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PATIENT SAFETY EVALUATION IN RADIODIAGNOSIS SERVICES IN GOVERNMENT AND PRIVATE HOSPITALS IN NORTH SUMATERA

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ABSTRACT

Patient safety in diagnostic radiology is an essential component of healthcare quality, directly influencing patient outcomes and the efficiency of medical diagnostics. Despite continuous advancements in imaging technology, risks associated with radiation exposure, misdiagnosis, and procedural errors remain significant challenges. These issues are particularly complex in developing countries, including Indonesia, where the implementation of patient safety protocols is often inconsistent. In North Sumatra, disparities in infrastructure and regulatory enforcement between public and private hospitals may contribute to variations in radiology safety practices. This study aimed to evaluate and compare the implementation of patient safety practices in diagnostic radiology services between public and private hospitals in North Sumatra. A comparative cross-sectional design with a mixed-methods approach was employed. The study involved 200 radiographers and radiology technicians, equally divided between 10 public hospitals and 10 private hospitals, selected through stratified random sampling. Data were collected using a standardized questionnaire with a Cronbach's alpha of 0.88 and a content validity index (CVI) of 0.92, supplemented by structured observation checklists and semi-structured interviews to capture contextual insights. Data analysis included descriptive statistics, independent samples t-tests, and chi-square tests, with significance set at $p < 0.05$. Findings revealed significant differences between public and private hospitals. Compliance with radiation protection protocols was higher in private hospitals (mean = 4.2 ± 0.6) compared to public hospitals (mean = 3.5 ± 0.7), with a statistically significant difference ($t(198) = 7.87$, $p < 0.001$, Cohen's $d = 1.11$). Private hospitals also demonstrated stronger implementation of quality assurance measures and patient identification procedures. However, both sectors showed inconsistent application of informed consent for contrast media use. Qualitative data indicated that private hospitals generally had more advanced equipment, while public institutions emphasized continuous staff training. In conclusion, private hospitals exhibited higher compliance with patient safety practices, yet both sectors face challenges requiring targeted interventions. This study underscores the importance of standardized training programs, robust regulatory oversight, and the development of a proactive safety culture across healthcare facilities. Theoretically, it enhances understanding of how organizational factors shape patient safety, while practically, it provides evidence-based recommendations for policymakers and hospital administrators to strengthen diagnostic radiology services in Indonesia.

Keywords: Patient Safety, Diagnostic Radiology, Hospital Comparison, Radiation Protection, Healthcare Quality.

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EVALUASI KESELAMATAN PASIEN DALAM PELAYANAN RADIODIAGNOSTIK DI RS PEMERINTAH DAN SWASTA DI SUMATERA UTARA

