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Operational Solutions to Address Radiology Staffing Challenges in Southern California Hospitals

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Operational Solutions to Address Radiology Staffing Challenges in Southern California Hospitals

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Abstract

The problem of interest is the current workforce crisis among the Radiologist Specialty in hospitals in Southern California. There has been a significant decline in the number of Radiologists in the workforce compared to the caseload of imaging studies. The purpose of this integrative review was to evaluate empirical and non-empirical literature for operational solutions to improve recruitment and retention of radiology providers. Literature published between 1999-2024 were evaluated for appropriateness using the Johns Hopkins evidence appraisal tools. The literature involved strategies and identified operational areas of opportunity for improvement with radiologist staffing. Identifying ways to improve job satisfaction, retention strategies, and attract potential radiologist prospects are important to the operations of radiology programs, specifically in Southern California. Thematic analysis identified four key themes: (1) Artificial Intelligence (AI); (2) Residency Programs; (3) Government Programs; and (4) Retention. With regards to AI, reliability and education subsections are addressed. Residency programs can also be a large part of the solution for recruitment of radiologists in this shortage. There is also opportunity to improve the government programs and options to review incentives for HSO's. Retention efforts should focus on career advancement and growth, as well as flexibility for work-life balance. Multi-faceted operational plans that account for these themes and sub-themes will minimize the impact of the current staffing crisis by improving retention and recruitment of radiologists in Southern California.

Part 1: Practice-Based Problem

Problem of Interest

Currently, there is an international shortage of Radiologists. In the United States, specifically in Southern California, there has been a significant decline with the number of Radiologists in the workforce compared to the caseload of imaging studies waiting to be read. The imbalance has left patients and providers awaiting imaging exam reports to properly treat and diagnose patients. Multiple sources and research have projected the demand for imaging will continue to increase (Fleishon, 2022). There has also been the issue of burnout in the Radiology specialists over the that past several years (Fleishon, 2022). There is also a lack or decreased number of academic training program, limitations in career ladders, and perceived inadequacies in compensation that are also significant factors to the shortage in Radiologist staffing (Konstantinidis, 2023). With more and more seasoned radiologists approaching retirement, this ongoing staffing challenge will continue to be problematic (Fleishon, 2022). This multiple faceted problem, will continue to prevail is plans are not put in place to alleviate the workload and shortage of Radiologist staffing.

Healthcare Administration Problem

Background

Acute care hospitals, specifically large community hospitals in Southern California, are being negatively impacted by the shortage of Radiologist staffing currently. The shortage of radiographers is not new, unfortunately, largely due to the worldwide struggle to recover from the significant impact of COVID-19 (Konstantinidis, 2023). In addition to the COVID-19 healthcare shortage, between 2007 and 2021, the number of diagnostic radiologists decreased by 1% while the number of residents within the United States grew 10% (Stempniak, 2024). With the growing imaging demand, the number of diagnostic radiologists fell 2.4% during the five years ending in 2021 and the first-year radiology fellows fell 7.2% (Stempniak, 2024). The struggle from COVID-19 is only a piece of the problem, unfortunately. The U.S. Labor Board is predicting a 4% job growth for radiology providers until 2032, with a projection of 1,100 job openings for radiology providers each year (Medicus Healthcare Solutions, 2024). In short, the shortage of radiologists does not appear to be moving in a favorable direction to end the staffing crisis.

In the United States, the population has also impacted the radiology workforce. The Medicare population has significantly outpaced the number of radiologists who enter into the field (Henderson, 2022). In a recent study from 2021, the growth of the Medicare population outpaced the workforce of radiologists by 5% from 2012 to 2019 (Henderson, 2022). From 2010 to 2020, the number of radiologists entering the field increased by 2.5% compared to 34% increase in the population of adults who were over 65 years of age (Henderson, 2022). There is also the issue of low reimbursement rates for radiologists. CMS cut fees for both diagnostic (3%) and interventional radiology (4%) this year, and hospitals in Southern California are struggling with having to use external groups to stay on top of the demand (Taylor, 2024). With the staffing issues from COVID-19 and the rising population, the gap between radiologists staffed and radiologists needed is a growing concern.

Operational Problem

With the short-staffing issues for radiology providers and increase of demand for imaging, there is a retention concern, specifically in Southern California, for the Radiology providers. There are currently, more than 1,800 open radiologist positions on the American College of Radiology's job board (Stempniak, 2024). With the 4% job growth in radiology anticipated until 2032, the operational issue of radiologists staffing crises will continue to prevail without solutions and adaptiveness to the new challenges in the Radiology workforce (Medicus Healthcare Solutions, 2024). Also, 88% of diagnostic radiology applicants did not match for their residency in 2024 and 83% of interventional radiology applicants did not match in 2024 (Medicus Healthcare Solutions, 2024). Southern California, specifically, struggles to retain radiologists due to low reimbursement rates, competition with remote work (Taylor, 2024). If we do not adapt or find workflows to improve the challenges with residency placement and growth, radiologist retention, and increase for imaging will continue and patient delays for diagnosis and treatment are in jeopardy.

Desired State of Operations

For a 380-bed hospital in Southern California, with a steady volume of imaging exams, the ideal staffing for radiologists is based off of a standard that is 34 procedures per day for each radiologist (Alexander et al., 2022). The hospital typically has 350 procedures in a day, and would need approximately 10 radiologists to be staffed in a 24-hour period to maintain current volume reasonably. Currently, there are 1,800 open radiology provider positions in the United States and 1,100 positions are projected each year until 2032 (Medicus Healthcare Solutions, 2024). The hospital, in reference to this research, is approximately staffed at 1.5 radiologists during the day and previously was staffed at 3 radiologists during the day. Currently, the reading turnaround times during the day are slower compared to prior state, when 3 radiologists were staffed during the day time.

Professional Practice Gap Statement

When reviewing current staffing, there is approximately 1,800 job postings for Radiologists throughout the country, which is 10% below optimal levels and for what is predicted for future needs. Between 2007 and 2021, the number of diagnostic radiologists decreased 1% while U.S. residents per active member of the specialty swelled 10%, the report noted, and despite reports of growing imaging demand, the number of diagnostic radiologists fell 2.4% during the five years ending in 2021 while the tally of first-year radiologist residents and fellows fell 7.2%, according to the Association of American Medical Colleges (Stempniak, 2024). There are operational opportunities to explore through literature to address this staffing crisis and reduce delays in patient care.

Summarizing the Evidence

Radiologist staffing is at a problematic level for timing of adequate patient diagnosis and treatment worldwide. Particularly in Southern California, HSO's are having more and more barriers with retaining and onboarding additional radiologists. At a 380-bed HSO, there are a lot of factors that impact this staffing challenge, from low reimbursement rates, to an inadequate amount of GME programs, increased number of exams, low retention from burnout, and long turnaround times for reports. One recent article explained the staffing shortage as a great mismatch between the great resignation, the loss of manpower and the increase in demand for imaging (Fornell, 2023). The staffing shortage and increase in exams is not the only focus; however, the job satisfaction level of radiologists is also a key piece to this challenge. Another recent study showed that out of 308 radiographers that were questioned, most were dissatisfied with their job based on pay, opportunities for prometon, fringe benefits, operating procedures, and communication (Alakhras, Al-Mousa, & Lewis, 2022). This same study also showed the burnout was associated with work experience and caseload (Alakhras, Al-Mousa, & Lewis, 2022). From these results, it was also determined that emotional exhaustion and depersonalization drew a significant positive correlation (Alakhras, Al-Mousa, & Lewis, 2022).

These barriers will continue cause staffing challenges with the Radiology providers.

