LITHOS

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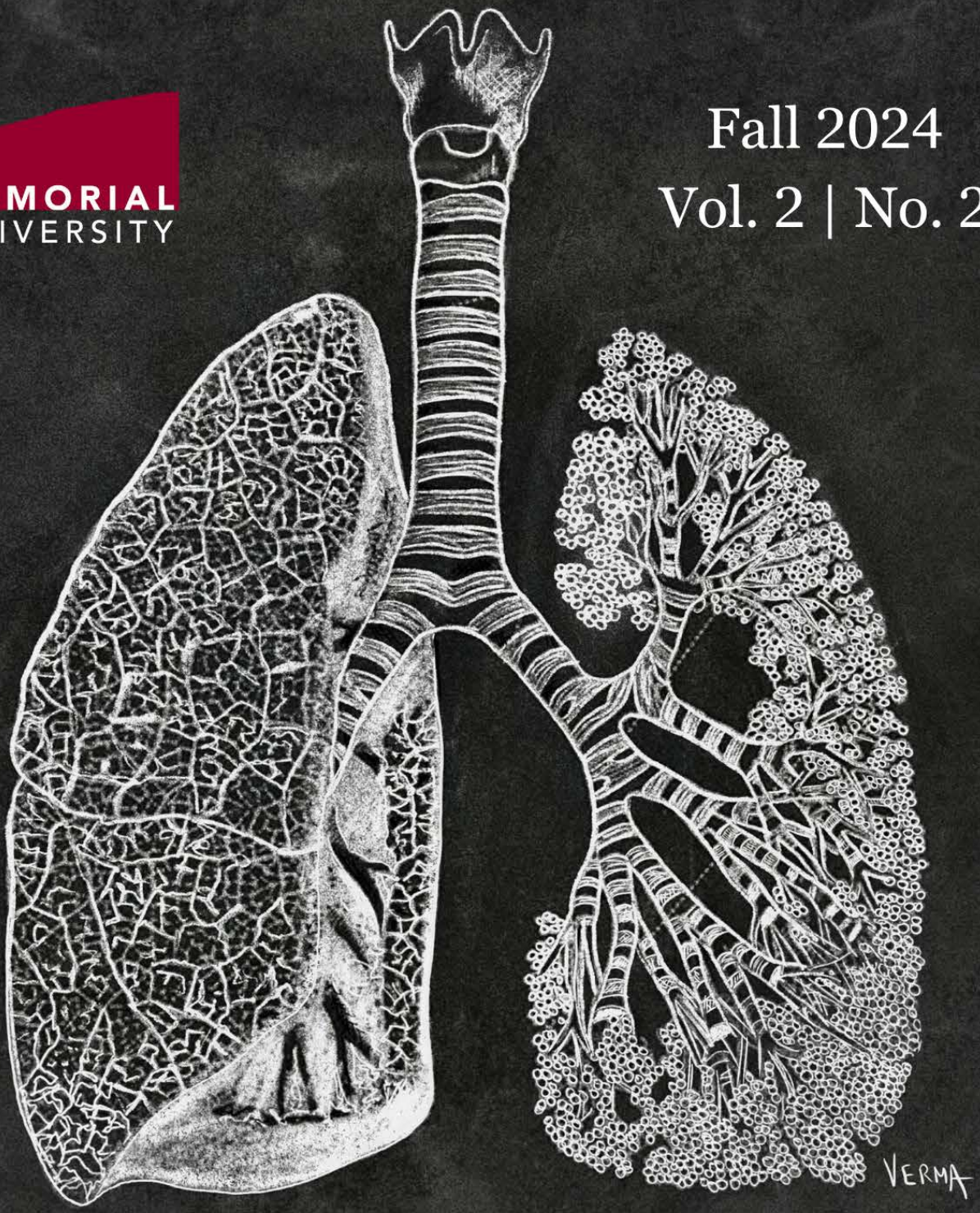

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Table of Contents

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Land Acknowledgement

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We respectfully acknowledge the territory in which we gather as the ancestral homelands of the Beothuk, and the island of Newfoundland as the ancestral homelands of the Mi'kmaq and Beothuk. We would also like to recognize the Inuit of Nunatsiavut and NunatuKavut and the Innu of Nitassinan, and their ancestors, as the original people of Labrador. We strive for respectful relationships with all the peoples of this province as we search for collective healing and true reconciliation and honour this beautiful land together.

Editorial

Nutrition in the medical curriculum: A vital missing ingredient

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Keywords: Nutrition, Medical Curriculum, Education, Chronic Disease Management

Physicians, and in particular, general practitioners (GPs), are often the first point of contact for patients into the health care system. Patients confide in their GPs – they trust that they are competent to recognize, diagnose, treat and provide long-term management for their conditions, and they hold their advice in high regard.[1] Physicians are also viewed as trusted and reliable sources of nutrition information, with the expectation that they can provide accurate information.[2,3] Despite this expectation and physicians' recognition of the importance of nutrition to health and disease progression, many do not feel equipped to address their patient's nutritional needs.[4-8] A Canadian study demonstrated that more than 80% of physicians believed their nutrition training was inadequate, including in medical school.[8] A recent systematic review also showed that these knowledge deficits in nutrition impeded physician's confidence when delivering nutrition information to patients.[9] Given the importance of nutrition in chronic disease progression, management, and prevention, it is important to highlight this gap in the medical curriculum, with the goal of improving nutrition education in medical schools to optimize patient care.

Globally, nutrition education in medical curricula has been shown to be insufficient.[10-13] In the United States, the absence of standardized competencies has resulted in inconsistent training, varying from no nutrition education to brief lectures or nutrition rotations.[10,11] Medical students in Ghana have also identified nutrition education as inadequate, noting its low priority within the curriculum and poor translation into clinical practice.[12] Interestingly, an Australian study involving interviews with medical students revealed that nutrition education in their curriculum was not graded.[13] This led to frustration among students as they were trying to prioritize other subjects that were testable on exams, such as physiology.

Similarly, Canadian medical schools have been found to lack adequate nutrition education. In a survey of 933 medical students, 87.2% expressed the need for more nutrition education in their undergraduate programs, and many students reported dissatisfaction with the nutrition training they received and their confidence in providing appropriate nutrition counseling.[14] Moreover, a recent study at Dalhousie University revealed that medical students felt the curriculum did not adequately equip them with confidence in their nutrition knowledge and skills.[15]

Consequently, inadequate nutrition education for physicians can negatively impact patient outcomes, as diet and nutritional status play a critical role in maintaining good health. Poor diet is the second leading cause of death worldwide, with dietary risk factors contributing to 11 million global deaths in 2017.[1,16] Nutrition has been identified as a key modifiable factor in the prevention and management of non-communicable diseases, including cardiovascular disease, hypertension, and diabetes.[17] To address the growing burden of preventable chronic diseases, physicians play a vital role in delivering nutrition interventions in primary care. Due to the trust that patients place in physicians, physicians have potential to improve patient's dietary habits by providing evidence-based nutrition advice and resources, and advocating the importance of good nutrition.[1] Physicians should also be confident in recognizing patients 'at risk' and refer them to dietitians, who are health care professionals with specialized training in nutrition.[18] However, physicians have been shown to lack evidence-based nutrition knowledge, confidence, and the ability to apply this knowledge in practice, which can limit the nutritional advice that physicians offer their patients.[9] This also impacts physician's referral rates to dietitians, as shown by Pojednic et al. who demonstrated that physicians who do not provide nutrition counselling are less likely to refer patients to dietitians for diet therapy.[19] As a result, patients with chronic disease who would benefit from nutrition counselling may lack appropriate care. Evidently, inadequate nutrition education poses a risk to patient health, particularly for those with chronic diseases who could benefit from nutrition counseling but may not receive adequate care.

Collaboration between physicians and dietitians is vital for providing effective healthcare to patients.[20] A study in 2020 showed that medical students found collaboration with dietitians to be helpful when providing nutrition care, and believed that dietitians provide more effective nutrition care than physicians.[13] Supporting this, clinical guidelines recommend that patients be referred to dietitians to receive nutrition therapy when required.[19] Studies also show that there is value in a multidisciplinary team approach when managing patients with chronic disease.[1,21] This approach emphasizes that physicians can focus on the diagnosis and treatment plans, while dietitians can integrate their nutrition knowledge into the patient care plan to optimize patient outcomes.

The medical curriculum clearly places insufficient emphasis on nutrition education for future physicians. To address this gap, medical students at Dalhousie University proposed several recommendations to improve the nutrition curriculum in Canadian medical schools.[15] One key suggestion was to incorporate a longitudinal nutrition program throughout the four-year curriculum. This program would deliver evidence-based nutrition content, including the role of nutrition in disease prevention and management, nutrition support, and nutrient requirements across the lifespan. Students also recommended that dietitians teach nutrition-related topics and participate in relevant tutorials. Additionally, they emphasized the importance of opportunities for medical students to collaborate with dietetic interns and dietitians during clinical training. Finally, they suggested formally assessing nutrition knowledge through methods such as multiple-choice questions and objective structured clinical examinations (OSCE). These recommendations highlight that medical students recognize the importance of nutrition education and have a strong desire for it, yet they currently lack adequate training in this area.

In summary, nutrition education in the medical curriculum is historically and globally inadequate. Despite medical students' and physicians' recognition of the importance of nutrition, they lack the knowledge and confidence to provide sufficient nutrition advice to patients. Particularly, dietary support is crucial to prevent and manage chronic disease, and a lack of nutrition support for patients can compromise patient health. Moving forward, emphasis should be placed on the prioritization of relationships between dietitians and physicians through a multidisciplinary team framework, as well as the improvement of nutrition education in medical training to improve patient care.

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Original Research

Assessing clinical appropriateness: A retrospective audit of CTEs performed in St. John's, Newfoundland and Labrador, during 2022

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ABSTRACT

Objectives: Computed tomography enterography (CTE) is an abdominopelvic computed tomography (CT) specifically designed to evaluate the small bowel. Guidelines exist regarding what clinical situations warrant CTE. This study intends to assess how CTE is currently used locally in St. John's, Newfoundland and Labrador (NL) and compare the results to the literature to determine whether CTEs are being requested according to best practices.
Methods: This study consisted of a retrospective audit of all CTEs (n = 422) performed in St. John's, NL in 2022. CTEs were performed at three major hospitals (Health Science Centre, St. Clare's Mercy, Janeway Children's Hospital and Rehabilitation Centre). Extracted information included the patient's clinical history, age and sex, and results of the imaging study. Results were compared to the Canadian Association of Radiologists gastrointestinal imaging referral guideline as well as the American College of Radiology appropriateness guidelines to determine whether the use of CTE was appropriate.
Results: CTEs had been ordered to investigate iron deficiency anemia, patients with a known Crohn's diagnosis, and patients with suspected small bowel Crohn's. Based on the guidelines, its use in such situations was appropriate. 41 CTEs were ordered to investigate vague abdominal symptoms; upon comparing to guidelines, it was determined that its use in such situations is inappropriate. Infrequently, CTEs were ordered to investigate suspected gastrointestinal bleeding; guidelines recommend use of CTE in suspect chronic gastrointestinal bleeding, but not acute. Unfortunately, the acuity of the bleed was rarely noted on the requisition.
Conclusions: CTE is, undoubtably, a valuable imaging modality to visualize the small bowel. Most of the clinical indications prompting CTE requests within the St. John's region aligned with published indications for CTE referral. However, the majority of studies did not identify a small bowel cause for the patient's symptoms.