ABSTRAK

Keselamatan pasien dalam radiologi diagnostik merupakan komponen esensial dari mutu pelayanan kesehatan, yang berdampak langsung terhadap luaran pasien dan efisiensi diagnostik medis. Meskipun teknologi pencitraan terus berkembang, risiko terkait paparan radiasi, kesalahan diagnosis, dan kesalahan prosedural masih menjadi tantangan signifikan. Kondisi ini semakin kompleks di negara berkembang, termasuk Indonesia, di mana implementasi protokol keselamatan pasien belum merata. Di Sumatera Utara, perbedaan infrastruktur dan penegakan regulasi antara rumah sakit publik dan swasta berpotensi menimbulkan disparitas dalam praktik keselamatan radiologi. Penelitian ini bertujuan mengevaluasi dan membandingkan implementasi praktik keselamatan pasien pada layanan radiologi diagnostik di rumah sakit publik dan swasta di Sumatera Utara. Desain penelitian yang digunakan adalah komparatif potong lintang dengan pendekatan campuran. Sampel penelitian terdiri dari 200 radiografer dan teknisi radiologi, masing-masing 100 dari 10 rumah sakit publik dan 100 dari 10 rumah sakit swasta, dipilih melalui stratified random sampling. Instrumen penelitian berupa kuesioner terstandar dengan reliabilitas Cronbach's alpha 0,88 dan CVI 0,92, ditambah observasi terstruktur serta wawancara semi-terstruktur untuk memperdalam konteks. Analisis data menggunakan statistik deskriptif, uji-t independen, dan chi-square pada tingkat signifikansi $p < 0,05$. Hasil penelitian menunjukkan adanya perbedaan signifikan antara rumah sakit publik dan swasta. Tingkat kepatuhan terhadap protokol proteksi radiasi lebih tinggi di rumah sakit swasta (mean = 4,2 ± 0,6) dibanding publik (mean = 3,5 ± 0,7), dengan perbedaan signifikan ($t(198) = 7,87$, $p < 0,001$, Cohen's $d = 1,11$). Rumah sakit swasta juga lebih unggul dalam penerapan jaminan mutu dan prosedur identifikasi pasien. Namun, kelemahan umum ditemukan pada keduanya, yaitu ketidakonsistenan dalam penerapan informed consent penggunaan media kontras. Data kualitatif mengungkap bahwa fasilitas swasta memiliki peralatan lebih canggih, sedangkan institusi publik lebih menonjol dalam penyediaan pelatihan berkelanjutan. Kesimpulannya, rumah sakit swasta menunjukkan tingkat kepatuhan keselamatan lebih baik, tetapi keduanya menghadapi tantangan yang perlu intervensi khusus. Penelitian ini menegaskan pentingnya pelatihan standar, pengawasan regulasi yang kuat, dan pembentukan budaya keselamatan proaktif di seluruh fasilitas kesehatan. Secara teoritis, penelitian ini memperkaya pemahaman tentang pengaruh faktor organisasi terhadap keselamatan pasien, sementara secara praktis memberikan rekomendasi berbasis bukti bagi pembuat kebijakan dan pengelola rumah sakit untuk meningkatkan mutu layanan radiodiagnostik.

Keywords: Patient Safety, Diagnostic Radiology, Hospital Comparison, Radiation Protection, Healthcare Quality.

INTRODUCTION

The landscape of modern healthcare is increasingly reliant on advanced diagnostic imaging technologies, with radiology serving as a cornerstone for accurate disease detection, staging, and management. Diagnostic radiology, encompassing a spectrum of modalities from

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conventional radiography and fluoroscopy to sophisticated techniques like computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound, plays an indispensable role in patient care pathways. The global demand for these services continues to surge, driven by an aging population, the rising prevalence of chronic diseases, and advancements in imaging technology that enable earlier and more precise diagnoses (WHO, 2023). In 2022, the global medical imaging market was valued at approximately USD 47.1 billion and is projected to grow at a compound annual growth rate (CAGR) of 5.5% from 2023 to 2030 (Grand View Research, 2023). This escalating utilization, however, amplifies the inherent risks associated with the procedures, underscoring the critical importance of robust patient safety protocols.

The imperative for precision in patient safety within diagnostic radiology is not merely an operational consideration; it is a fundamental ethical and clinical obligation. While the benefits of diagnostic imaging are undeniable, the potential for adverse events, including radiation exposure, misdiagnosis, and equipment-related incidents, necessitates a vigilant and proactive approach to safety. The World Health Organization (WHO) has consistently highlighted patient safety as a global health priority, emphasizing that preventable medical errors contribute significantly to morbidity and mortality worldwide (WHO, 2019). Specifically within radiology, the use of ionizing radiation, while often essential for diagnosis, carries inherent risks of stochastic effects (e.g., cancer induction) and deterministic effects (e.g., skin burns) if not meticulously managed (ICRP, 2017). Furthermore, the increasing complexity of imaging equipment and protocols, coupled with the high volume of procedures, creates a fertile ground for potential errors if adequate safety measures are not in place and rigorously enforced. The Indonesian healthcare system, like many developing nations, faces the dual challenge of expanding access to advanced medical services while ensuring their quality and safety. The Ministry of Health of Indonesia has recognized patient safety as a key performance indicator for healthcare facilities, aiming to reduce adverse events and improve patient outcomes (Kemenkes RI, 2021). However, the implementation and effectiveness of patient safety initiatives can vary significantly across different healthcare settings, influenced by factors such as resource availability, staff training, regulatory oversight, and organizational culture. Publicly funded government hospitals and privately owned healthcare institutions often operate with distinct financial models, management structures, and patient demographics, which can lead to divergent approaches to patient safety implementation. Understanding these differences is crucial for developing context-specific strategies to enhance safety.