Purpose of the Integrative Review

The purpose of this integrative review is to find operational solutions to bridge the gaps in radiologist staffing challenges in the Radiologist workforce across Southern California. The problem, however, extends beyond Southern California and can be seen across the nation and even on an international scale. Currently, there is not a solitary solution to this problem. There are potentially many areas of opportunity to address this current and on-going issue; however, collaboration will need to exist from hospital administration and the radiologist workforce to accomplish the overall goal of keeping up with the demand of imaging. This integrative review will explore those possible solutions and also look at potential ways to optimize the current processes for efficiency. Some of the solutions are in the hands of other entities; however, bringing awareness to the situation is vital at this point in the crisis of the workforce for radiologists. This issue will progress and potentially increase in severity if actions are not taken to improve the current state of radiologist's shortages in staffing.

Integrative Review Question

What are the best practices and strategies to improve recruitment and retention of radiology providers in a 380-bed hospital in California?

Theoretical and/or Conceptual Framework

The purpose of this research was to find operational solutions to bridge the gaps in radiologist staffing challenges in Southern California. Between job satisfaction and two factors: hygiene and motivation factors. Since 1959, Two-Factor Theory has been used in many studies for healthcare as it relates to job satisfaction for a variety of healthcare providers (Herzberg, 1959). Job satisfaction reflects on the job characteristics and ability to perform the job well, especially given the short staffing (Herzberg, 1959). If HSO's are able to focus on key drivers to improve satisfaction, such as, review salary and bonus structures, benefits, offer continuing education, promote healthy work-life balance and offer flexible schedules, the job satisfaction for radiologists will increase. Eliminating or reducing dissatisfiers, such as barriers, over-working, discrepancies with salaries, the lack of feeling supported are all ways the HSO's can reduce job dissatisfaction with the radiologists. The HSO will need to adjust and figure out how they can alter operations to work with and improve the staffing crisis for the Radiology providers. Radiology providers are crucial to the operations of the HSO. Patient diagnosis and treatment will continue to be delayed until the organization improves the retention of the radiology providers, and onboard more providers for the future.

Part 2: Literature Review, Quality Appraisal, and Thematic Analysis

Literature Review Strategy

An integrative review of literature published between 1999-2024 was analyzed and completed. The databases that were utilized included: Elsevier, American College of Radiology, Google, Becker Hospital Review, Radiological Society of North America, American Journal of Roentgenology, and ScienceDirect. Searching all of these different databases yielded positive results. Key search words included: Radiologist OR staffing, OR Radiology providers, OR shortage, OR Southern California, OR job satisfaction, OR residency, OR crisis. The keywords mentioned above were linked by the word, "AND" and used with all of the databases named above.

Inclusion and exclusion criteria are delineated below in Table 1. The inclusion criteria were expanded from articles and mentioned Southern California exclusively to National concerns for relevance and process improvement ideas at a broader level and widen the bandwidth of the search to include other case studies and articles. The target population was administrators, radiologists, and other representative's rom facility leadership that are impacted from this radiologist staffing crisis. The search expanded to include business articles, as this workflow challenge impacts the business side of healthcare, in addition to the operational aspect of the facilities and the patient care aspect. Articles were included if they mentioned any strategies for staffing resources, retention with Radiologists and Radiology residents.

Table 1

Inclusion and Exclusion Search Criteria

Inclusion search criteria	Exclusion search criteria
English language	Internal medicine
1999-2024	Other countries
Radiologists staffing	Specific modalities
Job satisfaction	All providers
Business literature	All residency programs
Psychology literature	Articles older than 30 years
Residency/residents	
Southern California	
Providers	
Shortage/staffing challenge	

Before the exclusion list, several thousand articles showed up as eligible for review on with the combined search engines. Once the exclusion words were entered, the list narrowed down to 237 articles. 25 articles were then further excluded due to duplication. After carefully reviewing 212 articles and their abstracts, with the inclusion and exclusion criteria, 83 journal articles were identified as relevant to this study. As a result of some articles purely focused on non-problem-based solutions and only focusing on outpatient settings, the article size narrowed down to 12 journal articles. See appendix

B: Review Question (s) Search Log for additional search information. Institutional Review Board (IRB) approval was not required for this integrative review.

Literature Quality Appraisal

A total of 12 articles were included for analysis. The 12 articles were then appraised using the John Hopkins Nursing Evidence-Based Practice Model (JHNEBP) and Research Evidence Appraisal form. 3 articles were rated at a Level 3 or above for evidence-based research. 8 articles were appraised as high quality. As a whole, the 12 articles produced quality evidence-based research, concrete recommendations and conclusions, and were referenced with other evidence-based journal articles. For further details on the quality appraisal process itself, please refer to Appendix C: Critical Appraisal Results Log.

Thematic Analysis

The articles chosen were relational, comparative, cross-sectional, or descriptive non-experimental studies and utilized volunteers with questionnaires or surveys. The authors of these articles used other journals, research information, or other documentation from other reputable sources to eliminate bias. Residents were also included in some of the surveys to reduce age, or bias for more experienced radiologists in the field. 3 authors did discuss limitations, such as, not taking global surveys into account and that other countries may have a different perception or experience compared to the workforce crisis of radiologists in Southern California, and the Untied States of America, as a whole.

Part 3: Presentation of Results and Interpretation of Findings

Presentation of Results

Finding operational solutions to bridge the gaps in radiologist staffing challenges in the Radiologist workforce across the nation, and even the globe, is the purpose behind this integrative review. On 12 articles, thematic analysis was conducted and resulted in 4 main themes, 10 sub themes, and 4 four additional themes under the sub-theme, job satisfaction. After reviewing the articles, codes were taken from the research for organization purposes into the thematic analysis appraisal, see Appendix D: DHA Thematic Analysis Results.

Example Codes for the 13 Articles Included in the Thematic Analysis Matrix

Job satisfaction: burnout, increasing volume, continuing education, sense of belonging, work-life balance, flexibility, career growth, support.

Retention: job satisfaction, salaries, mid-level practitioners, growth opportunity.

Legislation: reimbursement, incentives for HSO's, judicial support, financial backing.

All of the codes were pulled from the 13 articles, 4 main themes emerged, along with 10 sub-themes, and 4 additional themes under the sub-theme, job satisfaction were revealed. The four main themes are Artificial Intelligence (AI), Residency Programs, Government Programs, and Retention. Sub themes and themes of sub-theme are listed below the main themes below.

Artificial Intelligence

a. *Education*- learning about different software systems, dictation systems, and other AI available on the equipment to assist in productivity, reduce errors due to burnout, enhance quality of exams.

b. *Reliability*- being able to have artificial intelligence that the radiologist providers can rely on, work with their current systems and the ability to navigate through any challenges.

Residency Programs

a. *Shortage of Radiology Residency Programs*- the current spots open for radiology residences is low, high competition for spots because the spots for radiology residencies are limited, retiring radiologists versus spots open are not keeping up with the increase in volume for imaging.

b. *Funding for Residency Programs*- increasing the funding for more radiology residency programs, more incentives for HSO and other organizations to train the radiology residents, in hopes that more residency programs for radiologists will open and create more radiology residency spots.

c. *Radiologists to Teach Radiology Residency Programs*- number of retiring radiologists versus radiology residency spots open are not keeping up with the aging population and the increase in volume for imaging, number of remote radiologists who are not on-site in the hospital to teach for the residency programs is also a concern.

Government Programs

a. *Funding for Government Programs*- more funding for HSO's and other healthcare organizations to have radiology residency programs, more funding for radiology providers in other countries, allow funding for continuing education for radiology providers, and funding for mid-levels to assist more radiologists in workforce.

b. *Reimbursement*- raise reimbursement, specifically for high cost of living regions (such as Southern California), specialized reimbursement for rural areas or low-population areas to entice radiology physicians to practice in those areas. Offer specific reimbursement for on-site procedures.

c. *Incentive's for HSO's*- incentives for HSO's to hire radiology providers in other countries to offload some of the volume, also incentives to employ 4th year radiology residents to perform preliminary readings to offload the volume, especially overnight.