Keywords: CT Enterography, Crohn's Disease, Anemia, Iron Deficiency, Malignancy

INTRODUCTION

Computed tomography enterography (CTE) is an abdominopelvic computed tomography (CT) specifically designed to evaluate the small bowel. CTE requires distention of the small bowel, typically via oral contrast.[1] Canadian guidelines exist regarding what clinical situations require assessment by CTE.[1-2] The American College of Radiology (ACR) has also put forth a set of guidelines to help providers determine which clinical scenarios require imaging via CTE.[3] Notably, CTE has proven useful in the assessment of patients with Crohn's, chronic diarrhea, abdominal pain, suspected small-bowel bleeding, among other patient presentations.[1,2-6]

In recent years, CTE has become a prominent imaging modality for small bowel disease.[4] CTE can identify both intramural and extra-intestinal manifestations of small bowel disease.[5] The most sensitive indicator on CTE of active Crohn's disease is mural hyperenhancement.[6] It also allows for the differentiation between active and fibrotic disease. Such differentiation guides treatment strategy.[4-6] CTE's accuracy in detection of Crohn's disease is comparable to biopsy.[7]

CTE is also a reliable tool to evaluate and monitor treatment effectiveness.[8-9] In patients with Crohn's disease, research has demonstrated that CTE results correlate highly with clinical remission and is therefore useful in evaluating treatment response.[8] As such, CTE can be used to evaluate Crohn's disease status and aid in stratification of disease thereby helping with prognosis and assessment of therapeutic response.[8]

CTE takes approximately two hours in comparison to 24 hours for capsule endoscopy and can visualize the entire small bowel wall, mesentery and perienteric fat.[10] In patients with suspected chronic gastrointestinal bleeding, CTE is recommended as the initial imaging modality.[2] If CTE is negative and further imaging is required, capsule endoscopy can be used as a second imaging modality.[2] CTE also has a role in assessing small bowel bleeding as it is able to better detect protruding lesions, such as tumors of the small bowel, which may be a source of obscure gastrointestinal bleeding (OGIB).[10]

INDICATIONS FOR CTE

Indications for CTE include the diagnosis of suspected inflammatory bowel disease (IBD), surveillance of known IBD and its complications, suspected chronic mesenteric ischemia, detection/characterization of small bowel masses (SBM) and obscure small bowel bleeding.[11] CTE is also useful in the investigation of celiac disease as well as to assess polyposis.[6,12] CTE may be beneficial in the evaluation of suspected low grade or intermittent small bowel obstructions (SBO) but is not typically used in the setting of acute SBO as patients are often unable to tolerate the large amount of oral contrast administered into the obstructed bowel.[13]

In 2022, 422 CTE studies were performed in the St. John's region (Health Science Centre, St. Clares Mercy Hospital, Janeway Children's Health and Rehabilitation Centre) of Newfoundland and Labrador (NL). At present, no studies have been conducted to assess whether CTE is used appropriately in the St. John's region of NL. Therefore, via a retrospective audit, we intend to assess whether its use is consistent with recommendations and published guidelines**.**

Our usage of the term "appropriateness" refers to whether the clinical indication warranted ordering of the CTE. As such, we will be referring to the Canadian as well as the ACR appropriateness guidelines. These guidelines exist to help guide clinicians in choosing the most appropriate imaging study for their patient's presentation.[2-3]

METHODS

This study took the form of a retrospective chart review. All CTEs (n = 422) performed in the St. John's Region (Health Science Centre, St. Clare's, Janeway) of NL from January 2022 to December 2022 were collected and reviewed. Using the picture archiving and communication system (PACS), the date range had been set from January 2022 to December 2022 inclusive. The imaging modality of interest was set to CTE, and the location was set to the Eastern Health region. From there, all CTEs performed within the St. John's region (Health Science Centre, St. Clare's, Janeway) were able to be identified and reviewed. From each CTE, patient demographics (age and sex only), the patient's clinical history (i.e., indication for referral), and results of the imaging study were recorded. The indication for referral was obtained from the clinical diagnosis section of the CTE requisition. This information was compiled and results were compared to the literature, including the Canadian Association of Radiologists gastrointestinal imaging referral guidelines as well as the ACR appropriateness guidelines, to determine whether CTE use in St. John's, NL is following best practices.

RESULTS

422 CTEs were reviewed, with the aforementioned details compiled. The average patient age was 56.6 years. Of the patients, 234 were female and 188 were male. Of note, the youngest patient age was 19. As such, there will be no discussion of CTE use among the paediatric population. The following results were categorized based on clinical indication for referral.

Table 1 provides a summary of results and Table 2 provides a summary of results by clinical indication.

Table 1. *Summary of results.*

Total number of Studies	Age Range (years)	Avg. Age (years)	Gender	Results	% Normal Study
422	19-95	56.6	Female = 234 Male = 188	Normal Study = 289 Abnormality identified = 133	68.5%

Table 2. *Summary of results by clinical indication.*

Indication	Number of Requests	Age Range	Avg. Age	Gender	Results	% Normal study
Iron deficiency anemia	114	29-86	63.8	Female = 68 Male = 46	Normal study = 92 Abnormality identified = 22	80.7%
Known Crohn's	91	21-82	51.4	Female = 47 Male = 44	Normal study = 32 Abnormality identified = 59	35.2%
Suspected small bowel disease	80	19-88	46.8	Female = 44 Male = 36	Normal study = 58 Abnormality identified = 22	72.5%
Abdominal Symptoms	41	20-82	53	Female = 25 Male = 16	Normal study = 36 Abnormality identified = 5	87.8%
Gastrointestinal Bleeding	28	26-95	68	Female = 14 Male = 14	Normal study = 27 Abnormality identified = 1	96.4%
Malignancy	17	37-84	66.5	Female = 8 Male = 9	Normal study = 10 Abnormality identified = 7	58.8%
Small Bowel Obstruction	14	33-84	56	Female = 7 Male = 7	Normal study = 9 Abnormality identified = 5	64.2%
Other	37	21-90	60	Female = 21 Male = 16	Normal study = 26 Abnormality identified = 11	70.2%

Iron Deficiency Anemia

114 CTEs were requested to assess a cause for iron deficiency anemia (IDA). This accounted for 27.0% of all CTE requestions in 2022 within the St. John's region. Of these requests, 68 patients were female and 46 were male. The average patient age was 63.8 years.

The majority of the CTEs were requested by gastroenterologists (44), general surgeons (33) and general internists (18); 4 were requested by family physicians. The remaining CTEs (19) were requested by subspecialties including respirology, haematology, cardiology, endocrinology, urology, and neurology. 1 was requested by a nurse practitioner.

Of the CTEs, 92 (80.7%) did not identify a small bowel lesion to account for the patient's symptoms. 13 (11.4%) studies found evidence of angiodysplasia within the small bowel (Figure 1). 2 studies found evidence of Crohn's disease. Other findings included ileal mass (1), malabsorptive disease (3), malignancy (2), and small bowel obstruction (SBO) (1).

Known Crohn's

91 (21.5%) CTEs were ordered to investigate the small bowel in patients with known Crohn's disease. Specifically, studies were ordered to assess disease extent. 17 requisitions had explicitly stated that the patient was being treated for their Crohn's. However, not all requisitions stated the specific medication. Among this group, 47 patients were female and 44 were male. Average patient age was 51.4 years.

Those requesting CTE included 66 gastroenterologists, 11 were general surgeons, and 11 were general internists. The remaining 3 CTEs were requested by a respirologist, haematologist, and a nephrologist.

Of the 91 CTEs ordered, 59 (64.8%) CTEs demonstrated findings of active Crohn's disease (Figure 2). 32 studies reported normal small bowel appearance. Other findings included malignancy (1), fistula (2), and query findings of chronic Crohn's disease manifestation versus normal variant (1).

Suspected Small Bowel Disease

80 (18.9%) studies were ordered to investigate patients for possible small bowel Crohn's (undiagnosed patients). Among this category, 44 patients were female and 36 were male. The average age was 46.8 years.

12 studies were limited by under-distention. Referring providers included gastroenterologists (23), general surgeons (22), general internists (18), and family physicians (17).

58 (72.5%) studies demonstrated no evidence of active IBD. 19 (24.1%) had reported findings of Crohn's disease (Figure 3). 2 studies had reported evidence of angiodysplasia, and 1 made note of a stricture visualized in the small bowel.

Abdominal Symptoms

This category consists of patients referred for imaging based on various gastrointestinal symptoms including nausea, bloating, pain, vomiting, diarrhea, constipation and weight loss. This category accounted for 41 (9.7%) of CTE requisitions in 2022. The average patient age was 53 years and consisted of 25 females and 16 males.

15 studies were ordered by family physicians, 12 by gastroenterologists, 9 by general surgeons, 4 by general internists, and 1 by a nurse practitioner.

36 studies (87.8%) did not demonstrate any small bowel pathology. 2 found evidence of active small bowel disease, 2 had noted evidence of angiodysplasia, and 1 study made note of changes consistent with malabsorptive disease (celiac disease).

Gastrointestinal Bleeding

Unsurprisingly, CTEs were periodically requested for investigation of a possible small bowel source for a patient's gastrointestinal (GI) bleeding. Requestions were submitted to investigate patients presenting with query lower GI bleeding as well as patients with query upper GI bleeding.

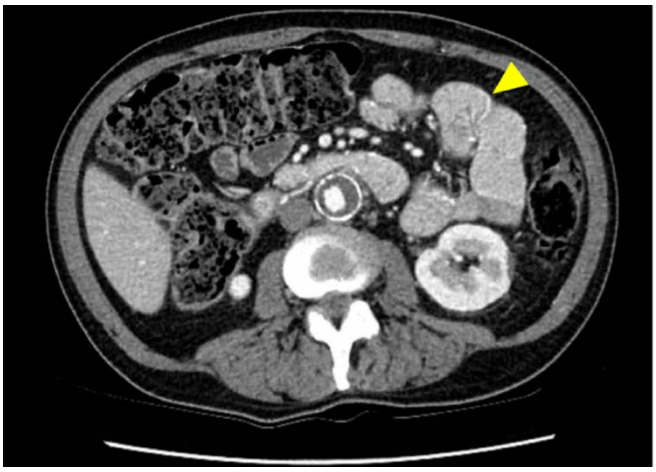

Figure 1. *67 year old male undergoing CTE to investigate for possible small bowel source of patient's iron deficiency anemia. Transverse image above demonstrates a foci of angiodysplasia within the proximal jejunum (arrowhead).*

Figure 2. *40 year old female with known Crohn's disease. Coronal image demonstrates mild hyperenhancement with moderate mural stratification and luminal narrowing at level of the terminal/distal ileum (arrowheads). These findings are in keeping with acute on chronic Crohn's disease.*

This accounted for 28 (6.4%) of the 422 studies ordered in 2022. Of these, 14 were female and 14 were male. Average patient age was 68 years. Among specialties requesting CTEs for this reason, 11 were general surgeons, 9 were general internists, and 3 were gastroenterologists. Of the 28 studies, 4 explicitly stated that the bleeding was chronic in nature, and

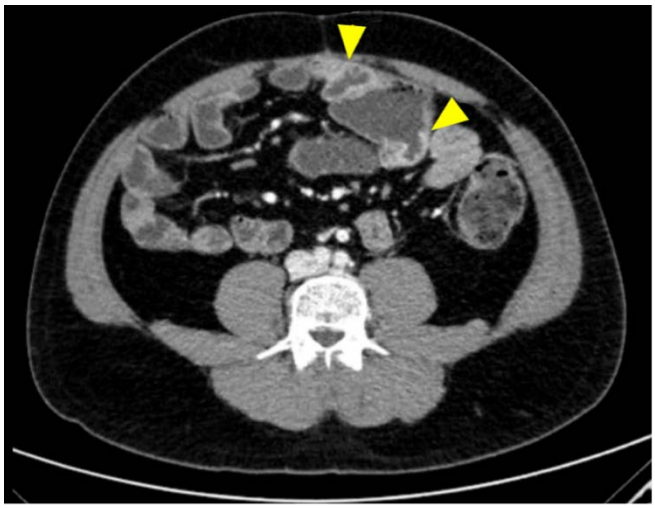

Figure 3. *34 year old male undergoing CTE for investigation of possible small bowel Crohn's disease. Two segments of mural hyperenhancement demonstrated in the ileum above demonstrates active Crohn's disease with skip lesions (arrowheads).*

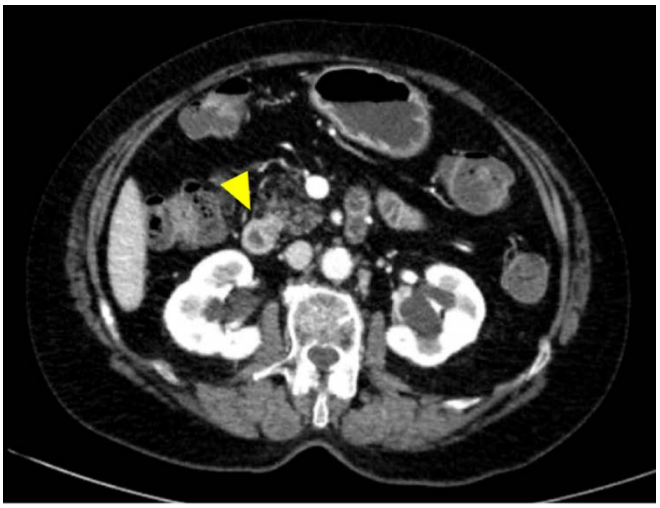

Figure 4. *76 year old female referred for CTE after CT demonstrated duodenal stricture and questioned possible malignancy. Transverse image demonstrates an abnormality of the medial wall of the duodenum with heterogenous enhancement (arrowhead) – a finding concerning for malignancy.*

1 stated the bleeding had been acute. 27 studies (96.4%) studies did not localize a small bowel source for the patient's symptoms. 1 study identified angiodysplasia which could be a possible explanation for the patient's presentation.