The ongoing evolution of diagnostic radiology, characterized by the rapid adoption of digital technologies (e.g., Picture Archiving and Communication Systems - PACS, and Radiography Digital Imaging and Communication - DICOM), artificial intelligence (AI) in image analysis, and interventional radiology procedures, presents both opportunities and challenges for patient safety. While AI holds promise for improving diagnostic accuracy and workflow efficiency, its integration requires careful validation to prevent algorithmic bias and ensure patient well-being (Topol, 2019). Similarly, the increasing sophistication of equipment necessitates continuous training and competency assessment for radiographers and radiologists to ensure their safe and effective operation (European Society of Radiology, 2020). This dynamic environment demands a continuous re-evaluation of existing safety

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practices and the development of new strategies to address emerging risks.Despite the global emphasis on patient safety, empirical data specifically evaluating the comprehensive safety practices within diagnostic radiology departments in regions like Sumatera Utara, Indonesia, remains limited. Existing research often focuses on specific aspects, such as radiation dose optimization or the prevalence of certain types of errors, but a holistic assessment of patient safety frameworks in both government and private hospitals within this specific geographical context is a significant gap. This lack of localized, comprehensive data hinders the development of targeted interventions and policy recommendations tailored to the unique challenges and opportunities present in the region. Therefore, this study is urgently needed to bridge this knowledge gap and provide evidence-based insights into the current state of patient safety in diagnostic radiology services in Sumatera Utara.

LITERATURE REVIEW

The critical role of diagnostic radiology in modern healthcare necessitates a rigorous examination of patient safety within these services. This literature review aims to explore the multifaceted aspects of patient safety in diagnostic radiology, with a specific focus on the comparison between public and private healthcare institutions in North Sumatra. Patient safety, defined by the World Health Organization (WHO) as the avoidance, prevention, and amelioration of adverse events or injuries resulting from healthcare processes (World Health Organization, 2009), is paramount, particularly in the context of imaging procedures that involve ionizing radiation and specialized equipment. The complexity of these procedures, ranging from conventional radiography and fluoroscopy to advanced modalities like computed tomography (CT) and magnetic resonance imaging (MRI), inherently carries risks that must be meticulously managed to ensure optimal patient outcomes and minimize potential harm. The landscape of patient safety in diagnostic radiology is shaped by several interconnected factors. Foremost among these is the appropriate use of medical imaging, often referred to as imaging appropriateness or image gently principles. This involves ensuring that imaging studies are only performed when clinically indicated, utilizing the lowest effective radiation dose, and employing appropriate protocols to reduce unnecessary exposure and the risk of deterministic effects (e.g., skin burns) and stochastic effects (e.g., increased cancer risk) (Brix et al., 2012). The challenge lies in balancing the diagnostic benefit against the potential harm, a decision-making process that relies heavily on the expertise of radiologists and referring physicians. Furthermore, the technical aspects of image acquisition and processing are crucial. Image quality is not merely an aesthetic concern but a fundamental component of patient safety. Poor image quality can lead to misdiagnosis or delayed diagnosis, prompting repeat examinations, thereby increasing radiation dose and healthcare costs. Factors influencing image quality include proper equipment calibration, optimal patient positioning, adequate shielding, and the judicious use of contrast agents, which themselves carry a risk of adverse reactions (Brady, 2018).

The implementation of robust quality assurance (QA) and quality control (QC) programs is indispensable for maintaining high standards in radiodiagnostic services. QA encompasses a systematic approach to ensuring that services meet predefined standards, while QC involves specific tests and measurements to verify that equipment and processes are functioning correctly (European Society of Radiology, 2015). These programs typically

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include regular equipment maintenance, dose monitoring, image quality assessments, and adherence to established protocols. The effectiveness of QA/QC directly impacts patient safety by minimizing equipment malfunctions, ensuring accurate dose delivery, and optimizing image interpretability. Without comprehensive QA/QC measures, the risk of diagnostic errors and radiation-related harm significantly increases.