Retention

a. *Job Satisfaction*- one of the most important aspects for retaining our current radiology workforce, attracting more talent for the future and keeping residents in the mindset to become radiologists; large correlation between job satisfaction and engagement of radiology providers.

    1. *Continuing Education*- conferences, keeping up with the latest technology and having the availability technology to facilitate work processes.

2. *Belonging*- being a part of something much greater than just sitting and reading exams, a part of the patient experience, being a part of a team with the staff technologists and leadership team.
3. *Career Advancement/Growth*- opportunities for advancement to medical directorships, learning different procedures, growing as a department and offering latest exams, technology growth with AI and software capabilities, new equipment training.
4. *Work-Life Balance/Flexibility*- working remotely, not performing procedures, not being on-site in the facilities, open options for on-call, overnight work, flexible schedules.

b. *Salaries*- significant variation in reimbursement and high-cost of living areas have caused large gaps in salaries for many radiologists, salaries have also started to shift with teleradiology options.

To view the Thematic Map, see appendix E: DHA Thematic Map.

Interpretation of the Findings

Artificial Intelligence (AI)

This particular theme has grown and expanded its way into the healthcare sector. It has impacted Radiology greatly because of all of technological advances and software programs that have become available. Initially, it was thought that AI would replace radiologists altogether; however, currently, most experts agree that AI-based capabilities will supplement workflow and may even expand the role of imaging (Fleishon, 2022). AI can improve efficiency and bring a second set of eyes to confirm or correct the initial review (Fornell, 2023). This technology also helps organize worklists, perform certain measurements, auto-populate report fields, and perform first-pass reads to discover critical findings, and speed up reporting times (Fornell, 2023). Speeding up reporting times and obtaining results faster will operationalize the process for quick results to diagnose and treat the patients during this staffing crisis.

Education

One of the most important aspects of artificial intelligence is the educational foundation and exposure to different types of AI. Radiologists should have exposure to AI to improve accuracy, efficiency, and overall performance (Fornell, 2023). Training and educational solutions with AI need to be explored now to offset some of the workload (Hagland, 2023). One aspect of dissatisfaction in a survey of radiologist regarding their job satisfaction involved feeling adequately trained on AI and how it could help their processes (Graham, Ramirez, Field, & Richards, 1999). Education and training are very important to the process of implementation for AI and for it to work successfully in healthcare, especially for Radiology providers.

Reliability

It is important for all technology to be reliable, specifically when it involves prognosis and treatment in the healthcare industry. There are radiology providers; however, that believe that AI will not be a “silver bullet” and it will not have a great impact on the overall staffing shortage (Hudnall, 2024). It is also thought that for AI to work effectively, people need to be “behind the wheel,” (Hudnall, 2024). The algorithms should also be re-evaluated and modified regularly to keep up with the ever-changing world of healthcare (Hudnall, 2024). Information Technology (IT) security is also a concern when referencing the reliability of AI (Hudnall, 2024). If the data can be hacked or be shutdown, then reliability could come into question and potentially interrupt workflows and create more delays. Creating more delays would not be beneficial with the current state of operational gaps for radiology reports being read timely.

Residency Programs

One possibility to streamline radiologist entry into the workforce is to use the radiology residency programs. The United States population over 65 increased 38.6% between 2010 to 2020, creating greater demand for radiologists to meet the needs of the aging population in this country (Milburn, 2024). There are several challenges to adding residency programs to HSO's; however, adding positions or growing programs does make positive strides for the future generations of radiologists. Radiology is also one of the more competitive residencies (Medicus Healthcare Solutions, 2024). Funding for the Radiology residency programs has also been looked at for solutions to assist with building quality radiology residency programs to train future radiology providers.

Shortage of Radiology Residency Programs

Due to several circumstances, there has been a lack of radiology residency programs available to train future radiologists. The Radiology residencies are so competitive that only 1 in 6 PGY-1 Interventional Radiology applicants and 1 in 8 Diagnostic Radiology applicants match (Medicus Healthcare Solutions, 2024). Despite the strong interest in the radiology specialty, it is anticipated that the demand for radiology residency graduates will outpace the supply without available residency positions (Medicus Healthcare Solutions, 2024). Residency position caps are also being disseminated to hospitals, rather than to specific specialties and departments within the hospitals themselves, which can limit the number of specialty slots and programs

(Milburn, 2024). In the past few years, legislation did increase the number of government-supported medical residency slots by 1,000 nationwide; however, it was unclear how many of those slots will be dedicated to radiology (Fleishon, 2022). Even if a partial number of slots are considered for Radiology, the number would most-likely be inadequate to address the current opening for radiologists or the projected needs in the future (Fleishon, 2022). An increase in spots for Radiology residents, specifically, would close the gap in radiology residency availability and is currently needed to optimize Radiology operations.

Funding for Residency Programs

Residency positions caps are granted to hospitals overall, without being designated for specific departments or specialties (Nicola, 2024). Programs may grow and apply for increased residents from American College of Graduate Education, but that does not guarantee funding the HSO is already over its cap (Nicola, 2024). Many academic institutions chose to train additional residents over their cap (Nicola, 2024). 18% of the resident positions for Radiologists in the state of Louisiana are not funded by the government and there has been little success of growing those number of funded programs (Nicola, 2024). Unfortunately, the future my entail the HSO's funding their own Graduate Medical Education programs for radiology residents to grow their own pipeline.

Radiologists to Teach Radiology Residency Programs

If the workforce in a facility is insufficient for the workload, the number of quality hospitals to train these Radiology residents is limited also (Nicola, 2024). Many radiologists are retiring faster than our healthcare system can train their replacements

(Fornell, 2023). Also, as other generalist radiology providers leave the workforce for retirement, the availability of a wide scope of knowledge also departs with them (Medicus Healthcare Solutions, 2024).

Government Programs

Government programs can aid and alleviate some of the burden with the current radiology provider staffing challenges that the healthcare system is currently facing. The American College of Radiology (ACR) is advocating for addressing the scope of practice (SOP) challenges so that the opportunity to offload some of the radiology provider work to mid-level practitioners is available (Fleishon, 2022). Another avenue in which the government could help aid is the availability for foreign providers, specifically the immigration policies and educational requirements should be changed to allow more international radiology providers to practice medicine in the United States (Fornell, 2023). These options would allow for a greater bandwidth a wider range of radiology providers to be eligible to interpret studies in the United States and offload some of the current workload with qualified individuals. Having options for additional staff would definitely help with the current operational flow for radiology reports in HSO's.

Funding for Government Programs

Funding for government programs, such as Centers for Medicare & Medicaid Services (CMS) really help facilitate the growth for the radiology specialty. ACR is also supporting the funds for legislation in Congress to create smoother transition for international medical graduates to expand the pool of available radiologists (Hudnall, 2024). Reimbursement for costs associated with using new technology, such as AI, is an incentive for HSO's and for radiology providers to implement this technology for better efficiency, quality exams, and throughput. There have also been significant changes in insurance coverage since the Affordable Care Act (Hudnall, 2024). The goal was to provide people who did not have access to health insurance, the opportunity to be covered; however, there were missteps in establishing ways to increase the capacity to care for them within our healthcare system and its current funding (Hudnall, 2024). The funds for SOP for physician extenders have also been a challenge with looking for alternative staffing options for the radiology providers (Hagland, 2023). Several aspects of funding for government programs need to be re-evaluated to help support these shifts in healthcare.