Malignancy

CTEs were infrequently requested as part of an investigation for possible malignancy in 17 patients (4%); 8 patients were female and 9 were male. Average age was 66.5 years. Studies were ordered by family physicians (4), general internists (4), general surgeons (4), gastroenterologists (2), nurse practitioners (2), and 1 haematologist. Of these studies, 10 (58.8%) concluded that the small bowel had a normal appearance, 1 had stated that there was evidence of active IBD, 2 identified polyps, and 1 noted evidence of angiodysplasia. 1 study noted that the duodenum had an abnormal appearance that was concerning for malignancy and required further investigation (Figure 4). 2 studies identified enhancing lesions within the small bowel requiring further imaging for characterization.

Small Bowel Obstruction

In 2022, 14 (3.3%) CTEs were ordered to investigate the cause of small bowel obstruction. This category included 7 females and 7 males, with an average patient age of 56 years. Studies were ordered by general surgeons (9), gastroenterologists (4), and a family physician. 9 (64.2%) studies demonstrated normal small bowel. 3 found active inflammatory small bowel disease. Only 1 of these 3 studies identified evidence of stricturing with upstream dilatation, noting this as a possible cause for the patient's symptoms. 1 study identified a right lower quadrant mass, and 1 identified a small bowel obstruction that was quoted as presumably due to stricture or adhesions.

Other

37 CTEs (8.8%) ordered in 2022 had been requested for reasons that did not fit the above categories. Examples of clinical histories within this category include "RLQ mass", "abscess", "stomach lesion", "peutz-jeghers syndrome", "endometriosis and fecal incontinence", "protein losing enteropathy", "Crohn's vs malignancy", "IBD and IDA" and "query malabsorptive disease". 21 patients were female, 16 were male; the average patient age was 60 years. Studies were ordered by a variety of specialists including 12 general surgeons, 8 gastroenterologists, and 3 family physicians.

26 (70.2%) patients had a normal small bowel appearance and 5 demonstrated active IBD. Ischemia, soft tissue prominence, intraperitoneal mass, and "unchanged mass" were each noted on one occasion, respectively, with angiodysplasia identified twice.

DISCUSSION

CTE is, undoubtably, a valuable imaging modality to visualize the small bowel.[2-5,11] The most common clinical histories for CTE referral among our patient population included investigation of the small bowel in the setting of IDA, assessment of patients with known Crohn's disease, suspected Crohn's disease, and bleeding. These histories align well with published indications for CTE referral.[2-6,11,14-16] Uncommon indications for referral included investigation of malignancy, query SBO and vague abdominal symptoms.

Iron Deficiency Anemia

While IDA was a common reason for CTE requisition, few studies have documented CTE's clinical use in the investigation of the same.[15] That said, in situations where imaging is required to investigate IDA, Canadian guidelines

recommend CTE as the initial imaging study. Of the 114 studies ordered to investigate IDA, 92 (80.7%) resulted in normal small bowel. Documented small bowel causes of IDA include IBD, malignancy, vascular malformations (angiodysplasia), and malabsorptive conditions such as celiac disease.[17] The most common cause of IDA in adult men and postmenopausal women is chronic blood losses from the GI tract.[17-18] The most common cause of IDA in premenopausal women is menstrual losses.[17-18] Given that the average patient age within this category was 64 years, it is reasonable that patients were referred for CTE with the intent of investigating for possible small bowel causes of the patient's IDA. Therefore, the use of CTE within this category is considered appropriate.

Twenty-two studies ordered for investigation of IDA identified abnormalities within the small bowel. In this category, 13 identified the presence of angiodysplasia, 3 identified malabsorptive disease and 2 identified changes consistent with malabsorptive disease – all of which are documented causes of IDA.[17] Evidently, in this patient population, IDA is infrequently caused by a small bowel source. It is also documented that, in the elderly population, IDA is often multifactorial which should be considered among this patient demographic.[17] Other causes include malabsorptive disease, non-steroidal anti-inflammatory use, dietary intake, and iron chelation (tea, coffee, calcium, etc.).[17] Future research should focus on exploring causes of IDA among elderly patients in NL to guide the use of appropriate investigations.

Known Crohn's

CTE is a commonly used imaging technique for surveillance of known IBD.[11] Of the 91 studies ordered, 59 identified evidence of active disease. While CTE has proven useful for surveillance of disease in patients with known small bowel Crohn's it is recommended that, where possible, such patients be followed with magnetic resonance enterography (MRE).[13] In St. John's, NL access to MRE is poor, which may explain the large number of CTEs requested to evaluate patients who had been previously diagnosed with Crohn's. In such a case, the use of CTE is considered appropriate.[2-3] Therefore, it can be concluded that CTE is being used appropriately in this patient population. Furthermore, the ability to identify active disease in such patients will help guide disease management.[8]

Of the 91 studies reported, 9 reported underdistention. Underdistention can complicate assessment of the small bowel as it is difficult to differentiate between thickened loops of bowel from normal, poorly distended bowel.[19] It is important to keep this in mind when interpreting the results outlined herein.

Suspected Small Bowel Disease

In 2022**,** 79 patients in the St. John's region were referred for investigation of suspected IBD. Based on both Canadian and American guidelines for assessment of suspect small bowel Crohn's, the use of CTE as a first line imaging study is considered appropriate.[2-3] That said, among our patient population undergoing investigation for suspected small bowel IBD, only 19 CTEs reported evidence of the same. Furthermore, 12 had reported underdistention. While this impacts our results, it remains that over 50% of patients referred for suspected IBD, did not show evidence of the same on CTE. Such findings guide management plans, as CTE has high sensitivity and specificity for detecting Crohn's disease; negative results provide clinicians with reassurance that they can exclude IBD as a cause for the patient's symptoms.[20]

Abdominal Symptoms

Among patients referred for vague abdominal symptoms, the majority of CTEs did not localize a cause originating from the small bowel (87.8%). We are unable to comment on what investigations this patient population had prior to their CTE, as such information was not included on the requisition. Given that CTEs expose patients to radiation, our results raise the question as to whether CTEs should be ordered for vague abdominal symptoms. Canadian imaging guidelines exist for specific abdominal symptoms including diarrhea, dyspepsia, and pain with recommendations differing slightly for each category. That said, across all categories, CTE was not a recommended imaging modality to investigate such presentations. Therefore, it can be concluded that the use of CTE to investigate vague abdominal symptoms does not align with current guidelines and is considered inappropriate.

Gastrointestinal Bleeding

Of the 28 referrals requested to investigate possible small bowel bleeding, 27 demonstrated normal small bowel. While seven referrals explicitly stated that both an Oesophagogastroduodenoscopy (OGD) and colonoscopy were negative, it is unclear whether the remaining 20 patients had other imaging investigations prior to their CTE. Canadian guidelines indicate that endoscopy should be the initial investigation in this clinical scenario.[2] In the setting of an acute GI bleed (both upper and lower), where imaging is needed, the study of choice is a CT angiography.[2] CTE is not recommended.[2-3] When investigating suspected chronic small bowel bleeding, CTE is recommended as first line.[2] Capsule endoscopy may be used if further imaging is required after CTE is completed.[2] In the case of the four GI bleeds identified as chronic, it can be concluded that CTE was appropriately ordered. However, given that only 5 of the 28 requisitions had outlined the acuity of the bleed, we are unable to comment on whether CTE was appropriately ordered for the 23 remaining studies. As such, we simply highlight the importance of ensuring that patients undergoing investigation for possible GI bleeding – both acute and chronic – follow the appropriate protocol to avoid unnecessary radiation.

Malignancy

Infrequently, CTEs were requested to investigate for possible malignancy. Of the 17 studies ordered, only 1 study noted an abnormal appearance of the duodenum that was concerning for malignancy, and 2 other studies identified enhancing lesions requiring further visualization.

The ACR appropriateness guidelines as well as the Canadian Association of Radiologists GI referral guidelines do not comment on the use of CTE in investigating suspected GI malignancy. That said, literature exists which has proven that CTE is reliable in the diagnosis and staging of small bowel malignancy.[6,21] Therefore, clinicians can be reassured when small bowel malignancies are not identified on CTE.

Small Bowel Obstruction

In 2022, 14 (3.3%) patients underwent CTE to assess for a cause of their SBO. Based on the ACR guidelines, the first line investigation for suspected acute SBO is a standard CT abdo-pelvis with IV contrast.[13] CTE is typically not recommended in the acute setting due to lack of toleration of the large volume of oral contrast required to perform the study.[13] In the case of suspected intermittent or low-grade SBO, CT abdo-pelvis with IV contrast or CTE are considered appropriate studies; however, CT abdo-pelvis is generally recommended over CTE as the clinical utility of CTE to diagnose intermittent or low grade SBO is not well established.[13]

Of the 14 studies ordered to investigate SBO, 3 noted that the patient had recurrent SBOs, making CTE an appropriate investigation.[13] However, CT abdo-pelvis may be more appropriate due to reduced cumulative radiation dose if the patient requires repeated scans or multiphase CTE acquisition studies. 1 study noted that the patient had a prior CT but no transition point was identified. Therefore, CTE was requested. In such a case, CTE is an appropriate complimentary tool.[13] The 10 remaining studies did not specify whether the SBO was considered acute or low grade. To comment on whether the use of CTE for these remaining patients was appropriate, information is needed regarding the acuity of the SBO. That said, overall, it appears that CT abdo-pelvis should be the initial investigation of choice.[13]

Other

The CTEs included in this section consisted of a variety of clinical histories which were infrequently requested and were unable to be included in other outlined categories. Given that the majority of clinical indications within this category are inconsistent with the published indications for CTE, it can be assumed that CTE may not have been appropriate in some cases.

The clinical histories of “IBD and IDA” and “Crohn’s vs malignancy” align with indications for CTE and was used appropriately in these specific cases.

Limitations

As with all research, limitations were identified throughout this study. First, 49 (11.6%) studies were complicated by underdistention of the small bowel. As discussed previously, underdistention compounds the radiologist’s ability to discriminate between normal, collapsed bowel, from thickened loops of bowel.[19] Appropriate distention may have resulted in different outcomes for such studies, which would impact the outcomes documented herein.

Secondly, few referrals indicated what investigations patients had had prior to CTE and what the outcomes of these studies were. Such information would be beneficial to guide our suggestions with regards to appropriate investigations and work up prior to CTE.

With regards to suspected GI bleeding, only five requisitions made note of the acuity of the bleed. As outlined, the recommended imaging modality changes based on acuity.[2] Without this information, we are unable to comment on whether the use of CTE in this category was appropriate.

Finally, many referrals were quite vague with regards to the reason(s) for CTE request. In the future, it would be beneficial if clinicians provided specific information, as well as the results of previous investigations, to help aid radiologists in the interpretation of the CTEs. Providing detailed information assists radiologists, prompting them to look for specific small bowel changes that may align with the patient’s symptoms.

CONCLUSION

Several conclusions can be drawn from this study. First, the use of CTE to investigate IDA was considered appropriate. Among this cohort of patients, those with IDA typically had a normal CTE. This provides guidance for management plans, but also suggests that IDA is infrequently due to a small bowel cause among this patient population.

Secondly, the use of CTE to investigate known small bowel Crohn’s also aligned with guidelines.[2-3] However, as discussed, MRE is typically the imaging modality of choice, but access is limited across our centres. In such a case, the use of CTE is considered appropriate, and is assumed to be the explanation for its use in this population. Evidently, CTE is able to detect active inflammation among patients with known Crohn’s disease, aiding in medical management of this population. Furthermore, in patients with suspected IBD, CTE is the imaging study of choice and was appropriately ordered to investigate this.

With regards to GI bleeding, guidelines recommend visualization with endoscopy prior to obtaining a CTE.[2] Unfortunately, we are largely unable to comment on whether CTE had been used appropriately to investigate GI bleeding as any prior investigations were rarely noted, and the acuity of the bleed was infrequently stated. As such, we take this opportunity to remind clinicians to ensure their patients obtain the appropriate investigations and consider the acuity of the GI bleed prior to advancing to CTE.

As outlined, the use of CTE to investigate vague abdominal symptoms does not align with current guidelines, and other imaging modalities are recommended in place of this.[2-3] Finally, with regards to SBO, CTE did not often identify a small bowel source. ACR guidelines indicate that CT abdo-pelvis with IV contrast is first line in acute SBO and should be considered prior to CTE in the setting of intermittent/low grade SBO.[13] Ultimately, CTE is a valuable tool to help investigate a wide variety of patient presentations. However, it is important that the use of this imaging modality follows best practices.