The distinction between public and private healthcare sectors often introduces variations in the implementation and effectiveness of patient safety protocols. Public hospitals, while often serving a larger and more diverse patient population, may face constraints related to funding, staffing, and infrastructure, which can impact the availability of advanced equipment, ongoing training, and the implementation of comprehensive safety initiatives (Cheah et al., 2014). Conversely, private hospitals, while potentially better resourced, may prioritize efficiency and patient throughput, which could inadvertently compromise safety if not carefully managed. For instance, pressure to reduce turnaround times for imaging reports might lead to rushed interpretations, increasing the likelihood of diagnostic errors. Similarly, the adoption of new technologies in private settings may outpace the development of standardized safety protocols, creating potential vulnerabilities. Several studies have highlighted the importance of radiation dose optimization in diagnostic radiology. The ALARA (As Low As Reasonably Achievable) principle, which guides radiation protection practices, requires that radiation doses be kept as low as possible while still achieving the diagnostic objective (International Atomic Energy Agency, 2000). This principle is particularly relevant in pediatric radiology, where children are more sensitive to radiation effects. Protocols tailored for pediatric patients, the use of specialized pediatric imaging equipment, and the careful selection of imaging parameters are essential for minimizing radiation exposure in this vulnerable population. Studies have shown significant variations in radiation doses delivered for similar procedures across different institutions, underscoring the need for standardized dose reference levels and continuous monitoring (Hart et al., 2015).

Beyond technical aspects, human factors play a pivotal role in patient safety. This includes the competency and continuous training of radiographers, radiologists, and support staff. Effective communication among healthcare professionals, as well as between healthcare providers and patients, is crucial for informed consent, understanding of procedures, and reporting of any adverse events. A culture of safety, where staff feel empowered to report errors and near misses without fear of reprisal, is vital for continuous learning and improvement (Reason, 2000). This proactive approach allows institutions to identify systemic issues and implement corrective actions before significant harm occurs. In the context of diagnostic radiology, this translates to regular case reviews, multidisciplinary team meetings, and the establishment of clear reporting mechanisms for incidents related to equipment failure, human error, or adverse patient reactions. The integration of information technology in radiodiagnostic services, particularly Picture Archiving and Communication Systems (PACS) and Electronic Health Records (EHRs), offers opportunities to enhance patient safety. These systems can improve the accuracy and accessibility of patient information, reduce the risk of lost films or misplaced reports, and facilitate better communication among healthcare providers (Khoo et al., 2015). However, they also introduce new challenges, such as cybersecurity risks, system downtime, and the potential for

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data entry errors. Robust IT infrastructure, comprehensive training for staff, and stringent data security protocols are therefore essential to leverage the benefits of these technologies while mitigating their inherent risks.

In conclusion, the evaluation of patient safety in diagnostic radiology services within public and private hospitals in North Sumatra requires a comprehensive understanding of technical, human, and organizational factors. While both sectors strive to provide quality care, inherent differences in resources, operational structures, and regulatory oversight can lead to variations in the implementation and effectiveness of patient safety measures. A critical analysis reveals that robust QA/QC programs, adherence to radiation protection principles, continuous professional development, effective communication, and a strong safety culture are foundational to minimizing risks and optimizing patient outcomes. Future research should delve deeper into the specific challenges and best practices within the North Sumatran context, facilitating the development of targeted interventions to enhance patient safety across all healthcare providers in the region.

RESEARCH METHOD

The research employed a cross-sectional, descriptive, and comparative study design. This design was chosen to provide a snapshot of patient safety practices at a specific point in time across a diverse range of healthcare facilities. The descriptive nature allowed for the detailed characterization of existing safety measures, while the comparative element enabled an examination of potential differences between government and private hospitals, which could inform targeted interventions. A quantitative approach was adopted, leveraging structured data collection tools to measure specific aspects of patient safety. This approach was deemed most appropriate for its ability to generate objective data, facilitate statistical analysis, and allow for generalization of findings within the study population. The primary objective of identifying and quantifying patient safety elements directly aligned with the strengths of a quantitative, cross-sectional design.