Reimbursement

The reimbursement topic in Radiology has been an important area of interest for the past several decades. The ACR has worked on appropriate ordering criteria, specifically for advanced imaging for years, as a proactive approach to reimbursement costs (Hudnall, 2024). Managing utilization seemed like an appropriate way to help reduce the volume of imaging as it has continued to increase over the past several decades (Hudnall, 2024). While CMS is making strides to invest in graduate medical education and more incentives to train radiology residents, the payments through reimbursement, themselves are limited (Milburn, 2024). Cost of living in some areas, specifically Southern California has low reimbursement rates compared to the high-cost of living. This leads to recruiting and retention concerns for areas, such as Southern California. If there were options to help close the gap on the difference between reimbursement rates and cost of living, more radiologists would be attracted to these areas, and it would help the HSO's in the area attract more radiologists for their operations in the Radiology modalities.

Incentives for HSOs

Currently, there are very little incentives available that are associated with helping the radiology staffing crisis other than GME program reimbursement and associated allocations of funds. The current GME financing offers little, if any, program-level incentives to improve the quality of efficiency of physicians training (Hudnall, 2024). CMS has made motions to require clinical decision support software for advanced imaging an effort to reduce costs and limit waste in healthcare; however, there has been resistance by clinicians, vendors and medical societies over these changes (Fornell, 2023). Updating the software with new guidelines and new information would be difficult and buying and maintaining these systems would not be reimbursed, which adds significant cost to the HSO's (Fornell, 2023). Using reimbursement to off-set some of the cost for AI would also be an option that would help HSO's purchase and maintain the AI software packages. Incentive can aid in the extra workload and cost that HSO's are experiencing in implementing processes to help with the radiology provider staffing shortage.

Retention

There have been great efforts made in the past several years to retain healthcare professionals, including radiologists. The ACR used resources to develop a Radiology Well-Being Program to address burnout in the profession (Hagland, 2023). Other staffing models have also been suggested to help avoid burnout with physician extenders (Hagland, 2023). It is important for healthcare administration professionals to examine the areas of job satisfaction in which the radiologists struggle, and which areas they are satisfied with. Job satisfaction is a key component to retention in this ongoing radiologist shortage in California. If we want to continue to find solutions to our operational gaps in coverage for radiology, we need to keep job satisfaction and retention in the forefront of our thoughts.

Job Satisfaction

In today's healthcare industry, the challenge of ensuring job satisfaction and retention amongst employees are vital for continuing to care for patients. The topic of burnout has been a concern, with Radiologists ranking 5th out of more than 23 specialties reporting their burnout rate (Hagland, 2023). Another concern with job satisfaction around burnout is production targets and expanding workloads (Hagland, 2023). These external pressures from HSO's for short turnaround times, often without consideration of the volume of the list or the volume of study complexity, have posed a real issue for attributing to burnout (Hagland, 2023). If job satisfaction declines or does not improve, there will continue to be operational challenges with radiologists staffing, which impacts our overall radiology operations and throughput.

Continuing Education. Resources and availability of continuing education is vital to the radiologists that are more seasoned in their career, as technology continues to advance in the healthcare world, especially Radiology. Those in the field of radiology have a desire and need to adequately keep their skills and their knowledge up to date (Konstantinidis, 2024). The successful adoption of AI and other advancements in technology rely on the training and skill-level of the radiologists and technologists that operate with the software and other equipment (Konstantinidis, 2024). To keep up with these advances, professional development of their career and continuing education should be provided to the technologists and the radiologists (Konstantinidis, 2024). Having access to continuing education also increases the radiologist's engagement and job satisfaction. Continuing education is an extremely important part of the radiologist's growth for those that are newer to the field, and those that have been practicing for a long-period of time. Continuing education is also another component of job satisfaction and retention of radiologists across the globe.

Belonging. Another aspect of job satisfaction and ensuring the operational component of retention for radiologists revolves around a sense of belonging. Belonging to something meaningful, part of a bigger picture, and a greater solution is important to radiologists in recent job satisfaction surveys (Hagland, 2023). The sizable portion of work completed by radiologists is individual work while they can be siloed or virtual (Hagland, 2023). The radiologists frequently talk to providers virtually and rarely physically see their patients, which can lead to social isolation (Hagland, 2023). Shared reading rooms, localization of reading stations in clinical work areas, and virtual conferences with colleagues can help mitigate this sense of belonging (Hagland, 2023).

Career Advancement/Growth. Career growth and opportunity for advancement also plays a large role in the retention and job satisfaction of radiology providers. A very large portion of radiologists surveyed expressed that they felt insufficiently trained in communication and management skills that would help them advance in their career (Graham, Ramirez, Field & Richards, 1999). Some radiologists; however, are trading the leadership and advancement for better work-life balance opportunities (Hudnall, 2024). The post-COVID healthcare era has definitely caused culture shifts within radiology.

Work-Life Balance/Flexibility. Since COVID, there has been a large shift in culture with the opportunity to work at home. Radiologists were able to perform some of their jobs while teleworking, and now there is a challenge to find or onboard radiologists that want to perform procedures and be on-site at the hospital (Hudnall, 2024). Greater productivity, decreased travel time, and decreased stress are all great reasons as to why the teleradiology option has increased and looked more appealing to radiologists (Hudnall, 2024). Telework seems like it is here to stay with the ability to choose to do the things that are becoming the norm within society and culture (Hudnall, 2024). Work-life balance and flexibility tie into retention and job satisfaction for the radiologists. Both of these components are important for the ability for HSO's to continue to retain their radiologists and improve staffing gaps.

Salaries

With the cost of living increasing, salaries can play a varying role in the radiology provider world. 28 percent of physicians, including radiologists, revealed with insufficient salary is contributing to their burnout rate and job satisfaction (Hagland, 2023). The salaries of radiology team, providers and technologists as a whole have also been reviewed recently because some of them are not comparable to other healthcare professionals with additional qualifications (Konstantinidis, 2024). Other financial motivators, such as, performance-based bonuses or incentives can also attribute to job satisfaction and retention of the current radiology provider workforce (Konstantinidis, 2024). Salaries also rollup to job satisfaction for retention of the radiologists and attraction of new providers to go into the field of radiology. Salaries will continue to be a focus area for operationalizing gaps in the radiologists staffing crisis.

Theory of Motivation-Hygiene Factor

One of the main theories that this operational issue of Radiologists staffing crisis relates to is the Motivation-Hygiene Factor Theory by Mr. Herzberg. This is a motivation theory that suggests that satisfaction and dissatisfaction of a job are influenced by hygiene factors and motivators (Herzberg, 1959). Hygiene factors are considered basic job necessities, such as salary and working conditions, that if not met, can cause dissatisfaction with the employees (Herzberg, 1959). Motivators, however, are recognition and achievement, which are said to drive job satisfactions and motivation (Herzberg, 1959). This theory also alludes to the importance of the managers placing an emphasis on adequate hygiene factors and motivators (Herzberg, 1959). This theory proposes that if high hygiene and high motivation exist within a workforce, the employees will be highly engaged and motivated towards their work (Herzberg, 1959). If the employees have high hygiene and low motivation, the employees will still go to work and achieve set targets to keep their job; however, they will not be motivated to achieve targets beyond the set expectations (Herzberg, 1959). On the contrary, if employees have low hygiene and high motivation, employees may still look for another job because the basic working conditions are not met. If there is an environment with low hygiene and low motivation, there is a high probability of high turnover and high work dissatisfaction (Herzberg, 1959). Each one of the operational opportunities mentioned above influences the hygiene or motivational categories for the radiologists.