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Our recipe for world-class rural medical teaching sites

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If fortunate, we all have a favourite family recipe that when crafted, just tastes better. Maybe it is Nan's homemade bread or a soulful pot of soup. While we can all follow a recipe and have similar ingredients, the outcomes can vary. For some unknown reason, despite all variables being equal, some people are just better cooks.

Memorial University of Newfoundland's (MUN) Doctor of Medicine program has consistently been recognized as a better "rural cook." Currently, our program has twenty-seven rural teaching sites with approximately three hundred preceptors. MUN is a ten-time recipient of the Keith Award, presented by the Society of Rural Family Physicians to the medical school with the highest number of graduates in rural practice ten years after graduation. It has also received the Rural Medical Education Award presented annually to the residency program that matches most graduates to a rural family medicine residency.[1]

As physicians working in rural sites, we bake our own bread, but can we share our recipes and collaborate to create a superior bakery? As we continue to increase medical school and residency enrolments in Newfoundland and Labrador, where our focus is often the creation of rural practitioners, it is essential to have the best recipe for success. This opinion piece draws on our experience as rural practitioners, learners, and researchers, to identify ten key ingredients we believe are required to "bake" a world-class rural medical educational site:

INDEPENDENCE

It is no good to have Nan watching over your shoulder in the kitchen while you try to make bread; you have to bake it yourself to know if you can do it.

Medical training aims to develop independent practitioners. Rural sites foster independence since we often function without full specialist backup and there is a lesson in that discomfort. As a result, learners observe the independence of rural preceptors and develop confidence in assessment, formation of differential diagnoses, and patient management. Rural sites tend to demonstrate the value of learning independence.

COMMITMENT

We need to teach others to bake bread to continue to feed our rural communities.

Despite a perceived element of academic inferiority and a lack of guaranteed tenure, there is a high level of commitment to medical training in rural areas. We seek and accept medical students from undergraduate medical education, often in pairs, and layer learners at different levels to enhance everyone's experience. We dedicate time to teaching and invite students to present.

COMMUNITY

Ingredients are always plentiful when there's a neighbour's door to knock on.

There is no welcome like that at a rural site. Where else are you embraced by the community with baked goods, personal meetings, or even supper with the mayor? In rural areas, whether due to cultural factors or an appreciation for medical care, patients are generally more accepting of learner involvement, often welcoming interactions with all members of the care team. The ideal rural site focuses on the learning experience and an outstanding life experience. For learners, this approach helps foster the desire to enter a profession of rural medicine that extends beyond the clinical atmosphere. Ensure that you provide learners with comfortable and safe housing, and access to amenities such as grocery stores, fitness equipment, coffee shops, sports facilities, and hiking trails, as these are integral to success.[2]

EXPANSIVENESS

Be sure to cook over an open fire in the woods.

Rural physicians, in our experience, are accustomed to fulfilling an expansive role. The triage, management, and constant tasks expand the scope of a physician to include stabilization and follow-through, often without in-house consultation support. This is attractive to learners who are eager for hands-on experience. In our rural hospitals, a physician's finger is always on the pulse of what is happening throughout the whole medical community, and it is an open medical wilderness that must be sold.

FREEDOM

A recipe isn't meant to confine ambition but provide a foundation for creativity.

Providing an education that goes beyond the classroom or the clinic creates lifetime memories. Provide opportunities for medical transfer - by road, snow, mud, water or air. Be sure to highlight some of the valuable, non-traditional educational experiences often not available to trainees at urban sites. Additionally, continuing to provide opportunities for unique learning experiences outside of regular business hours is essential for the development of a well-rounded medical professional. Spontaneity is important and learners appreciate impromptu rural teaching. Thankfully, the broad scope of practice and exposure in rural medicine means new things happen every day.

UNIQUENESS

Our cookbooks are not mass-produced.

Medicine in rural environments is very unique. From rare pathology to unconventional treatments, rural medicine allows for the development of knowledge and skills not available elsewhere. From administering Factor VIII to a patient in the "Hemophilia capital of the world" in Twillingate to performing phlebotomy at "Hemochromatosis Central" in Brookfield, novel experiences help develop clinical knowledge. You must be aware of your local strengths and sell them. The further creation of opportunities for longitudinal learning, such as Longitudinal Integrated Clerkship (LIC), permits valuable continuity of care from both the patient and learner perspectives and allows learners to capture the full unique flavour of rurality.[3]

GENERALISM

When there is no bakery within one hundred kilometres you just learn to bake better bread.

There is an assumption that medical education in rural areas is of a lesser quality and the highest level and quality of learning often occurs at the highest level of subspecialty. Rural generalists and specialists often mirror the broad scope of practice of rural primary care providers: the general internist who does endoscopy, central lines, pacing wires, stress tests, dialysis and more; or the general surgeon performing vasectomies, trigger finger releases, fracture clinic follow up, and hiatal hernia repairs. These are diverse and highly specialized exposures for a student, available all in one place.

COLLABORATION

You are not afraid to knock next door and borrow a cup of sugar.

Rural settings provide opportunities for optimal team cooperation. Learners and physicians are part of an interprofessional team that includes allied health workers, paramedics, nurses, managers, and more. What better way to learn to collaborate than with a rural "work family" that strives to accomplish a common healthcare goal during the day and at a local coffee shop or pub during the night? Collaboration and exposure to other fields of medicine and rural health care lead to improved overall medical graduate preparedness. Understanding the roles of others, engaging in different methods and techniques (e.g., nursing IV access tricks) and sharing stories with the team over a coffee can only optimize confidence and competence.

DIRECTORSHIP

Julia Child does not live in Newfoundland but many there have baked her cakes.

MUN's Faculty of Medicine boasts an extensive network of staff dedicated to the onboarding and orientation of learners and faculty throughout the province. The Office of Distributed Medical Education works with the disciplines, learners, faculty, health authority and community players to best ensure travel, lodging and community connectivity are delivered flawlessly. Collaborative efforts with our provincial and community partners are necessary to ensure infrastructure and faculty needs are supported and maintained. We must continuously assess our environment, the faculty and learner climate and the needs of our people and communities through social accountability assessments. To achieve high-quality rural medical education, the instructional components must be free of deficiencies and led by insightful rural faculty.

INCENTIVIZE

You're more likely to cook if you know someone else will wash the dishes.

Since rural physicians often see themselves as clinicians first and teachers second,[5] it is important to highlight the importance of rural faculty. We must provide stipendiary and full-time appointments equally to rural and urban faculty, as well as preceptor remuneration models comparable to those across Canada. Further provision of productive faculty development with opportunities such as faculty-wide preceptor meetings and retreats, access to library privileges, and inclusion in academic committee work are essential. Communication must also be strong with enhancements through rural-led newsletters, faculty development sessions, provincial tours, and virtual town halls. Financial support through infrastructure funding and travel are integral to optimal rural faculty engagement.[4]

CONCLUSION

MUN has had sustained success in rural medical education, and we hope that others can learn from our success. While we've identified the ingredients for a successful rural teaching site based on our practical experiences, more formal research should be conducted to support our beliefs and identify additional factors associated with successful medical teaching sites in other rural areas. We believe that rural medical education creates a lifelong educational memory for all

medical learners. Let's be sure to join in the potluck and make it taste rich.

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Case Report

Utilization of POCUS in acute pulmonary embolism with hemodynamic instability: A case presentation

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ABSTRACT

Introduction: A pulmonary embolism (PE) is a life-threatening condition requiring rapid identification and treatment. However, the non-specific symptoms associated with the acute onset of a PE make clinical diagnosis difficult. Point of care ultrasound (POCUS) is a readily available and evolving technique that allows for rapid identification of a PE.
Case Presentation: 57-year-old patient presented to the Emergency Department (ED) hemodynamically unstable following an acute onset of shortness of breath and syncope. Ultrasonography revealed right ventricle (RV) dysfunction, abnormal tricuspid annular plane systolic excursion (TAPSE), and intravascular thrombosis, indicating a PE. Subsequently, the computed tomography pulmonary angiogram (CTPA) showed large bilateral pulmonary emboli and the patient received tissue plasminogen activator (TPA).
Discussion: The dependence of EDs on CTPA to rule in a PE before initiating thrombolytics may delay life-saving treatment. This case demonstrates the valuable addition of POCUS to the diagnostic protocol for PEs and reduces the waiting period in hemodynamically unstable patients to initiate empiric reperfusion therapy.
Conclusion: This case report demonstrates the benefits of POCUS in clinical decision making and highlights the advantages of its utility in the ED.

INTRODUCTION

A PE is an emergent condition associated with high rates of morbidity and mortality. Severe right ventricle outflow tract (RVOT) obstruction can develop which leads to obstructive shock thus, time to initiation of anticoagulant can be critical.[1,2] The diagnosis of a PE can be difficult as the signs and symptoms are often non-specific. Such symptoms as dyspnea, chest pain and syncope can also be attributed to a number of conditions including acute coronary syndrome, pneumothorax, or cardiac tamponade.[3] Previously the diagnosis of a PE required a CTPA however, prolonged wait times, institutional access to CT, and inability to obtain imaging at various times throughout the day highlighted the need for alternative imaging modalities.[3] Additionally, relative or absolute contraindications to CTs including contrast allergy, chronic kidney disease, and pregnancy also supported the need for alternative imaging methods.[3] According to the 2019 European Society of Cardiology (ESC) Guidelines on the Diagnosis and Management of Acute Pulmonary Embolism, it is now recommended that for those patients with suspected PE who are hemodynamically unstable, the diagnosis should be made with echocardiography to prevent delay in the initiation of thrombolytics.[3] POCUS is a readily available, rapidly evolving technique whose usage has many advantages in the emergency department including being readily available and non-invasive while reducing patient exposure to radiation. POCUS allows for rapid assessment and multi-organ visualization to aid in clinical decision making in hemodynamically unstable patients to rule in/out other potential conditions, as rapid treatment decreases mortality and incorrect administration of TPA can be harmful as well. This case demonstrates the usefulness of POCUS during assessment of a hemodynamically unstable patient presenting with non-specific symptoms and illustrates the various findings on multi-system ultrasonography that are associated with a PE.

CASE PRESENTATION

A 57-year-old-patient presented to our ED via Emergency Medical Services (EMS) following a syncopal episode. EMS reported the patient was walking up the staircase at their home when they experienced a brief syncopal episode, not resulting in any head injury or trauma, preceded by acute onset of shortness of breath. The patient was reported to be very agitated when EMS arrived at the home and the patient indicated that they were experiencing some chest pain. On arrival, at the ED, a rapid assessment was performed. Their airway was patent with increased work of breathing at a respiratory rate of 50 breaths per minute. Their O2 saturation was 89% on a non-rebreather at 15L O2. Their color appeared normal. Their blood pressure was 80/64 mmHg and heart rate 126 bpm. They were somewhat confused and vague in providing a history. Their temperature was recorded at 33.7°C. When fully exposed it became apparent that they were wearing an Air-Boot on their left leg. Immediate investigation and management measures were instituted including, blood draw for cardiac and potentially septic protocols. Intravenous (IV) crystalloid bolus was given with

no response therefore vasopressor support was begun with norepinephrine.

Review of the patient's electronic health record revealed no allergies, no medications, no chronic medical conditions. Past medical history included an admission five weeks prior for open reduction and internal fixation (ORIF) of a distal left tibial fracture. On physical examination, auscultation of the lungs revealed decreased breath sounds bilaterally with no adventitious sounds appreciated. The heart sounds appeared to be normal without any murmurs noted. The abdomen was soft, non-tender. Subsequent reassessments revealed that the patient's blood pressure dropped to 68/50 mmHg. Additionally, a Bair Hugger was placed on the patient to improve core body temperature.

An electrocardiogram (EKG) was completed during the patient's admission five weeks prior which was normal at that time. The EKG obtained on arrival showed sinus tachycardia and a new Right Bundle Branch Block (Figure 1).