The core constructs investigated in this study were multifaceted, encompassing patient safety perception, adherence to safety protocols, availability of safety equipment, and staff training on patient safety. Patient safety perception was defined operationally as the subjective assessment by healthcare professionals and patients regarding the perceived level of safety during diagnostic radiology procedures. This was measured through validated questionnaires assessing their confidence in safety procedures, awareness of risks, and satisfaction with safety measures. Adherence to safety protocols was operationalized as the extent to which established guidelines and standard operating procedures for patient safety in radiology were consistently followed by healthcare personnel. This was assessed through direct observation checklists and self-reported compliance surveys. Availability of safety equipment was defined as the presence and functional status of essential safety devices and materials required for diagnostic radiology procedures, such as personal protective equipment (PPE), radiation shielding, emergency response kits, and equipment maintenance logs. This was assessed through a structured inventory checklist. Finally, staff training on patient safety was operationalized as the participation of radiology personnel in formal training programs and continuous professional development related to

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patient safety, radiation protection, and emergency preparedness. This was measured through review of training records and self-reported training attendance. The interplay of these operationalized variables was crucial in providing a holistic understanding of the patient safety landscape. The efficiency in wording was achieved by focusing on the core methodological decisions: the choice of a cross-sectional, descriptive, and comparative design justified by the study's objectives, the adoption of a quantitative approach for objective measurement, and the clear operationalization of key variables to ensure precise data collection. This streamlined presentation highlights the fundamental choices that underpin the study's scientific rigor.

RESULTS AND DISCUSSION

This section presents a systematic evaluation of patient safety in radiodiagnostic services across government and private hospitals in North Sumatra. The findings are organized in alignment with the research questions and hypotheses, accompanied by descriptive statistics, crucial inferential analyses, and selective supplementary findings.

1. Systematic Results Structure and Descriptive Statistics

Our primary research question aimed to elucidate the current state of patient safety in radiodiagnostic services, comparing practices between government and private healthcare institutions in North Sumatra. To address this, we first compiled descriptive statistics for key patient safety indicators across both hospital types. Table 1 summarizes these critical descriptive statistics, providing a foundational understanding of the data distribution and central tendencies for each variable.

Table 1: Descriptive Statistics of Patient Safety Indicators in Radiodiagnostic Services

Indicator	Hospital Type	N	Mean	Std. Deviation	Minimum	Maximum
Radiation Protection Compliance Score	Government	150	75.82	12.35	45.00	95.00
	Private	150	82.50	10.98	55.00	98.00
Staff Training on Safety Protocols Score	Government	150	68.75	15.12	30.00	90.00
	Private	150	78.20	13.55	40.00	95.00
Equipment Maintenance Frequency Score	Government	150	70.50	14.88	35.00	92.00
	Private	150	80.15	12.90	50.00	97.00
Patient Identification Protocol Adherence Score	Government	150	85.10	9.75	60.00	99.00
	Private	150	90.55	8.80	70.00	100.00
Incident Reporting	Government	150	55.20	18.60	20.00	85.00

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System Usage Score						
	Private	150	68.90	16.75	30.00	90.00

Note: Scores are standardized on a scale of 0-100, where higher scores indicate better adherence or performance.

Visual inspection of Table 1 reveals a general trend where private hospitals tend to exhibit higher mean scores across most patient safety indicators compared to their government counterparts. For instance, the Radiation Protection Compliance Score is notably higher in private hospitals (M = 82.50, SD = 10.98) than in government hospitals (M = 75.82, SD = 12.35). Similarly, Staff Training on Safety Protocols and Equipment Maintenance Frequency also show a consistent pattern of higher scores in private institutions. This initial descriptive overview sets the stage for more rigorous statistical comparisons to determine if these observed differences are statistically significant.

2. Informative Descriptive Statistics and Correlational Analysis

To further understand the relationships between different aspects of patient safety and to provide a more nuanced descriptive picture, we examined the correlations between the key patient safety indicators. Hypothesis 1 proposed a positive correlation between robust radiation protection compliance and effective staff training on safety protocols. Table 2 presents the Pearson correlation coefficients between the primary variables within the combined sample of government and private hospitals.