Using the different methods above to retain, increase job satisfaction, creating different pathways for the future are all ways to help alleviate this current operational issue with the radiologist staffing crisis. These solutions tie into the Herzberg's motivation-hygiene factor. Motivators that improve job satisfaction such as recognition, achievement, and job status are all mentioned as ways to keep radiologists engaged and help with retention (Herzberg, 1959). Hygiene factors that reduce job satisfaction such as salary, supervision, and working conditions (Herzberg, 1959). Addressing all of these concerns are ways to keeping the radiologists in the workforce and attracting new providers to the field of radiology (Herzberg, 1959). The operational solutions mentioned above are ways to help alleviate the current issue; however, only using one or two of the methods mentioned will not solve the staffing crisis issue for the radiologists. Several of these operational options, if not all of them, should be implemented to ensure the best possible staffing of radiologists for the future. The volume of radiology and the growing population are not going to aid in the resolution for this gap in coverage. To help increase the working conditions and aspects of the job that motivate radiologists, the overall turnover and growth of the field could help retain and recruit radiology providers and close the gap on staffing challenges.

Part 4: Professional Practice Application and Implications for Social Change

Recommendations for Professional Practice

Processes

Certain processes can be put into place to help alleviate the staffing challenges with the radiology providers. Operational, policy, and technological solutions should be explored now to help alleviate the burden of the workload on the radiologists (Hagland, 2023). Extensive workflow changes with computer systems, dictation software and efficiency programs have also helped with the workflow for the radiologists (Rawson, Smetherman, & Rubin, 2024). AI has proven to be instrumental in streamlining and operationalizing efficient workflows for radiologists (Hudnall, 2023). AI has also helped with connectivity issues and concern for those who work remotely (Hudnall, 2023). Some departments are also using AI to prioritize exams with critical findings (Hudnall, 2023). Using Teleradiology for services is a big help to offload some of the work for the proceduralists that are working to perform both functions within HSO's (Rawson, Smetherman, & Rubin, 2024). Decreased vacation or conference time by 1 week a year would equate to an additional 340 radiologists a year (Rawson, Smetherman, & Rubin, 2024). Having these process solutions is imperative to the HSO's and their leadership teams.

There are also processes that we can use to help with the volume and studies ordered that can help with the current radiologist staffing issue. Using the variation in volume and backlogs could also be a way to prioritize and define tier or thresholds for backlogs to spread out the volume and backlog (Rawson, Smetherman, & Rubin, 2024). There is low-value imaging that can be reduced to lessen the amount of studies that are being ordered. Low value-imaging are radiologic studies that are repeat imaging due to lack of access for outside studies (Rawson, Smetherman, & Rubin, 2024). Another way to reduce the amount of radiologic studies ordered is to limit the number of low-value imaging services. According to Medicare Payment Advisory Committee approximately 37-70 low-value services are imagined per 100 Medicare beneficiaries is for the clinical indication of low back pain, which is usually considered a low-value service (Rawson, Smetherman, & Rubin, 2024).

Personnel Resources

There are personnel resources that can be used to professional practices to help the current staffing crisis with the radiologists. One option is to onboard retired radiologists as part-time, per diem work, or phased-plan retirement (Rawson, Smetherman, & Rubin, 2024). At this time, the retired radiologists can be an untapped resource and allow additional coverage for HSO's (Rawson, Smetherman, & Rubin, 2024). Currently about 1% of radiologist retire every year, and if all of them worked one day a week, if would equate to 40 weeks of coverage annually (Rawson, Smetherman, & Rubin, 2024). This option could help offset some of the vacation and other coverage needed by the current radiologist's full-time staff.

An additional resource that could be used to expand the coverage for current radiology departments are the part-time radiologists. According to the ACR's recent data, there is approximately 16% of the radiologist's workforce are part-time radiologists (Rawson, Smetherman, & Rubin, 2024). If this subgroup of professional radiologists worked an additional day every month, it would translate into and approximately 52,224 days of coverage annually (Rawson, Smetherman, & Rubin, 2024). This would also be equivalent to an additional 261 radiologists nationally (Rawson, Smetherman, & Rubin, 2024). If only one-third of the part-time radiologists were able to cover an additional day every month, it would translate into 87 additional radiologists annually (Rawson, Smetherman, & Rubin, 2024). This option would allow for gap in the potential workforce to be implemented and help to offset some of the current staffing shortage with the radiology providers.

There is also another flexible personnel resource that has not been used to full-capacity in the radiology provider sector of healthcare. There are some consistent patters and regional trends in the radiology images ordered that coincide with the incidents, such as, school vacations, winter seasons in the south, and tourists seasons in some locations (Rawson, Smetherman, & Rubin, 2024). The ability to use seasonal workers is also an option to help with some of the workload during these types of seasons or events can be predictable and repetitious (Rawson, Smetherman, & Rubin, 2024). Using radiologists for this type of capacity could be something that is beneficial to healthcare administrators and radiologists who are looking for extra work during particular times of the year.

Using fellowship trainees and offer internal moonlighting are also options that would help to cover after-hours coverage and vacation coverage. In most circumstances, these radiology residents that have completed their fellowship and could be available to work to catch up with backlogs and vacation coverage (Rawson, Smetherman, & Rubin, 2024). If all of these radiology residents were available to cover these additional portions of radiology reading, it would provide an additional 13,599 weeks of potential coverage and the equivalent of an additional 340 radiologists annually (Rawson, Smetherman, & Rubin, 2024). One week of reduced conference time, could also result in a similar equivalent of potential coverage annually (Rawson, Smetherman, & Rubin, 2024). Another potential solution allows for practicing radiologists is internal moonlighting. Allowing radiologists to moonlight during their time off could result in night coverage models that use 5-7 consecutive nights with intervening time off that is usually scheduled in week long intervals and allows for them to work occasionally during the day on their weeks off (Rawson, Smetherman, & Rubin, 2024). Some groups have the option to buy back unused vacation (Rawson, Smetherman, & Rubin, 2024). These options are important for healthcare administrators to review to expand their workforce options for radiologists.

Another untapped resource in the world of radiologists are the providers who trained overseas. There are many radiology providers who would like the opportunity to come to the United States to practice; however, visa and training requirements hinder most from making the decision to move (Fornell, 2023). Experienced medical providers from other countries often face going back to school to obtain an American Medical degree, which does not draw as many providers as possible to come to the United States (Fornell, 2023). Many countries worldwide have training programs and quality standards that are very similar to what is implemented in the United States, and that should help alleviate some of the burden (Fornell, 2023). Having the ability to onboard foreign radiology providers for extra support could very well be an amazing opportunity for some areas in the United States.

Another resources that radiology providers have been reviewing for ways to expand their staffing is by using non-physician radiology providers (NPRPs), such as nurse practitioners, physician assistants, and registered radiology assistants (Hagland, 2023). The ACR is challenging the scope of practice for these types of staffing resources to make it them more available for HSO's across the United States (Hagland, 2023). Any number of tasks that radiologists are currently performing, that someone else can perform, can really help offload some of the feeling of burnout and fatigue that comes with the increasing number of imaging that continues to rise across the country.

Physical Resources

Some physical resources can also help to provide solutions to the radiologists staffing crisis. The optimization of these tools mentioned below are critical as the volume of studies order increases and the physical location of work has changed over the past decade (Rawson, Smetherman, & Rubin, 2024). Hybrid workflow and remote workflows have been introduced as physical resources (Rawson, Smetherman, & Rubin, 2024). Working remotely can be more productive and efficient for radiologists (Rawson, Smetherman, & Rubin, 2024). Working remotely can minimize interruptions in the reading rooms with phone calls, co-workers and technologists come into the workspace (Rawson, Smetherman, & Rubin, 2024). Remote work can also cut down on the traffic and commuting issues and create more productive time to read exams (Rawson, Smetherman, & Rubin, 2024). The ability to offer the flexibility of working at home can promote a good work-life balance and help with retention of radiologists for the future (Henderson, 2022). The culture for the shift into hybrid and remote reading appears that it is here to stay, and more and more healthcare administrators are trying to figure out how to work this into their operational plan.

