaches to interpreting complex cardiothoracic radiology cases. The participants included current and former fellows who had undertaken a structured senior clinical fellowship in cardiothoracic imaging. The Ethical Review Board, Health Services Academy, Islamabad, Pakistan, approved the study (reference: RO-423/2026/HSA/DHPE-V; approval date: 2 January 2026). Written informed consent was obtained from all participants before participation in the study. Participants were selected using purposive sampling to ensure relevant clinical experience. The sample size was guided by thematic saturation. Saturation was assessed by reviewing the interview data as data collection progressed and was considered to have been reached when later interviews produced similar repetitive themes without identifying any new themes. Recruitment was therefore concluded after seven participants. Data were collected through face-to-face interviews using a structured questionnaire that included both open-ended and Likert-scale questions. The structured questionnaire ensured consistency across interviews and covered the study objectives. It included open-ended questions that allowed participants to describe their experiences and perspectives in their own words. Qualitative interview data were analysed using Braun and Clarke's six-phase thematic analysis framework. Following transcription and anonymisation, the lead researcher repeatedly read the transcripts to become familiar with the data and

generated the initial codes. Codes were compared across participants and grouped according to recurring patterns in the data. Related codes were then organised into candidate themes. A second researcher reviewed the initial codes and candidate themes to provide an additional perspective on the interpretation of the data. Any differences in interpretation were discussed between the researchers and resolved through consensus. The candidate themes were subsequently reviewed against the original interview data and refined. The final themes were defined and named to ensure that they accurately represented participants' accounts and addressed the study objectives. This methodology examines how radiologists make decisions in complex cases by interviewing fellows and analysing their answers to find common patterns.

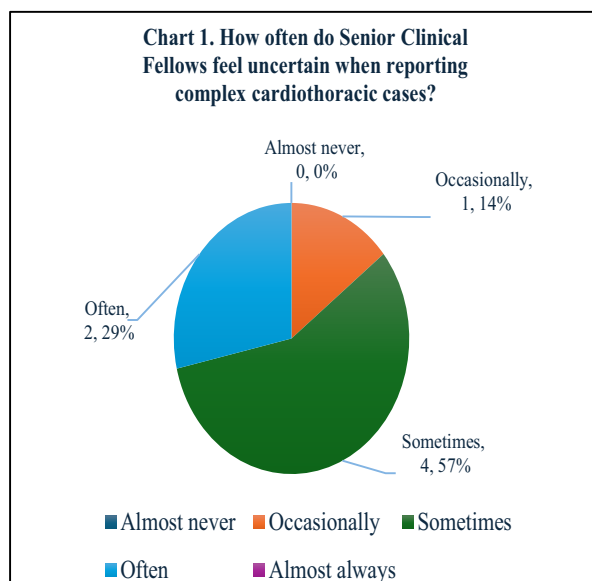
RESULTS

Seven senior clinical fellows participated in the study. Their demographic and professional characteristics are summarised in Table 1.

Table 1: Demographic and Professional Characteristics of Participants (n = 7)

Characteristic	Category	n (%)
Gender	Female	04 (57.1%)
	Male	03 (42.9%)
Duration as Senior Clinical Fellow	3–6 months	02 (28.6%)
	9–12 months	04 (57.1%)
	>1 year	01 (14.3%)

Participants generally rated cases as moderately to highly complex, with moderate to high confidence in identifying complexity. However, uncertainty was common, with most fellows reporting occasional to frequent uncertainty, often of moderate intensity as shown in Chart 1.



Fellows reported a strong sense of responsibility and moderate confidence in managing uncertainty. Most sought consultant support regularly, particularly for complex cases. Time pressure had a moderate impact on decision-making, and stress was reported occasionally to often. All participants noted increased confidence over time. Qualitative responses highlighted the importance of consultant support, clinical information, multidisciplinary discussion, and experience in managing complex cases, as given in Table 1.

Table 2: Themes and Subthemes Influencing Clinical Decision-Making

Theme	Subthemes	Representative Quotes / Findings
Clinical Support Systems	Consultant supervision	"Having an available consultant nearby for advice if I am uncertain."
	Multidisciplinary discussion	"Discussion with clinicians helps pinpoint diagnosis."
	Peer and team input	Fellows reported better decisions with shared opinions ("two heads are better than one").
Clinical Information	Availability of clinical history	"Knowing the exact clinical history and intraoperative notes."
	Operative details	Accurate operative information improved diagnostic confidence.
	Lack of information	Missing data increased uncertainty and required further imaging or discussion.
Diagnostic Uncertainty	Overlapping imaging findings	Difficulty distinguishing haemorrhage vs surgical material
	Complex vascular/postoperative cases	Endoleak vs penetrating ulcer confusion
	Inadequate imaging	Poor-quality imaging increased uncertainty.
Decision-Making Under Pressure	Time constraints	Rapid decisions required despite incomplete data
	Clinical urgency	Managing unstable patients
	Stress and cognitive load	Balancing speed with diagnostic accuracy
Learning Through Experience	Case exposure	Recognition improves with repeated cases
	Consultant feedback	Helps refine decision-making
	Self-directed learning	Literature review and case-based learning
	Increasing independence	Transition from reliance to confidence over time

The findings show that managing complex cardiothoracic imaging cases is influenced by multiple interacting factors, including clinical support systems, clinical context, uncertainty, and experience. Most participants reported increased confidence over time, with the majority feeling more confident in managing complex cases during their fellowship.