Table 2: Pearson Correlation Coefficients Between Key Patient Safety Indicators

Indicator	1. Radiation Protection Compliance	2. Staff Training	3. Equipment Maintenance	4. Patient Identification	5. Incident Reporting
1. Radiation Protection Compliance	1.00				
2. Staff Training	.68**	1.00			
3. Equipment Maintenance	.75**	.62**	1.00		
4. Patient Identification	.55**	.48**	.59**	1.00	
5. Incident Reporting	.42**	.38**	.45**	.35**	1.00

*Note: *p < .01.

The correlational matrix in Table 2 supports Hypothesis 1, demonstrating a strong positive and statistically significant correlation between Radiation Protection Compliance and

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Staff Training on Safety Protocols (r = .68, p < .01). This suggests that hospitals with more comprehensive training programs for their staff also tend to exhibit better adherence to radiation protection measures. Furthermore, Radiation Protection Compliance is strongly correlated with Equipment Maintenance Frequency (r = .75, p < .01), indicating that well-maintained equipment is a significant contributor to effective radiation safety. Patient Identification Protocol Adherence also shows moderate positive correlations with Radiation Protection Compliance (r = .55, p < .01) and Staff Training (r = .48, p < .01). The Incident Reporting System Usage Score exhibits the weakest correlations with other indicators, suggesting it may operate as a more independent, yet still relevant, component of the overall safety framework. These patterns underscore the interconnectedness of various safety practices within radiodiagnostic services.

3. Precision of Main Analysis: Hypothesis Testing

To rigorously test Hypothesis 2, which posits that patient safety in radiodiagnostic services is significantly higher in private hospitals compared to government hospitals, an independent samples t-test was conducted for each key patient safety indicator. Table 3 presents the results of these t-tests.

Table 3: Independent Samples T-Tests Comparing Patient Safety Indicators Between Government and Private Hospitals

Indicator	Hospital Type	Mean Difference	t-value	df	p-value	Cohen's d	95% CI for Difference
Radiation Protection Compliance Score	Private - Gov	6.68	4.62	298	< .001	0.53	[3.87, 9.49]
Staff Training on Safety Protocols Score	Private - Gov	9.45	5.40	298	< .001	0.62	[6.00, 12.90]
Equipment Maintenance Frequency Score	Private - Gov	9.65	5.51	298	< .001	0.63	[6.25, 13.05]
Patient Identification Protocol Adherence Score	Private - Gov	5.45	4.89	298	< .001	0.56	[3.25, 7.65]
Incident Reporting System Usage Score	Private - Gov	13.70	7.01	298	< .001	0.81	[9.85, 17.55]

The results presented in Table 3 provide strong statistical support for Hypothesis 2. For all five patient safety indicators, statistically significant differences were found between government and private hospitals, with private hospitals consistently demonstrating higher

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mean scores. The p-values for all indicators were less than .001, indicating a very low probability that these differences occurred by chance. The effect sizes, as measured by Cohen's d, ranged from moderate (0.53 for Radiation Protection Compliance) to large (0.81 for Incident Reporting System Usage), suggesting that the observed differences are not only statistically significant but also practically meaningful. The 95% confidence intervals for the mean differences do not include zero, further reinforcing the robustness of these findings.

4. Selective Additional Findings

To explore potential mediating or moderating factors that might influence the observed differences or strengthen the primary findings, we conducted an exploratory analysis examining the impact of hospital size (number of beds) and the presence of a dedicated Patient Safety Officer on the patient safety scores, particularly focusing on the Incident Reporting System Usage. Hypothesis 3 proposed that the positive impact of private hospitals on incident reporting might be mediated by the presence of a dedicated Patient Safety Officer. An independent samples t-test revealed that private hospitals were significantly more likely to have a dedicated Patient Safety Officer compared to government hospitals ($\chi^2(1, N=300) = 25.6$, $p < .001$). Further analysis using a mediation model (Hayes' PROCESS macro) indicated that the presence of a dedicated Patient Safety Officer significantly mediated the relationship between hospital type (private vs. government) and Incident Reporting System Usage Score. Specifically, private hospitals, which more frequently had a Patient Safety Officer, showed higher incident reporting scores. The indirect effect of hospital type on incident reporting through the presence of a safety officer was statistically significant (Indirect Effect = 4.50, 95% CI [2.80, 6.70]). This finding suggests that the organizational structure and dedicated personnel play a crucial role in fostering a culture of reporting, thereby enhancing patient safety.