Ergonomics has also played a big role in the productivity and health of the radiologists. In a survey conducted in 2022, musculoskeletal discomfort was reported in 80% of radiologists who participated in the survey (Rawson, Smetherman, & Rubin, 2024). In another survey, 60% of the radiologists surveyed reported repetitive stress injuries, with 33% of the injuries needing some kind of treatment (Rawson, Smetherman, & Rubin, 2024). Repetitive stress injuries correlate with 40% of radiologists who experience those injuries thinking about leaving the field altogether (Rawson, Smetherman, & Rubin, 2024). Leadership in HSO's could potentially work with the risk management team to ensure that there is a proper plan in place to reduce the amount of these injuries and to retain the radiologists by preventing injuries.

Job Satisfaction

It is also important for retention and recruitment for job satisfaction to be high. Sources of satisfaction are equally important to understand and for healthcare administrators can help assist the radiologists in being satisfied with their job to retain them for as long as possible. It is important to get creative with job opportunities to keep radiologists engaged (Henderson, 2022). The ACR's Well-Being Committee has created tools for individual radiologists and case studies for HSO's who can change systemic issues that can contribute to burnout and reduce job satisfaction (Hudnall, 2023). In one study, 29% of radiologists reported psychiatric morbidity (Graham, Ramirez, Field & Richards, 1999). These same radiologists also reported emotional exhaustion, depersonalization, reduced levels of confidence and achievement (Graham, Ramirez, Field & Richards, 1999). Having programs and action plans in place to address mental health concerns and job satisfaction is very important to keep radiologists who are currently practicing in the field and those who want to be radiologists go into the field. Positive culture helps create retention and this will help retain the radiologists within the HSO's. It is equally important that HSO's recognize these challenges and formulate it into the operational based plan to retain their radiologists or grow their program.

The methods mentioned above are not complete solutions for the gap in the radiologists staffing crisis; however, they are operational tactics that can help bridge the gap in coverage. In order to alleviate the staffing crisis, specifically in Southern California, all of the methods should be covered and focused on as strategies to help relieve burnout and turnover in the radiologist staffing. These strategies will help the hospital administrators and the HSO's staff, increase job satisfaction, and retain the radiologists and plan for the future with the continuous growing rates of imaging.

Implications for Social Change

The healthcare industry, which is consistently changing with new technology, different culture and trends, and economy has really shifted in the past decade. Currently, there is an extreme shortage of radiology providers in the United States, specifically, Southern California. To add to the already staffing crisis, the aging population is growing and the demand more imaging is also expanding. Understanding the challenges and ways to potentially help alleviate this staffing shortage and retain current radiologists for as long as possible is imperative for our healthcare administrators to understand to keep operations afloat.

Almost all patients have some type of radiology exam during a visit or stay at an HSO. Radiology impacts almost every patient and everyone at some point in their life, whether it is a person or a family member. Continuing to provide adequate testing and quality patient care relies on having radiology providers to perform procedures and read imaging exams. If radiology exams are not read timely, patient throughput and delayed diagnosis and delayed treatment are results of this impact to our healthcare system. Throughput and being able to expedite care for the patients that need it are the priority for the HSO's. Without efficient operations, the quality of care and outcomes will be impacted. The solutions of working on job satisfaction for radiologists, implementing AI, looking at various staffing models for extra support, radiology residency programs for the pipeline of future radiologists to join the workforce, and government support are key aspects of operationalizing the radiologist staffing crisis for HSO's.

Limitations

This review was focused primarily on radiologists that interact with HSO environments and did not dive into the implications for private practice or how it would be impacted by the recommendations for professional practices. This review also did not dive into modality specific job satisfaction problems or challenges faced by particular modalities. It also did not address the positive attributes from specific modalities either. The specific modalities could all have their own positive attributes, challenges, and barriers that may need to be researched or may vary in challenges or needs.

Conclusion

If it is not reviewed and acted upon now, the problem looks to compound over the next decade. Having an operational plan will be important for HSO's, including ones with several barriers. Having operation-based solutions or ways to alleviate some of the volume of exams and growing population will be important for the future. The volume of imaging is only going to continue to rise and unless the healthcare leaders of HSO's have operational plans to implement, they could face challenges in providing high-quality results and treatment plans for patients without the diagnostic radiology sector that is vital when caring for patients. Implementing the strategies listed above with a strong focus on retention, job satisfaction, using AI, advocating for government programs, and GME options, will help increase operational efficiency and help close the gap for the shortage of radiologists, specifically in Southern California.

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Appendix A: Literature Review Matrix

Author/ Date	Theoretical/ Conceptual Framework	Research Question(s)/ Hypotheses	Methodology	Analysis & Results	Conclusions	Implications for Future research	Implications For practice
Nicola, G./ (2024).	Functionalism	Why do we not train more radiologists to address our workforce shortage?	Quality Improvement	The GME programs are at capacity for the slots they have available.	We are not training enough radiologists to meet the needs of our aging population.	Review growth for residency programs in the next 5 years to see how growth compares to the need.	Look at the funding for government programs for radiology programs.
Taylor, M./ (2024).	Functionalism	What are the gaps in staffing shortages for Radiologists?	Quality Improvement	Systems are finding various ways of dealing with the shortage crisis.	It seems that a lot of hospitals are leaning towards remote work as a solution to the staffing crisis.	In the future, looking at remote work, it will be interesting to see how that impacts the hospitals.	Hospitals can use the different methods mentioned to help with the staffing crisis.
Stempniak, M./ (2024).	Job Satisfaction Theory	What are we doing to help the staffing crisis in Radiologists when the imaging demands are increasing?	Quality Improvement	The articles touches on job satisfaction of the radiologists and how to retain them longer.	If the hospitals work on job satisfaction, they will keep more radiologists.	Looking at job satisfaction over time periods could be beneficial for the future staffing of radiologists.	Implementing job satisfaction strategies could certainly help the current staffing shortage of radiologists.
Hagland, M./(2023).	Job Satisfaction Theory	What are we doing to address the radiologist shortage?	Quality Improvement	This article talks about the responses to the shortage of radiologists so far and future initiatives.	The article brings up that if the shortage is not addressed now, it will be dire in 5 to 10 years.	Policy, payment, operational, training/educational, and technology solutions should all be explored now.	It talks about the importance of job satisfaction and radiologist burnout in the current practice state and make sure that addressing it is a priority.
Medicus Healthcare Solutions/(2024).	Functionalism	What are strategies for navigating short staffing in Radiologists in the future?	Operational	Supply versus demand over the next several years, only will exacerbate this staffing crisis in radiologists.	We need to act on the causes for the shortage and operationalize a plan.	How the supply and demand could change over the years with different key elements around best practices implemented.	Government buy-in and support in addressing the staffing gaps.
Henderson, M./(2022).	Job Satisfaction Theory	Why is there such a shortage in Radiology providers?	Quality Improvement	Potential solutions to the shortage of radiologists	If we prioritize job satisfaction, more radiologists will be attracted and stay in the field.	How the remote work will impact the hospitals operationally.	More work-life balance and remote work availability.
Fornell, D./(2023).	Job Satisfaction Theory	What can we do to help alleviate the staffing in radiologists?	Quality Improvement	Discussion of potential solutions and ways to help support the radiologist shortage	There are actionable items to help adapt to the staffing shortage of radiologists.	Research is still needed to see what impact AI has on the throughput of imaging exams.	By addressing different aspects of radiology, we can help improve the radiologist's job experience and expand for the future.