Theme 1: Clinical Support Systems in Decision-Making

Fellows said they make better decisions when they have support from consultants and the wider team. When cases get tricky, having a senior radiologist involved makes a big difference. It gives them confidence and helps them avoid going down the wrong path. As many would say, "two heads are better than one." They also valued team discussions, like MDT meetings. Hearing different viewpoints helps build a clearer picture and ensures nothing important is missed. It is a way of keeping each other in check and learning along the way. Overall, good support means fellows are less likely to second-guess themselves and more likely to reach the right decision. In simple terms, fellows make safer and more confident decisions when they can talk things through with experienced colleagues instead of going it alone. "Having an available consultant nearby for advice if I am uncertain." "Discussion with clinicians helps pinpoint diagnosis."

Theme 2: Importance of Clinical Information

Fellows said that detailed clinical information and concise clinical questions are essential for interpreting imaging correctly. When they had clear details, such as the patient's history or operative notes, it made decision-making much easier and more accurate. As one participant put it, "Knowing the exact clinical history and intraoperative notes." It helps them connect the dots and see the full picture. On the other hand, when information was missing, uncertainty increased. In those situations, fellows often had to fill in the gaps by requesting more imaging or discussing the case with others.

Theme 3: Diagnostic Uncertainty

Fellows said that uncertainty is part of daily practice, especially in complex imaging cases. They often found it difficult to tell apart conditions that look similar on imaging, particularly in postoperative and vascular cases. For example, it can be challenging to distinguish haemorrhage from surgical material or endoleak from a penetrating ulcer. The uncertainty is even worse when the imaging is inadequate. Fellows often face uncertainty because different conditions can look alike on imaging, so they consider several possible diagnoses before concluding.

Theme 4: Decision-Making Under Pressure

Fellows said they often work in high-pressure situations, especially when dealing with unstable patients. In these cases, they have to make decisions quickly, even when

enough information is not available. There is little time to pause, so they have to think on their feet and make a quick decision. This creates a clear tension and tests their nerves. On one hand, they want to be certain about the diagnosis. On the other, they cannot afford to delay treatment. As a result, they often have to balance speed with accuracy and make the best possible decision with what they have. Fellows often make quick decisions in urgent situations, even without full information, balancing the need to act fast with the need to be accurate.

Theme 5: Learning Through Experience

Fellows said that experience is key to building confidence and improving decision-making. They learned over time through several ways: Seeing more cases, which helped them recognise patterns; and reading the literature to strengthen their knowledge. Getting feedback from consultants helped them correct mistakes and improve over time; this learning helped them find their feet and feel more comfortable handling difficult cases. They became better at dealing with uncertainty and more confident in making decisions on their own. Fellows become more confident and better at making decisions as they gain experience, learn from cases, and receive feedback.

DISCUSSION

This qualitative study points out several critical factors that influence clinical decision-making in cardiothoracic radiology despite limited sample size. Our findings show that clinical decision-making is not solely based on imaging, but is shaped by a combination of clinical information, consultant support, experience, and the ability to manage uncertainty, often in crucial time-sensitive and acute situations. Fellows described depending on accurate clinical history and operative details to interpret imaging correctly, especially in postoperative studies, while also seeking input from consultants and multidisciplinary teams to improve confidence and reduce errors in diagnosis. Uncertainty was a common feature, and all fellows reported a certain level of uncertainty, particularly in complex postoperative and vascular cases, where multiple differential diagnoses had to be considered at the same time. In addition, participants reported working under pressure, where rapid decisions were required despite incomplete or insufficient information, highlighting the balance between diagnostic certainty and timely intervention. These findings are consistent with the work of Mastrodicasa D et al., which emphasises the value of integrating imaging with clinical context and working within a multidisciplinary environment.⁷ Repeated exposures to complex cases helps fellows improve their clinical reasoning and recognise imaging patterns more confidently. This may reflect dual-process theory, where