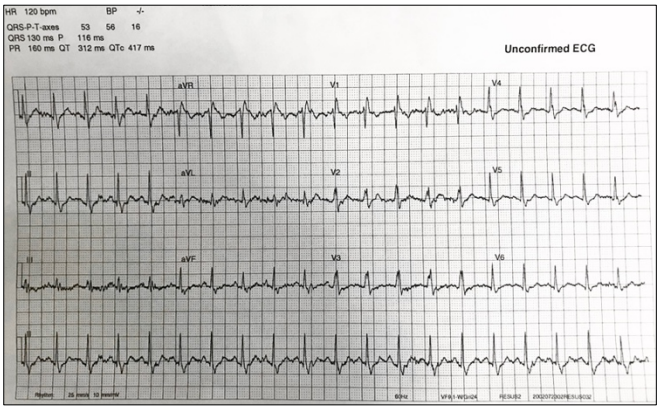

Figure 1. *EKG showing a new right bundle branch block demonstrated by RR' in V1 and V2.*

Our differential diagnosis was somewhat broad at this time owing to the patient's vague history, non-specific symptoms, and hemodynamic instability. The differential included various cardiac and lung pathologies including acute coronary syndrome, pulmonary embolism, cardiac tamponade, pneumothorax, pneumonia, and septic shock.

The laboratory results were significant for leukocytosis (Table 1). Additionally, the patient was determined to have a metabolic acidosis with an anion gap of 24.7 which was not compensated. Thus, an additional respiratory alkalosis was present. His chest x-ray was compared to a previous one, completed five weeks prior which was normal at that time. There were no infiltrates, pneumothorax, or effusions seen on the chest x-ray however, the superior vena cava (SVC) was newly enlarged (Figure 2). The tachycardia, and hypotension, in the presence of leukocytosis was concerning for sepsis thus, the patient was given IV Piperacillin/ Tazobactam 3.375g. Furthermore, the new EKG changes and reduced O_2 saturation in the absence of ST elevation and significantly elevated troponin placed PE at the top of our differential diagnosis.

Table 1. *Laboratory results and associated reference ranges.*

	Results	Reference Range
Complete Blood Count		
Leukocytes	12.2 ↑	4.5 – 11.0 x10^9/L
Hemoglobin	127 ↓	140 – 180 g/L
Platelets	234	150 – 400 x10^9/L
Chemistry		
Sodium	143	135 – 145 mmol/L
Potassium	3.9	3.5 – 5.0 mmol/L
Chloride	105	95 – 110 mmol/L
Creatinine	153 ↑	54 – 113 µmol/L
Urea	7.0	3.0 – 7.0 mmol/L
Glucose	15.7 ↑	3.5 – 7.8 mmol/L
Estimated Glomerular Filtration Rate (EGFR)	41	
Lactic Acid	12.71 ↑	0.5 – 2.2 mmol/L
Troponin	6.3	0 – 34.2 ng/L
Creatine Kinase	41	30 – 200 U/L
Coagulation		
International Normalized Ratio (INR)	1.21	0.8 – 1.2
Activated Partial Thromboplastin Time (APTT)	35.1	30 – 45 seconds
D - Dimer	13978 ↑	0 – 230 ng/ml
Venous Blood Gas		
pH	7.105 ↓	7.320 – 7.430
PCO2	57.2 ↑	38.0 – 50.0 mmHg
O2 Saturation	17.9% ↓	60 – 85%
HCO3	17.2 ↓	22 – 29 mmol/L
Base Excess	10.8	mmol/L
Arterial Blood Gas		
pH	7.342 ↓	7.350 – 7.450
PCO2	23.7 ↓	35 – 45 mmHg
PO2	119	83 – 108 mmHg
HCO3	13.3 ↓	21 – 28 mmol/L
Base excess	13.2 ↑	-2.0 – +2.0 mmol/L
O2 Saturation	99.1%	95 – 99%

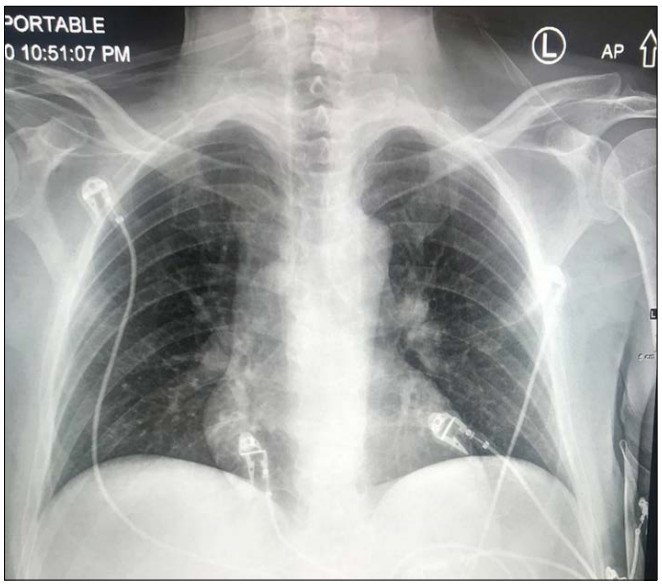

Figure 2. *Anterior-posterior chest radiography exhibits an expanded SVC.*

Subsequently, the pre-test probability of a PE to determine the need for diagnostic work-up was calculated using the Wells' Criteria for PE (Figure 3). The patient received six points, placing them in the moderate risk range according to the Three Tier Model therefore we decided to order both a D-dimer and CTPA (Figure 3).[4]

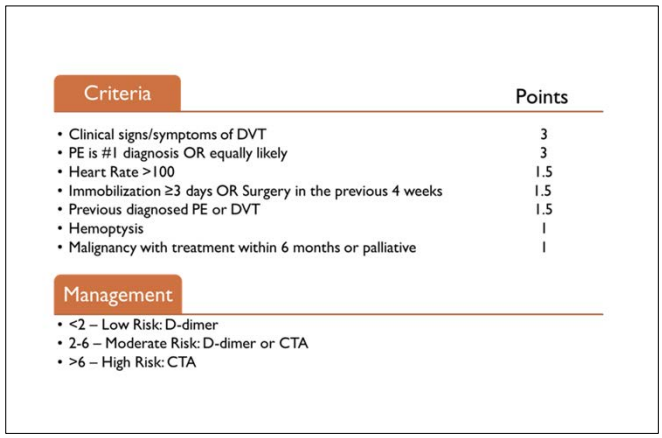

Figure 3. *Wells' Criteria for PE used to calculate the patients pre-test probability of a PE.*[4]

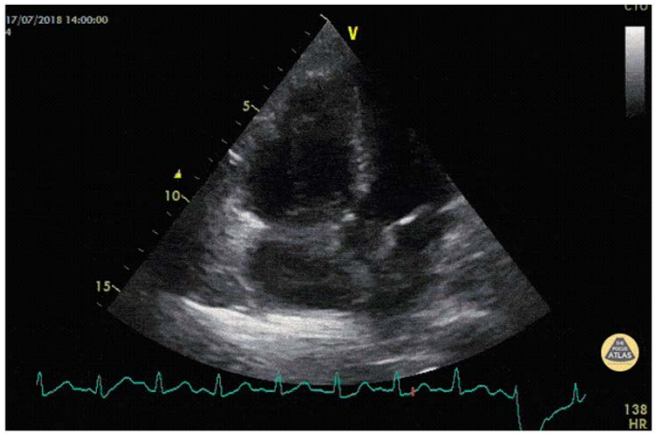

Figure 4. *Transthoracic Echocardiography (POCUS) Apical 4 chamber view. Dilated RV with interventricular septum flattening and McConnell's Sign demonstrated by RV wall hypokinesis with preserved apical contractility.*[5]

While awaiting the CTPA, a POCUS assessment was completed. Evaluation of the cardiovascular system revealed RV failure as RV wall hypokinesia was visualized with interventricular septal flattening. Additionally, abnormal TAPSE was visualized as the displacement of the tricuspid annulus towards the apex during systole had a value less than 16 mm, signifying abnormal systolic function. McConnell's sign was also present, described as diffuse RV free wall dysfunction with apical sparing signifying acute RV dysfunction (Figure 4).[2] The RV free wall thickness was less than 5 mm signifying an acute rather than chronic process. The tricuspid valve and RV function are best seen on the apical four chamber view (Figure 4).[2] The FAST scan was negative for free fluid in the abdomen, no pericardial effusion or abdominal aortic aneurysm were present. However, an expanded, non-compressible inferior vena cava (IVC) was seen indicating increased central venous pressure (Figure 5). Additionally, compression ultrasound examination of the left leg showed a non-compressible femoral vein with visible clot indicating a deep vein thrombosis (DVT) (Figure 6). Without the CTPA we were confident that the patient had a large PE as a result of the DVT in his left leg that formed following recent immobilization post-surgery. Thus, Internal Medicine was consulted at this time. Subsequently, the D-dimer was elevated at 13978 ng/mL and CTPA revealed large bilateral pulmonary emboli with poor perfusion of the lungs (Figure 7).

After consultation with the Internal Medicine team, Hematology, and the ICU, it was decided to initiate TPA at 50% TPA over 2 hours because of risk of further PE development with a known DVT. After an in-depth decision of the benefits and risks of TPA with both the patient and their family, the patient received the TPA in the ED and was transferred to the ICU shortly after.

His ICU course required dual vasopressor support initially but was discontinued within a day with the patient being discharged from the ICU within 24 hours.

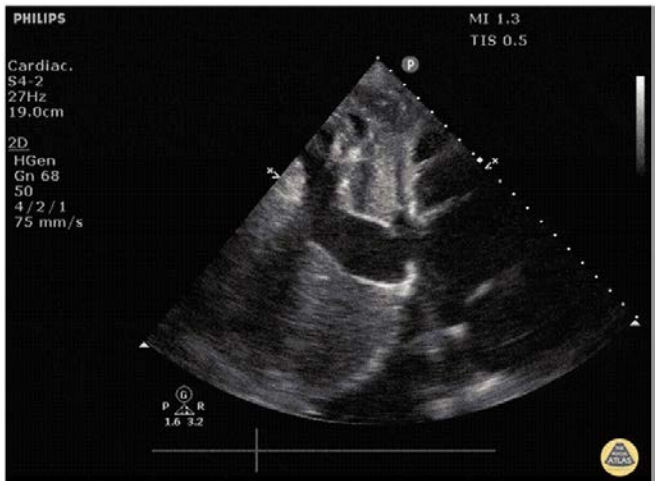

Figure 5. *Sagittal view of dilated IVC.*[6]

Figure 6. *Transverse view of left femoral artery and femoral vein with thrombus present resulting in incomplete compressibility of the vein.*[7]

Figure 7. *Transverse contrast-enhanced CT image demonstrates decreased contrast flow through right and left pulmonary arteries. Four emboli present with decreased perfusion of the lungs bilaterally.*

DISCUSSION

Our case demonstrates the use of POCUS in a hemodynamically unstable patient who presented to the ED following an acute onset of shortness of breath and syncope. POCUS revealed signs of RV dysfunction and an intravascular thrombosis, indicating a PE as the likely cause and subsequently, the patient received the appropriate reperfusion therapy. The patient's acute dyspnea and syncope were attributed to large bilateral PEs likely originating from the left femoral DVT precipitated by recent immobilization from a tibial ORIF surgery. The PE was complicated by unstable hemodynamics as a result of obstructive shock. Obstructive shock occurs when the RVOT is obstructed and pulmonary vasculature resistance is increased. The RV experiences volume and pressure overload resulting in dysfunction which reduces left ventricle (LV) filling (preload) and thus, decreases LV outflow resulting in circulatory failure.[1] Septal bowing into the LV further reduces LV filling volume and thus output. This is the presumed mechanism of RV failure as the primary cause of mortality in severe PE as a consequence of insufficient mean arterial pressure (MAP) reducing right coronary artery (RCA) perfusion.[3,8]

Initial laboratory investigations were non-specific. We attributed the metabolic acidosis to hyperlactatemia as elevated levels are seen in poor tissue perfusion during shock. In addition to metabolic acidosis, a mixed disorder with respiratory alkalosis appeared, likely a result of hyperventilation as the patient presented with a respiratory rate of 50 breaths per minute. The leukocytosis was initially treated as sepsis however, in the setting of a severe acute PE, it was likely a stress response, as was the elevated glucose level.