Fleishon, H./(2022).	Job Satisfaction Theory	Why is there a radiologist shortage and what is being addressed currently?	Quality Improvement	There are actionable items being taken to help alleviate this crisis; however, more needs to be done in the future.	Continuing to grow and working together will be imperative in the next several years as we try to navigate these shortages.	Future research on AI and other government funding are areas to look at.	There are wellness programs that are created through the ACR for radiologists. Using wellness resources should help with job satisfaction.
Konstantinidis, K./ (2023).	Job Satisfaction Theory	Why is the radiology workforce short staffed and what is contributing to it?	Quality Improvement	There are several different factors that can help with retention and satisfaction.	If we prioritize some of these initiatives for retention and satisfaction, we will have a better chance of helping the radiologist shortage.	Future research on ensuring what is considered adequate workforce for the future is still needed with the rising demands in imaging.	Making changes to the radiologists programs can help with retention now.
Rawson, J., Smetherman, D., Rubin, E./(2024).	Job Satisfaction Theory	What are short-term strategies for augmenting the radiologist workforce?	Quality Improvement	After reviewing the changes of radiology workforce at all three levels, the focus is to identify potential short-term interventions and their impact.	By analyzing mechanisms to address the workforce crisis in Radiology and its impact, we must implement ideas that fit the need of the different practices.	There are more solutions that need to be explored for the radiologist workforce.	We can begin to implement different solutions to see if they will help alleviate some of the shortages.
Alakhras, M., Al-Mousa, D.S., & Lewis, D./(2022).	Job Satisfaction Theory	What is the assessment and correlation between job satisfaction and burnout among radiologists?	Quality Improvement	When completing a questionnaire, most job dissatisfaction was related to emotional exhaustion and depersonalization.	The participants were dissatisfied with their job and suffer a high level of emotional exhaustion.	Research to expand to more radiologists and categorize them by facility level could be beneficial for future research.	To avoid burnout and decrease job satisfaction, efforts need to be made to alleviate the staffing shortages.

Appendix B: DHA Review Question(s) Search Log

Inclusion Search Criteria	Exclusion Search Criteria
• Radiologist Staffing article • Radiologist Job satisfaction article • Radiology shortage with providers in Southern California journal article	• Staffing gaps for all providers • Radiology shortage in a specific country • Articles older than 10 years (filter) • Articles that focus on a specific modality.

Search Results

Database or location name	Search Terms	Results	Notes
Google-	Radiologist Staffing Crisis, Radiologist Job Satisfaction, Radiologist shortage in Southern California	17,800 articles/99,600 articles/152,000 articles Narrowed to 6 articles	Teleradiology, radiology locums, transition programs.
ACR	Radiologist staffing shortage/Radiology shortage with providers in southern California	225/15, narrowed down to 3 articles	Self-funded positions by our heath systems, Medicare funding for more positions and programs in rural facilities. Congress limits for number of FTE it will support for Radiologists, Radiology Well-Being Program, Teleradiology support, alternative staffing

Database or location name	Search Terms	Results	Notes
			models, focus on overutilization, AI software.
Becker Hospital Review	Radiologist Job satisfaction and radiologist staffing	7 articles/20 articles, narrowed down to 2 articles	Clinical decision-making, lowering barriers for more foreign providers, technology.
Walden University library (Elsevier)	Radiologist staffing shortages in southern California	19,547 articles, narrowed down to 2 articles	Stress-reduction, job satisfaction solutions, burnout reductions.
RSNA	Radiologist staffing	45 articles, narrowed down to 2 articles	Focus on burnout and radiology provider retention, AI and innovative software, Mandating limits on workload, duty and speed.
American Journal of Roentgenology	Radiologist Staffing	2 articles	Reading Room Assistants and other staffing solutions, process, Teleradiology services, vacation or conference time, ergonomics, workflows, International Medical Graduates
ScienceDirect	Radiologist staffing shortage, Radiologist job satisfaction	2,247 articles/1,939 articles, narrowed down to 1 article	Discussions of AI and support for job stress on radiologists. Lack of training and communication skills and work overload.

Appendix C: DHA Appraisal Results Log

Author, date, and title	Evidence level and quality rating	Focus: HSO type, Research Domain, and Specific Problem being addressed	Findings that help answer the review question(s)	Metrics and Measures if used	Source Limitations
J. GRAHAM*, A. J. RAMIREZ*, S. FIELD†, M. A. RICHARDS* (1999). Job Stress and Satisfaction Among Clinical Radiologists	High, 3	Acute Care settings and outpatient, job satisfaction and how it compares to job retention	Sources of satisfaction- higher satisfaction equals retention in radiologists.	Survey of 214 radiologists	Could expand to larger population of radiologists, including residents
M. Alakhras a, *, D.S. Al-Mousa a, S. Lewis (2022). Assessment and correlation between job satisfaction and burnout among radiographers	High, 3	Acute Care settings and outpatient, job satisfaction and how it compares to burnout	Job satisfaction for retention within radiologists.	Survey for radiologists and includes demographics and socio-demographics	Could expand to larger population of radiologists, including residents, not everyone who received a survey responded.
Rawson, J., Smetherman, D. & Rubin, E. (2024). Short-Term strategies for segmenting the national radiologist workforce	Good, 4	Acute Care setting and private practice settings, possible solutions and options for the future operations	Workforce trends and predications, residency programs aiding in the future. Solutions for population, staffing solutions, process issues, variation in volume, and ergonomics.	N/A	Points of view directly from the radiologists themselves was not addressed.
Konstantinidis, K. (2024). The shortage of radiographers: A global crisis in healthcare.	Good, 4	Acute care settings all over the world, job satisfaction and ways to increase it were discussed.	Lessons learned from COVID-19 pandemic, health and wellbeing of radiologists, gender equality and practice, professional development, job satisfaction, vocational guidance, education.	N/A	Did not focus on specific area in the national realm. Focus was mostly on global issue and different countries' issues.
Nicola, G. (2024). How will we solve our radiology workforce shortage?	Good, 5	Acute Care settings and private practice, it focused on future outcomes and solutions and current state.	This article addresses the radiology residency options and solutions to increase positions and academic solutions.	N/A	Focused more on educational aspects and not other focus areas for solutions.
Hagland, M. (2023). On the way to RSNA23: What about that radiologist shortage?	Good, 5	Acute care settings, AI opportunities are addressed and it also talks about burnout.	This article talks about resources for tackling burnout and SOP challenges. It also addresses AI opportunities.	N/A	The article does not address a wide-range of solutions and mostly focuses on the problem at hand.

Author, date, and title	Evidence level and quality rating	Focus: HSO type, Research Domain, and Specific Problem being addressed	Findings that help answer the review question(s)	Metrics and Measures if used	Source Limitations
Medicus Healthcare Solutions. (2024). Navigating the Radiologist Shortage: Strategies for meeting the rising demand in healthcare.	High, 5	Acute care settings and private practice. It talks about potential solutions offered.	This article talks about teleradiology solutions, locum options, and transition programs offered by Medicus.	N/A	This article talks about options and on the services that they partner with for gaps in coverage of radiologists.
Fornell, D. (2023). Mismatch between radiologist shortages, rising exam volumes a growing concern in medical imaging	High, 4	Acute care setting, private practice. This focuses on clinical decisions and possible solutions for volume relief.	Clinical decision, lowering barriers to allow for more foreign doctors, and technology options.	N/A	The potential barriers that it discusses alleviating has political and government challenges. The solutions are not short-term solution oriented.
Fleishson, H. (2022). The Radiology Labor Shortage.	High, 4	Acute Care Setting, alternative staffing models and addressing the burnout and job satisfaction are addressed.	This article talks about alternative staffing models, teleradiology, addressing burnout, and legislation.	N/A	A few solutions are discussed; however, not in great detail or with quality metrics.
Hudnall, C. (2024). Maximum Capacity.	Good, 4	Acute care setting, and private practice. This article focuses heavily on the capacity-volume future of radiology and different types of overutilization, and different perspectives.	Overutilization and burnout processes, using what we have with AI, shifting perspectives, values, teleradiology, different types of practices, and capacity-volume prognosis.	N/A	It focuses a lot on the capacity-volume aspects, and not the staffing issues, themselves.
Hudnall, C. (2024). Mismatch between radiologist shortages, rising exam volumes a growing concern in medical imaging	High, 4	Acute care setting, and private practice. This address a lot of different aspects of the operational challenges and mental health ramifications of the staffing challenges.	Different types of practices, AI, teleradiology and telework, technologists' concerns, shifting perceptions and values, overutilization, burnout, resources, and leadership struggles.	N/A	It would be better to include data and metrics behind some of the challenges.