familiar cases are recognised more rapidly through pattern recognition, while difficult or unfamiliar cases require slower and more careful thinking. They also learn by observing how experienced supervisors approach difficult cases and reach a diagnosis. However, when cases are unfamiliar or uncertain, senior support remains important. The study also supports the idea that experience and ongoing learning play a key role in developing confidence and gradual independent decision-making. Overall, this suggests that decision-making in cardiothoracic radiology is a complex and evolving process that depends on both individual judgement, learning and effective teamwork. Seeking consultant input in dubious cases remains an important component of safe clinical practice in radiology. The review by Manoel PZ et al. describes how modern cardiovascular imaging is increasingly incorporated with clinical data to support more precise and bespoke patient care.⁸ This reflects our findings that accurate clinical information is essential for interpreting imaging and improving diagnostic confidence in reporting. The review also highlights the use of advanced technologies and quantitative imaging in making more structured and accurate reports. However, despite these advances, the need for clinical judgement, experience, and multidisciplinary feedback remains central. This supports our observation that decision-making in cardiothoracic radiology continues to depend on a balance between technology, clinical context, and human experience. Uncertainty is a fundamental part of radiology reports rather than a reflection of inadequate knowledge. It can be attributed to many factors, including technical difficulties and similar imaging features. Bruno et al. demonstrate how imaging interpretation often involves vagueness due to overlapping imaging findings, making uncertainty a central feature of radiological practice.⁹ Similarly, Littlefair et al. stresses that radiology decision-making frequently occurs in situations where complete certainty is not possible.¹⁰ This aligns with our results and themes, where fellows reported difficulty distinguishing between similar imaging features despite having adequate knowledge. Together, this suggests that complexity in cardiothoracic imaging arises mainly from the nature of the imaging itself, requiring clinicians to manage uncertainty and consider multiple possible diagnoses rather than simply applying factual knowledge. Adequate clinical information and multidisciplinary input help in these cases. Fellows trust a combination of support systems, clinical context, and experiential learning to navigate this uncertainty. Consultant supervision emerged as a key factor, reflecting the importance of mentorship in clinical training and fellowship. Fellows do not remove uncertainty, but they learn to manage it efficiently through a combination of support, clinical context, and experience. Access to

senior input helps reduce doubt and avoid errors. Mentorship has been shown to support radiological professional development by providing guidance, feedback, and reassurance during uncertain situations.^{11,12} The study by Zavala Calahorrano A et al. highlights that clinicians often work in active and uncertain situations, where time pressures, workload and incomplete information increase the risk of errors.¹³ Similarly, the systematic review by Carrie Reale et al. highlights that during stressful times, clinical decision-making is affected by stress, cognitive load, and situational complexity.¹⁴ These studies support our findings that fellows frequently make rapid decisions in urgent scenarios while balancing the need for accuracy with the requirement for timely intervention. Both studies also highlight the importance of experience, teamwork, and structured support systems in reducing error and improving overall outcomes. Both studies also highlight the importance of experience, teamwork, and structured support systems in reducing errors, mistakes and improving overall outcomes. This also links to cognitive load theory. Complex cases require fellows to consider several pieces of information at the same time. When this happens under time pressure, decision-making can become more difficult. Research studies show that as trainees progress from junior to senior stages, their confidence and ability to make independent decisions improve, reflecting increased clinical exposure and responsibility. Colarieti et al. state that perceived autonomy and readiness increase with training and extended experience. These are closely related to the quality of mentorship and education.¹⁵ Similarly, Vieira et al. and Fagan et al. emphasise that mentorship provides essential guidance, feedback, and support during uncertain situations, helping trainees bridge the gap between knowledge and practice. These findings strengthen the view that the transition from supervised to independent decision-making, like from trainee to a consultant, is a gradual process shaped by experience, structured training, and effective mentorship.^{11,12,18} These findings can also be understood through situated learning theory, which suggests that learning develops through active participation in everyday clinical practice. For fellows, working within the clinical team and taking increasing responsibility may support their gradual development towards independent practice. This study highlights that clinical decision-making in cardiothoracic radiology is a complex process shaped by uncertainty, clinical background, consultant support systems, and clinical experience. Fellows do not rely on a single factor but use a combination of basic knowledge, senior mentorship, and repeated exposure to similar cases to make safe and effective decisions. As training progresses, there is a clear shift from dependence on

supervision to greater independence, supported by growing confidence, experience and pattern recognition. These findings are consistent with the work of Berner ES and Graber ML, who highlight that both cognitive processes and system-level factors, including experience and clinical support systems, influence clinical decision-making.^{16,17} Overall, improving decision-making in cardiothoracic radiology requires not only advanced imaging tools but also strong, committed training environments, effective mentorship, and recognition of uncertainty as a core part of clinical practice.

LIMITATION

A small sample size and single-centre design limited the study. Self-reported data may introduce recall bias. Future studies with larger samples and other methodological approaches may provide broader insights.

CONCLUSION

This study highlights that interpreting complex cardiothoracic imaging requires more than image recognition alone. Clinical information, diagnostic uncertainty, time pressure, experience, mentorship and senior support all these factors influence clinical reasoning and decision-making. With increasing case exposure, feedback and mentorship, fellows develop greater confidence and independence. Ultimately, experience builds confidence, but knowing when to seek support remains an important part of clinical expertise and patient safety.

CONFLICT OF INTEREST: None

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AUTHORS CONTRIBUTION

Khalid Shakeel Babar - Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Supervision; Final Approval

Junaid Sarfraz Khan - Concept & Design; Drafting Manuscript; Critical Revision; Supervision; Final Approval

The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.



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