A PE is a clinical emergency requiring rapid identification. However, the associated non-specific clinical symptoms and need to rule in/out a PE before receiving reperfusion therapy may delay the administration of life saving treatment. Additionally, dependence on CTPA may prolong time to diagnosis, therefore, POCUS examination should be used to decrease the need for CTPA in hemodynamically unstable patients with suspected PE. The signs of RV dysfunction displayed on cardiac POCUS have a high predictive value for PE. These include RV enlargement and dysfunction as shown by the McConnell's sign and decreased TAPSE. In addition to the RV free wall hypokinesis with normal apical motion ("LV apical pull"), paradoxical interventricular septum motion may also be observed. Furthermore, dilation of the IVC occurs in the presence of restricted venous return to the right heart.[1,2,3] Tricuspid regurgitation and raised RV pressures are other ultrasonic characteristics of PE associated with acute RV dysfunction as well. In addition to the cardiac and venous ultrasonographic evidence previously discussed, lung POCUS can demonstrate subpleural infarcts as well.[9] Observational studies have found that POCUS provided an empiric diagnosis rapidly compared to longer times to diagnosis and thus, treatment with standard imaging modalities.[2,10,11]

The RUSH exam was developed to reduce mortality in shock by utilizing POCUS for rapid, non-invasive hemodynamic assessment in undifferentiated shock providing a more accurate diagnosis and initiation of appropriate treatment earlier. The RUSH exam is divided into three main parts. The first is the pump which assesses the cardiac status through echocardiography. The second is termed the tank which includes assessment of the IVC, lungs, and abdominal cavities including the right upper quadrant (RUQ), left upper quadrant (LUQ), and pelvis. The third part is titled the pipes which looks at a number of the major arteries and veins in the body. The exam is not always performed in this order as the presence of RV dilation with septal flattening during step one often signifies an increase in pulmonary artery pressure likely due to a PE, as described above, thus the RUSH exam supports moving directly to DVT assessment typically performed in part 3.[11]

The identification of new RV dilation with dysfunction on ultrasonography can provide a rapid presumptive diagnosis for the initiation of empiric thrombolytic therapy, supported by a study completed by Dresden, S. et al.[2] Additionally, Zhu, R. and Ma, X., reported a multiorgan ultrasound examination exhibiting PE-related signs can increase the diagnostic sensitivity up to 90%.[1] Subsequently, the absence of these signs, increase the negative predictive value to rule out PE to 95%.[1] Additionally, previous studies are discussed which demonstrated combining the pre-test probability Wells' score with multi-organ ultrasonography and a d-dimer, greatly reduces the need for CTPA in the diagnosis of a PE.[1]

The presences of a proximal DVT on compression ultrasonography, in addition to signs of RV dysfunction on echocardiography, is considered sufficient to warrant reperfusion therapy, discussed in the 2019 ESC Guidelines on

the Diagnosis and Management of Acute Pulmonary Embolism as the majority of PE are derived from a lower limb DVT.[3]

CONCLUSION

As demonstrated in this case, POCUS is a valuable addition to the diagnostic protocol for PE and current practice guidelines for the initiation of empiric thrombolytics. Identification of interventricular septal flattening, decreased TAPSE, and the McConnell's sign are signs of RV dysfunction displayed on cardiac POCUS that have a high predictive value for PE aiding in the rapid diagnoses in hemodynamically unstable patients and expediting life saving treatments. This new and rapidly evolving technique retains considerable utility for rapid clinical decision making in EDs.

CONFLICT OF INTEREST

The authors listed above certify that there are no financial or personal conflicts of interest affiliated with the subject matter discussed in this manuscript that could bias their work.

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DISCLOSURE

Some images in the article have been taken from The POCUS Atlas and have been referenced appropriately below. A copy of their license can be found at: https://creativecommons.org/licenses/by-nc/4.0/.

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Original Research

The effectiveness of cognitive behavioral therapy for insomnia in older adults: A rapid review

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ABSTRACT

Insomnia is a common sleep disorder encountered in older adults which causes many difficulties in daily life. Given safety concerns with sedative-hypnotic pharmacotherapy, behavioural treatments including Cognitive Behavioural Therapy for Insomnia (CBT-I) are preferred in the elderly. We have provided an updated, expanded evidence review of CBT-I in this population. A rapid review of randomized controlled trials evaluating CBT-I interventions in adults aged 60+ was conducted using a search of the databases PubMed and PsycINFO, returning 21 articles for analysis. Specific CBT-I interventions including individual, group, therapist-led, and self-guided formats were evaluated. Trials for novel formats including telehealth CBT-I were also assessed for subgroup analyses involving older adults. Quantitative (total sleep time, sleep efficiency, insomnia severity, etc.) and qualitative (participant feedback, etc.) outcomes were assessed. The research showed steadfast evidence for the effectiveness of CBT-I as the preferred intervention for insomnia disorders in the elderly. It also showed promising results for different delivery methods of CBT-I including self-help, group and virtual modes, which may help alleviate accessibility concerns to the service in the future. This represents a key area for further work to improve access to insomnia interventions in older adults.

Keywords: Insomnia, Cognitive Behavioural Therapy, Elderly, Older Adults

INTRODUCTION

Insomnia is a prevalent issue among older adults in today's society. Insomnia has been defined as difficulties with either the quantity or quality of sleep, which might include difficulties initially falling asleep, waking throughout the night, and more.[23] As of 2019, insomnia is experienced in up to 75% of older adults and has been documented as one of the most commonly experienced issues with sleep among this population.[23] Insomnia symptoms are estimated to be experienced by approximately 30 to 48% of older adults.[24] These are staggering numbers which also have a prominent economic impact on healthcare systems worldwide. The healthcare and productivity costs of insomnia symptoms in Canada in 2021 totaled $1.9 billion.[2] With these estimates, it is clear that insomnia warrants our attention as a society and that research on its associated impacts is critical to help alleviate such vast problems. Currently, the first-line recommendations for insomnia treatment consist of non-pharmacological treatments (NPTs) followed by treatment using medications only if NPTs fail.[17] The most widely used example of an NPT for insomnia, and the first-line treatment recommendation, is cognitive behavioural therapy for insomnia (CBT-I). This intervention is approximately 6-8 weeks long and consists of sleep restriction (concrete bed and awakening times), stimulus control (altering patient perspectives and experiences with their sleeping area), and reduction of hyperarousal.[11] Objective parameters of sleep quality such as total sleep time (TST) and sleep efficiency (SE) have shown improvement with CBT-I,[4] as well as subjective measure improvements via scales such as the Insomnia Severity Index (ISI) and Epworth Sleepiness Scale (ESS).[5] Of those studies examined, many noted that CBT-I and other NPTs are proven to be effective specifically in older adults diagnosed with insomnia.[3,8,13,17,19,28] However, medications such as benzodiazepines or non-benzodiazepine "Z-drugs" with faster action such as zolpidem can sometimes be prescribed more readily as an initial mode of treatment rather than CBT-I due to perceived convenience.[17] It has also been proposed that prescribing medications for insomnia may feel more within the physician's scope of practice than their perceived ability to educate patients about and refer them for CBT-I.[11] This represents a key area for further work to improve access to insomnia interventions in older adults.

Prior research in this area is limited. A systematic review published in 2003 examined the efficacy of CBT-I for older adults, but this study excluded participants with comorbid dementia or depression. A systematic review and meta-analysis on this topic has also been published which included 13 studies which were conducted between the years of 1993 to 2017.[8] Given these study time frames, more recent years of literature past 2017 have not yet been synthesized. While these comprehensive studies are important additions to the body of literature, there have been no studies to date on this subject in the novel form of a rapid review. This is a newer, alternative form of review which provides a more simplified summary of the existing literature, often with a particular focus on the most relevant or recent studies available. An updated rapid review in this area is particularly useful for

clinicians to reference to help inform their clinical knowledge and practice, especially in areas of healthcare that are constantly evolving. Overall, the purpose of this rapid review was to provide an updated, focused, evidence-based rapid review (the first of its kind) of CBT-I as a treatment for symptoms of insomnia in the elderly population over 60 years old.

METHODS

Selection Criteria

For this review, studies were included that applied CBT-I or a similar protocol as an intervention in the form of a randomized controlled trial. Several studies were found that did not use CBT-I specifically but used a very similar methodology (such as brief CBT-I, administered in fewer than 6-8 sessions), or had reported relevant outcomes. Randomized controlled trials were initially deemed most appropriate but the reviewers opted to include some comparable study forms with similar lengths, sample sizes, and established intervention and control groups. However, following a full-text review, only randomized controlled trials with clearly defined control groups were included. Only studies examining older adults with at least a mean age of 60 years or older were included; according to the United Nations, an older adult is defined as a person of age 60 or older.[32] Studies that were excluded did not meet the above criteria and were not written in English.

Data Sources and Searches

A search of the databases PubMed & PsycINFO returned 352 initial studies; 208 from PubMed and 144 from PsycINFO. Two reviewers participated in this process and worked independently. Search terms included "cognitive behavioural therapy", "insomnia", "older adult", "elderly", and relevant variations thereof. 94 duplicates were removed. Studies were assessed based on population, intervention used, control group characteristics, outcomes reported, and length of study. 194 studies were deemed irrelevant and excluded after the title and abstract screening. 43 studies were excluded following the full-text screening, leaving 21 remaining studies included in the final data collection, extraction and analysis (Figure 1). Reviewers preferred to include studies when uncertain of inclusion parameters to ensure that no relevant studies were excluded.

Data Extraction, Synthesis and Analysis

Data from all articles in agreement to include following the full-text review were extracted and organized into a structured table stratified into columns for year, participants, intervention, control, outcomes and results.

Upon review of the pertinent data from each of the papers, the results were grouped based on common characteristics and themes. The studies were classified based on the type of CBT-I involved; individual, group or combined CBT-I delivery; independent versus guided delivery; the presence or absence of telehealth in the delivery; the use of or withdrawal from sleep medications; and the inclusion of interventions other than CBT-I. The major themes of the studies were categorized into ideas such as:

a. Self-help versus professional-led CBT-I
b. The efficacy of individual, group and combined CBT-I
c. The implications of CBT-I conducted using telehealth
d. The efficacy of CBT-I versus sleep medications for insomnia relief
e. The impact of pre-existing sleep characteristics on the efficacy of CBT-I
f. The impact of comorbid health conditions on the treatment of insomnia with CBT-I
g. The effect of pre-existing beliefs about sleep on CBT-I treatment outcomes

These themes will be discussed in detail in the results section.

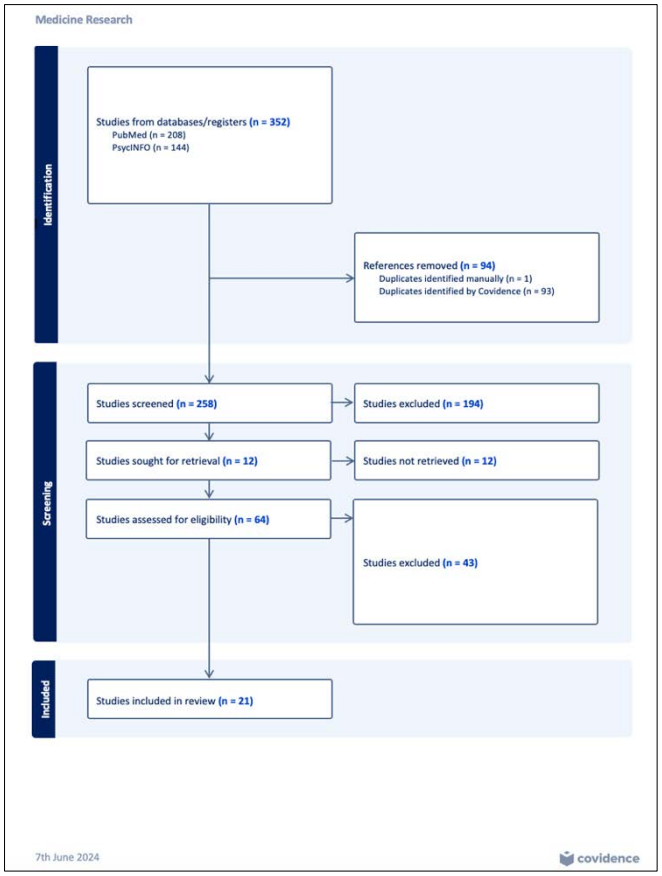

Figure 1. *PRISMA diagram.*

RESULTS

Descriptions of Included Studies

All 21 studies included and analyzed were randomized controlled trials. The sample sizes ranged from 14 to 327. Of the studies included, 19 used CBT-I manually led by a professional, 1 used a self-help intervention, 6 involved a telehealth intervention component, 3 involved a sleep medication intervention (1 with zopiclone; 2 with temazepam), 1 had a sleep medication withdrawal component, and 1 involved a Tai Chi intervention. 13 were individual interventions, 4 were group-based and 3 were a combination of both (see Appendix for details of included studies).