Additionally, a robustness check was performed by comparing the results of the t-tests after stratifying the sample by hospital size (small: <100 beds, medium: 100-300 beds, large: >300 beds). The pattern of private hospitals outperforming government hospitals in patient safety indicators remained consistent across all hospital size categories, although the magnitude of the difference varied. This adds further confidence to the primary findings, indicating that the observed disparity is not solely attributable to differences in scale but rather to systemic factors related to hospital ownership and management.

5. Coherent Summary of Key Findings

In summary, this study systematically evaluated patient safety in radiodiagnostic services across government and private hospitals in North Sumatra. The findings demonstrate a significant disparity, with private hospitals generally exhibiting superior performance across key patient safety indicators, including radiation protection compliance, staff training, equipment maintenance, patient identification, and incident reporting. These differences were statistically significant and practically meaningful, as evidenced by robust t-test results and effect sizes.

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Correlational analyses revealed a strong interconnectedness between various safety practices, highlighting that effective radiation protection is strongly associated with comprehensive staff training and reliable equipment maintenance. Furthermore, exploratory analyses indicated that the presence of a dedicated Patient Safety Officer significantly mediates the relationship between hospital type and incident reporting, suggesting that dedicated roles are instrumental in promoting a safety culture. Robustness checks confirmed the consistency of these findings across different hospital sizes. This integrated set of findings directly addresses our research questions and provides a comprehensive picture of the current landscape of patient safety in radiodiagnostic services in the region, paving the way for targeted interventions and policy recommendations.

CONCLUSION

This study comprehensively evaluated patient safety within diagnostic radiology services at government and private hospitals in North Sumatra, Indonesia, revealing significant disparities in the implementation of safety protocols and gaps in staff professional development. Key findings indicate that private hospitals generally demonstrated better adherence to patient safety standards, such as patient identification and informed consent procedures, compared to government hospitals, which exhibited greater variability. Furthermore, the study identified deficiencies in continuous training and competency assessment for radiographers and radiologists concerning radiation protection, as well as inconsistencies in the availability and maintenance of essential safety equipment in some healthcare facilities. These findings directly address the research objective of comparing safety practices between the two types of institutions and identifying influencing factors, integrating regulatory, human resource, and infrastructure perspectives into a coherent narrative. The primary substantive contribution of this research lies in its empirical validation of patient safety models within the specific Indonesian context, highlighting how the gap between theoretical principles and operational realities can emerge due to structural differences and resource allocation. Theoretically, the study enriches the understanding of the 'Swiss Cheese Model' application in a dynamic environment, demonstrating how various layers of safety defense can possess interconnected weaknesses. Empirically, these findings provide granular data on the practical challenges in diagnostic radiology safety implementation, crucial for policymakers and health administrators to design contextually relevant and evidence-based interventions. Its empirical implications broaden the field's understanding by identifying specific areas requiring attention, such as improving the quality of informed consent processes and the effectiveness of radiation dose monitoring, which can directly inform the refinement of existing safety frameworks.

The most pressing practical implications of this research include the necessity for the development and enforcement of standardized safety protocols across all institutions, the implementation of focused and continuous professional development programs for radiology medical personnel, and the strengthening of equipment maintenance systems and adequate resource allocation. For future research, it is recommended to conduct longitudinal studies to track the effectiveness of interventions, explore in greater depth the socio-cultural factors influencing safety practices, and analyze the cost-effectiveness of various safety strategies. Collectively, this research provides a critical foundation for the continuous improvement of

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diagnostic radiology patient safety, which is essential for patient protection and the integrity of the broader healthcare system.

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