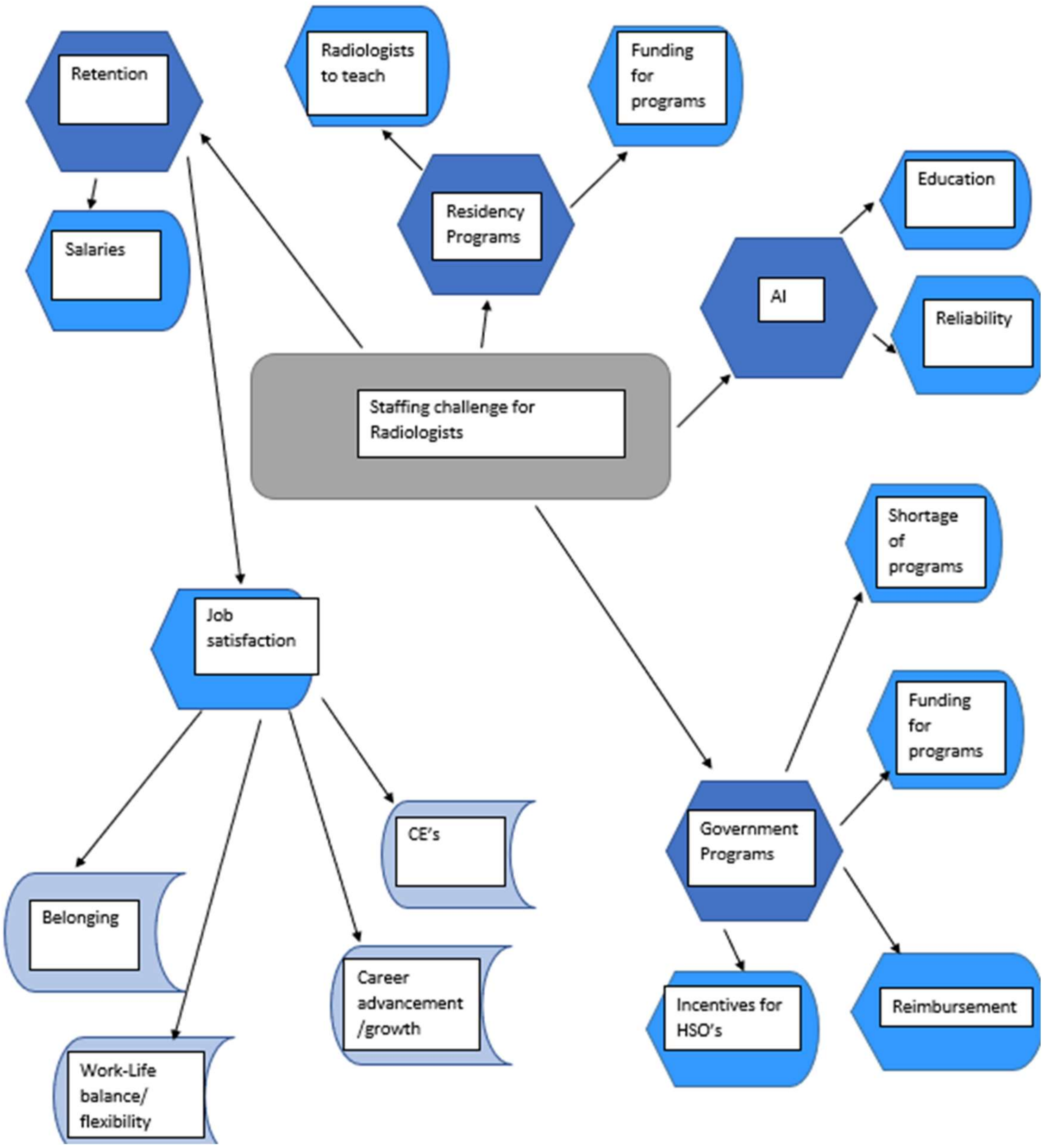
Author, date, and title	Evidence level and quality rating	Focus: HSO type, Research Domain, and Specific Problem being addressed	Findings that help answer the review question(s)	Metrics and Measures if used	Source Limitations
Alexander, R. et al. (2022). Mandating Limits on Workload, Duty, Speed in Radiology.	Low, 4	Acute Care setting, quality of the readings and the caseload of the radiologist is examined.	Quality and impact for Caseload	N/A	Quality does impact the imaging; however, it does have little to do with staffing.
Henderson, M. (2022). Radiology Facing a Global Shortage.	Good, 5	Acute Care Setting and private practice. It speaks to the problem; however, not the solution.	Global issues with radiologist staffing.	N/A	It speaks directly too the aging population and demand for imaging; however, it does not address operational solutions.

Appendix D: Thematic Analysis Results

Author(s) and date	Findings with Initial Codes	Code List for Theme Development
J. GRAHAM*, A. J. RAMIREZ*, S. FIELD†, M. A. RICHARDS* (1999).	Sources of satisfaction- higher satisfaction equals retention in radiologists.	Job satisfaction Retention Workforce trends Workforce predictions Professional development Vocational Guidance Continuing Education Staffing Solutions Process improvement Volume Ergonomics Residency Options Academic solutions Teleradiology AI Burnout Locums Transition Programs SOP challenges Additional country support Technology resources Legislation Practices Capacity versus volume Overutilization Resources Leadership struggles Caseload Values Perspective of Radiologists
M. Alakhras a, *, D.S. Al-Mousa a, S. Lewis (2022).	Job satisfaction for retention within radiologists.	
Rawson, J., Smetherman, D. & Rubin, E. (2024).	Workforce trends and predications, residency programs aiding in the future. Solutions for population, staffing solutions, process issues, variation in volume, and ergonomics.	
Konstantinidis, K. (2024).	Lessons learned from COVID-19 pandemic, health and wellbeing of radiologists, gender equality and practice, professional development, job satisfaction, vocational guidance, education and association with the labor market, briefly discusses issues in different countries.	
Nicola, G. (2024).	This article addresses the radiology residency options and solutions to increase positions and academic solutions.	
Hagland, M. (2023).	This article talks about resources for tackling burnout and SOP challenges. It also addresses AI opportunities.	
Medicus Healthcare Solutions. (2024).	This article talks about teleradiology solutions, locum options, and transition programs offered by Medicus.	

Author(s) and date	Findings with Initial Codes	Code List for Theme Development
Fornell, D. (2023).	This article talks about clinical decision, lowering barriers to allow for more foreign doctors, and technology options.	
Fleishson, H. (2022).	This article talks about alternative staffing models, teleradiology, addressing burnout, and legislation.	
Hudnall, C. (2024).	This article addresses overutilization and burnout processes, using what we have with AI, shifting perspectives, values, teleradiology, different types of practices, and capacity-volume prognosis.	
Hudnall, C. (2024).	This article talks about different types of practices, AI, teleradiology and telework, technologists' concerns, shifting perceptions and values, overutilization, burnout, resources, and leadership struggles.	
Alexander, R. et al. (2022).	Quality and impact for Caseload	
Henderson, M. (2022).	Global issues with radiologist staffing.	

Appendix E: Thematic Map



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