Description of Measured Outcomes

Efficacy of CBT-I versus Controls

20 studies found CBT-I significantly more effective than the control on at least one outcome measure (Figure 2). Only 1 study showed no statistically significant improvement in any outcomes measured (ISI, depression and anxiety ratings, quality of life ratings and use of sleep medications ratings) in the online delivery CBT-I group as compared to their control group in older adults with insomnia who were also experiencing bereavement.[7]

Self-help versus Professional-Led

Only 1 study used a self-help form of CBT-I with full independence bestowed upon participants.[20] According to this trial, 73% of participants surveyed indicated that they would recommend the self-help CBT-I intervention to others.[20]

Individual, Group-Based and Combined Delivery

Of the included studies, 14 used individual CBT-I.[1,6-7,10,12,14,18,20,25-27,29-30,34] 4 studies used group-based CBT-I.[9,15-16,33] 2 studies used a combination of individual and group CBT-I,[21-22] and 1 study offered a choice between the two modalities.[31] In the group-based studies, one study showed positive improvements in participants' scores on wakefulness after sleep onset (WASO-D), sleep efficiency (SE-D), ISI, Flinders Fatigue Scale (FFS), ESS, Daytime Feeling and Functioning Scale (DFFS), Sleep Anticipatory Anxiety Questionnaire (SAAQ), Dysfunctional Beliefs and Attitudes About Sleep Scale (DBAS) and Sleep Self-Efficacy Scale (SSES) compared to control.[15] Another group-based study found participants to have had significant positive improvements in sleep onset latency (SLAT), WASO, Short-Form McGill Pain Questionnaire (SF-MPQ) and SE scores.[33] A third group study found participants had positive impacts on their WASO and total sleep time (TST) scores in relation to the lessening of their insomnia symptoms.[16] Participants in a different group study also had improved positive findings regarding insomnia remission, sleep quality, sleep parameters, fatigue and depressive symptoms.

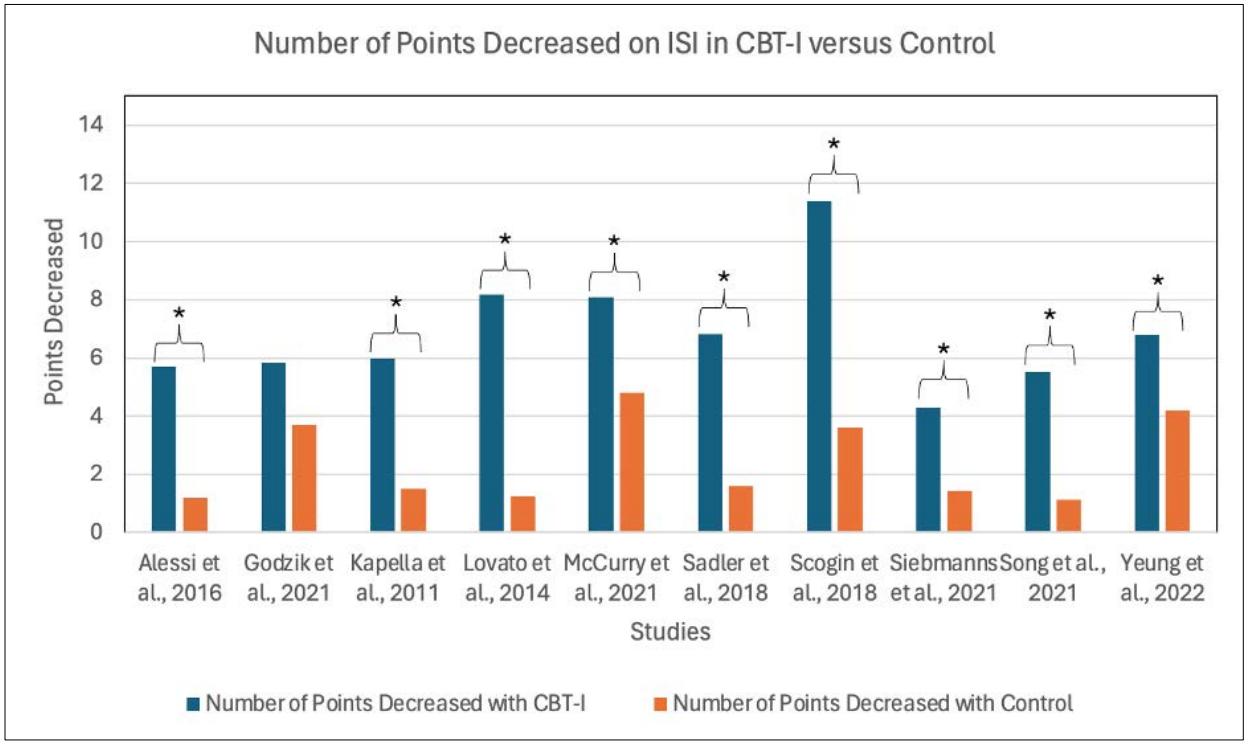

Figure 2. *The number of points decreased on ISI in CBT-I versus control conditions. Note: Asterisks indicate a statistically significant result ($p \leq 0.05$).*

Telehealth and CBT-I

6 studies included some form of telehealth.[7,18,20,26-27,34] Specifically, one study used a telephone delivery method for CBT-I in older adults with insomnia and comorbid osteoarthritis pain.[34] This study found that the use of telephone CBT-I specifically showed significant decreases in their older participants' ISI and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores, both being positive outcomes for the purpose of the study. It was also noted that these improvements in symptoms came at no increased cost; thus, this study has implications for the cost-effectiveness of telehealth modes of CBT-I. In contrast, a study using an online-based CBT-I intervention found no significant improvements in insomnia symptoms relative to scores on ISI, depression and anxiety ratings, quality of life ratings and use of sleep medications ratings, as mentioned previously.[7] However, the authors noted that all participants completing the study had reported that they were able to complete every online learning module, which still holds promise for the feasibility of online forms of CBT-I for older adults.[7]

CBT-I versus Sleep Medications and Other Interventions

5 studies explored the efficacy of CBT-I compared to sleep medications or other interventions.[9.12,21,29-30] In one trial, when compared to the participants given zopiclone, the participants undergoing CBT-I showed significant improvements in sleep efficiency and time in slow-wave sleep.[29] Meanwhile, outcomes between those given zopiclone and those given a placebo medication did not significantly differ.[29] Another trial had an almost identical structure, except for having an additional group of participants given both CBT-I and sleep medication (temazepam), and all three of the interventions were found to show greater improvements in sleep outcomes than the placebo.[21]

In a study examining participants dependent on sleep medications, the sample was stratified into groups of either CBT-I treatment or a placebo control with the participants instructed not to change their usage of sleep medications.[30] Those who underwent CBT-I had better outcomes in sleep onset latency, wakefulness after sleep onset and sleep efficiency.[30] In contrast, another study used a sample of hypnotic-dependent older adults with insomnia and tested a withdrawal of sleep medications either alone (control), combined with placebo biofeedback or combined with CBT-I.[12] While all groups were successful in achieving a decrease in sleep medication usage, the only group that displayed significant improvements in sleep diary measures and sleep onset latency was the group treated with CBT-I.[12]

Besides sleep medications, other trials have been conducted which have compared CBT-I to interventions such as Tai Chi. In one randomized controlled trial, older participants with insomnia were assigned to receive either CBT-I, Tai Chi or sleep education as a control.[9] The CBT-I group was reported to have the highest incidence of clinician-determined insomnia remission.[9]

Pre-Existing Sleep Characteristics

In 2 studies exploring pre-existing sleep characteristics, short sleepers were defined as those who identified as objectively getting less than six hours of sleep per night, while normal sleepers were getting six hours of sleep per night or more.[15-16] In both studies, which employed CBT-I in older adults with insomnia, it was found that both short and long sleepers achieved similar statistically significant benefits with no major differences between the groups.[15-16]

Comorbid Health Conditions

2 studies explored the impact of CBT-I on insomnia comorbid with pulmonary issues.[6,10] In one study, participants who received CBT-I as compared to those who received a wellness education control protocol achieved greater statistically significant improvements in measures of insomnia severity, global sleep quality, wakefulness after sleep onset, sleep efficiency, fatigue, and beliefs and attitudes about sleep.[10] Similarly, in the other study examining older adults with occult sleep-disordered breathing, CBT-I significantly improved insomnia symptoms as compared to a sleep education control.[6] 3 studies reported that participants who received CBT-I for comorbid insomnia and osteoarthritis pain showed statistically significant improvements on measures of sleep quality and lessening of insomnia symptoms.[18,33-34] 1 study showed significant positive effects on ISI and Short-Form 12-Item Survey (SF-12) scores following treatment with nurse-led CBT-I as compared to an online self-study educational control condition for older adults with comorbid insomnia and cardiovascular disease.[27] Further, 3 studies explored the effectiveness of CBT-I in individuals with mood or emotional disturbances.[7,25-26] One study showed the effectiveness of CBT-I combined with CBT-D (cognitive behavioral therapy for depression) in participants with comorbid insomnia and depression.[26] In another study, two forms of CBT-I (CBT-I and CBT-I+, or advanced CBT-I with positive mood elements) showed significantly greater improvements in insomnia and depression symptoms when compared to a psychoeducation control group.[25] However, a study on elderly people with insomnia who had recently lost a loved one found no significant improvements with the employment of online-based CBT-I as compared to a psychoeducational control.[7]

Pre-Existing Beliefs About Sleep

5 studies explored CBT-I in the context of pre-existing beliefs about sleep.[10,14-15,22,31] In one study, it was found that decreased DBAS scores, or fewer dysfunctional views about sleep, was significantly associated with improvements in sleep efficiency.[22] Another study produced similar findings, where decreases in dysfunctional beliefs about sleep were associated with positive changes in sleep.[31] Conversely, 2 studies found that a trial of CBT-I showed decreases in DBAS

as a measurable outcome.[14,15] A further study also measured DBAS as a dependent variable following a six-week trial of CBT-I in older adults with comorbid insomnia and chronic obstructive pulmonary disease (COPD), but no significant improvements were found.[10]

DISCUSSION

Based on the existing literature, our findings show that CBT-I for insomnia treatment in the elderly is efficacious and carries significant benefits. This has helped contribute to and broaden the research available on this topic in the form of an updated, more focused rapid review following the systematic reviews conducted previously.[8,19] While these studies provide valuable insights, this rapid review has allowed for a more recent, relevant synthesis of the existing literature. The most recent year of publication of any of the studies included in the aforementioned reviews was 2017; the current review has provided an expansion upon these with the inclusion of 9 new studies published between 2018 and 2022. The alternative methodology of a rapid review has also allowed for the exploration of studies that assessed relevant outcomes but may have been excluded from a systematic review with more rigid inclusion and exclusion criteria. As an example, one of the inclusion criteria from the more recent systematic review specified that studies must have employed CBT-I alone; however, this rapid review has allowed for the inclusion of studies that employed CBT-I in combination with other interventions, such as CBT-D or pharmacotherapy.[8]

In 20 of the 21 randomized controlled trials examined, CBT-I was found to produce significantly greater beneficial effects on insomnia symptom severity than control conditions. This therefore serves as another study which adds to the breadth of existing research in support of the use of CBT-I for insomnia. The ideas highlighted in this study can also serve to identify ways in which CBT-I can be improved in its implementation, as well as in its accessibility in applications for various subgroups of older adults.

Regarding CBT-I versus sleep medications, one of the studies discussed suggested that CBT-I as a behavioral intervention is an improved, more sustainable method of insomnia relief than sleep medications.[29] This also highlights how even sleep medications alone may not offer any significant benefits for insomnia symptoms when compared to a placebo control group, which calls into question the efficacy of these medications alone. Another of the studies comparing CBT-I versus sleep medications also poses an argument for the effectiveness of CBT-I — particularly how its effects were better conserved over time in comparison to temazepam.[21] These findings warrant the need for further research comparing the efficacy of behavioral and pharmacological interventions in the treatment of CBT-I to guide future healthcare guidelines and recommendations for insomnia treatment. In the same vein, healthcare guidelines must also take into account those older adults who are currently dependent on sedative-hypnotic medications in their treatment of insomnia or other conditions. In one study, the effect of CBT-I on sleep medication usage was purposely not studied.[30] However, their findings may have implications for the effect of insomnia symptom improvement with CBT-I and the potential for sleep medication users to feel less dependent on hypnotic medications if their insomnia symptoms were to resolve. In one study, the authors did not observe any significant effect of CBT-I on medication tapering.[12] However, it did also show that CBT-I can be used as a powerful supplemental tool to harness greater relief of insomnia symptoms in this older, hypnotic-dependent population. This may serve as an area of research which could inform how CBT-I may be used as a tool in achieving remission of sleep medications in older adults who are dependent on them.

Other authors have proposed that Tai Chi (in addition to CBT-I) could be used as a tool in a stepped-care approach to insomnia relief, particularly due to its benefits on inflammatory markers that were also found in this trial.[9] Again, this has implications for resource allocation and cost reduction in insomnia treatment by potentially using less expensive forms of therapy before moving to a comprehensive CBT-I treatment protocol. This could even lessen the duration or intensity of CBT-I that any given patient may require following treatment with a less intensive therapy.

6 trials explored insomnia treatment in the context of chronic illnesses and CBT-I benefits have been upheld in sleep-disordered breathing,[6,10] osteoarthritis,[18,33-34] and cardiovascular disease.[27] This certainly puts forth the idea that CBT-I can be used as a tool in the complex web of treatment modes that older adults with chronic conditions require. As well, 3 studies explored CBT-I through the lens of comorbid depression in older adults.[7,25-26] 2 trials may posit that CBT-I is more effective for both insomnia and depression than CBT-D.[25-26] In one trial, despite a lack of improvement in the CBT-I group, the participants positively favoured the online form of CBT-I used.[7] The main drawback identified by participants regarding the content of the trial was that there was no bereavement-specific content.[7] This could have partially explained the lack of efficacy of the CBT-I treatment in this unique population experiencing bereavement, but not necessarily meeting the diagnostic criteria for depression. It may be that other forms of treatment and education are needed for a comprehensive treatment method for insomnia with bereavement specifically.

2 studies produced findings in favour of the reduction of dysfunctional sleep beliefs in the improvement of insomnia symptoms.[22,31] Both highlighted how in the treatment of insomnia, it is important to also focus on treating maladaptive attitudes about sleep which may serve as confounding preconceived beliefs in CBT-I treatment regimens. On the other hand, 2 studies found that following CBT-I treatment, dysfunctional sleep beliefs were shown to decrease.[14,15] Further research is needed in this area to investigate the bidirectional association between CBT-I and DBAS.

Regardless, it is still notable that DBAS requires further exploration in research concerning CBT-I. This also highlights the need for more research on CBT-I and DBAS, given that there are varied findings across different studies, with one study finding no significant changes in DBAS following CBT-I.[10]

Finally, 2 studies also found that regardless of one's usual duration of sleep per night, CBT-I treatment was still equally as beneficial in improving insomnia symptoms.[15-16] These findings highlight how CBT-I can be beneficial not only for those with the most severe insomnia symptoms but also for those who may already have some healthy sleep habits and are looking to improve other aspects of their sleep.

More research is needed in the area of CBT-I in a self-help, independently practiced form. The majority of studies examined focused on guided CBT-I, but if independent CBT-I is also comparatively efficacious, this could have major implications for making CBT-I more economical cost-wise.[20]

In studies which used a combination of individual and group CBT-I,[21-22] or included the option to do so,[31] it was not specified whether type had improved outcomes. More research is needed in this area to concretely identify whether individual versus group CBT-I is favoured and the factors that may influence these results.

As well, more studies will need to be conducted regarding the cost and resource usage of telehealth and virtual CBT-I in comparison to more traditional forms. Appropriately investigating older adults' capabilities in online CBT-I and their technological literacy could have major impacts on the cost of CBT-I delivery, as this could preserve resources such as rent for spaces to host sessions and hourly pay rates for employed professionals. One study was beneficial in outlining how the older adults were entirely able to use the online form of CBT-I employed, and viewed this in a positive light, despite the lack of results supporting relief of bereavement and insomnia symptoms with CBT-I.[7] It is also important to note the 5 studies which showed statistically significant improvements in insomnia symptoms in groups of older adults who underwent telehealth-delivered CBT-I without issue.[18,20,26-27,34]

Strengths and Limitations

This rapid review has a focused scope, which has allowed us to focus the review more practically on what is most relevant from a clinical standpoint for CBT-I research in older adults. This is of particular value for busy clinicians who may not be heavily involved or versed in academia but are looking to inform their practice and knowledge. As well, not all older individuals have the same opportunities and circumstances to be able to easily access CBT-I treatment. One area we focused on as part of our literature review results was the cost associated with CBT-I in its different forms. We have explored and discussed options for modifications to improve accessibility to CBT-I not only from a monetary standpoint, but in light of other barriers as well. For example, self-help, group-based and telehealth forms of CBT-I have been shown to be feasible options to increase the availability and accessibility of CBT-I for older adults in contrast to more traditional in-person, individual forms.

In terms of limitations — as a rapid review, this study is not as wholly comprehensive as a systematic review or meta-analysis which would discuss a much broader range of topics. A more focused scope also inherently produces a less extensive array of results and discussions than a larger systematic review would. All articles deemed relevant from our database searches were selected for review, though it may exclude some that would have been analyzed and included in a larger review. As well, more research is warranted in the vast majority of areas studied in the area of CBT-I and many gaps currently remain to be filled. For instance, virtual modes of CBT-I have largely become popularized only since the beginning of the COVID-19 pandemic in 2020. This has led to a number of new topics for study that have not yet been widely explored outside of the studies mentioned in this work.

CONCLUSION

CBT-I is the preferred method of treatment for insomnia in the elderly population. This is largely due to negative perceptions and concerns about side effects associated with pharmacological treatments, such as benzodiazepines. However, not all providers feel capable of educating and referring patients to obtain treatment. This has led to a discrepancy between the treatment recommendations and the actual prescribing patterns that are being practiced by healthcare providers. We have completed an updated analysis of the evidence-based efficacy of CBT-I for those aged 60 years and older via the results of 21 randomized controlled trials. This will help to inform best practices for insomnia treatment for this group of individuals and alleviate this discrepancy in what is recommended versus what treatments are actually given to patients. We also discussed options for making CBT-I more accessible for individuals at this age, with the aim of helping to ensure that all who wish to avail of it will have equitable opportunities to do so in the future. Virtual, self-help or group modes of delivery of CBT-I becoming more mainstream may ease the burden on the healthcare system, allowing more people to be treated effectively while using fewer resources. Currently, barriers such as provider shortages and financial constraints do not yet allow for this type of seamless access in many areas of the world. With more research and training in this area, CBT-I accessibility may be improved in years to come.

COMPETING INTERESTS

The authors declare there are no competing interests.

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APPENDIX

Table A1. *Study characteristics of included studies.*

Study Authors and Year of Publication	Participants	Intervention	Control	Outcomes	Results
Morgan et al., 2012	Adults aged 55 to 87 years (mean age 66.6 ± 7.43 years) with chronic diseases associated with chronic insomnia symptoms (N=193).	Self-help program consisting of six booklets provided at weekly intervals with advice on CBT-I, plus access to a telephone helpline.	A single sheet of advice regarding sleep hygiene.	Sleep quality. Primary outcome: PSQI. Secondary outcomes: ISI, SSEI, FSS.	Significant improvement on sleep outcomes in intervention group compared to control immediately post-treatment (PSQI - p<0.001; ISI – p<0.001; SE – p<0.001), at 3-month follow-up (PSQI – p-0.002; ISI – p=0.006; SE – p=0.001) and at 6-month follow-up (PSQI – p=0.003; ISI – p=0.003; SE – p=0.001).
Alessi et al., 2016	Community-dwelling veterans aged 60 and older (mean age 72.2 ± 7.7 years) meeting insomnia diagnostic criteria for 3 months or longer (N=139).	Five-session CBT-I delivered by non-clinician sleep coaches with masters' degrees including stimulus control, sleep restriction, sleep hygiene and cognitive therapy with weekly telephone behavioral sleep medicine supervision.	Five sessions of general sleep education.	Primary outcomes: SOL-D, WASO-D, TWT-D, SE-D, PSQI, objective sleep efficiency via wrist actigraphy. Secondary outcomes: ISI, depressive symptoms (PHQ-9) and quality of life (SF-12v2).	Significant improvement in SOL-D (p=0.02), TWT-D (p=0.004) and SE-D (p=0.005) in the intervention group compared to control group at 6-month follow-up (the primary outcome time point). Significant improvement in PSQI and ISI in intervention group compared to control group at post-treatment, 6-month follow-up and 12-month follow-up (all p<0.05).
Lovato et al., 2016	Adults with mean age 63.34 ± 6.41 years with sleep maintenance insomnia, stratified into short sleepers (<6 hours of sleep per night) and long sleepers (>/=6 hours of sleep per night) (N=91).	Four weeks of group-based CBT-I.	Waitlist.	One-week sleep diary, actigraphy, questionnaires (ISI, FFS, ESS, DFFS, DBAS, SSES, SAAQ).	Intervention group had significant improvements in WASO-D (p<0.001), SE-D (p<0.001) and TST (p<0.001), as well as significantly reduced scores on ISI (p<0.001), FFS (p=0.010), ESS (p=0.003), DFFS (p=0.003), SAAQ (p=0.006), DBAS (p<0.001), and significantly improved scores on the SSES (p=0.009) compared to control. No differences were observed between short and long sleepers.
Soeffing et al., 2008	Older adults aged 50 years or older (mean age 63.5 ± 8.7 years) with chronic insomnia and dependent on prescription sleep medications (N=47).	Eight-week individual CBT-I program consisting of relaxation training, stimulus control and sleep hygiene instructions.	Placebo group.	SOL, NWAK, WASO, TST, SE, SQR, SF-36.	Intervention group had significant improvements in SOL (p<0.05), WASO (p<0.05) and SE (p<0.05) compared to control.
Kapella et al., 2011	Adults with mild-severe COPD aged ≥45 years (mean age 63 ± 10 years) with self-reported sleep difficulties (N=14).	Six-week CBT-I provided by a nurse behavioral sleep medicine specialist consisting of stimulus control and sleep restriction.	Six-week wellness education (WE) program.	ITAS, SII, PSQI, ISI, sleep diary with actigraphy, DBAS, fatigue measures, anxious and depressed mood measured, perceived daytime function.	CBT-I group showed significant improvements in ISI (p=0.000), PSQI global sleep quality (p=0.002), WASO via sleep diary (p=0.030), SE via sleep diary and actiwatch (p=0.017; p=0.028), and beliefs and attitudes about sleep (p=0.000) compared to control. The control WE group showed significant improvements in depressed mood only (p=0.005).
Vitiello et al., 2009	Older adults (mean age 67.9 ± 8.23 years) with osteoarthritis and insomnia (N=51).	Eight-week group CBT-I program consisting of stimulus control, sleep restriction, cognitive restructuring, relaxation training and sleep hygiene education.	Attention-control (MSW) condition consisting of multi-component interventions for management of chronic pain (problem-solving, goal-setting, cognitive approaches to reducing stress and anxiety, interpersonal skills training, education about exercise enhancement).	Sleep log (SLAT, TST, WASO, SE), SF-MPQ, SF-36, GDS.	CBT-I group showed significant decreases in SLAT (p=0.014), WASO (p=0.000), and SF-MPQ (p=0.010), and increases in SE (p=0.000) post-treatment compared to control.
Sivertsen et al., 2022	Adults aged 55 years or older (mean age 60.8 ± 5.4 years) with insomnia (N=46).	Six weeks of CBT (consisting of sleep hygiene, sleep restriction, stimulus control, cognitive therapy and	Six weeks of placebo medication.	TWT, SOL, WASO, early morning awakening, TST, SE, slow-wave sleep.	CBT group experienced significantly improved outcomes on TWT compared to sleep medication and placebo (p<0.001), SE compared to placebo (p=0.004), slow-wave sleep compared to sleep medication and control (p=0.002; p=0.03), and TST over time (p=0.003).

		relaxation) or sleep medication (zopiclone).			
Scogin et al., 2018	Rural older adults aged 50 years or older (mean age 58.1 ± 5.62 years) with depressive and insomnia symptoms (N=40).	Integrated telehealth-delivered CBT-D (for depression) and CBT-I.	Continuation of usual care for depression and insomnia.	Primary outcome: ISI. Secondary outcomes: HAM-D, sleep diary (CSD - TIB, SOL, NWAK, WASO, TWAK, SQR, SE), formal assessment of depression and insomnia (SCID I).	Intervention group had improvements in ISI ($p<0.001$), SOL ($p=0.02$), SE ($p=0.02$), and SQR ($p=0.007$) compared to control.
Fung et al., 2016	Adults aged 60 years and older (mean age 72.2 ± 7.7 years) with insomnia and apnea-hypopnea index (AHI) < 15 (N=134).	Five sessions over six weeks of CBT-I provided by a health educator supervised by a sleep psychologist.	Sleep education control.	SOL, TWT, WASO, SE, PSQI.	Participants in CBT-I group with mild sleep-disordered breathing showed significant improvements in SOL ($p=0.0087$) and sleep quality via PSQI ($p=0.002$) compared to control at 6-month follow-up. The efficacy of CBT-I was similar for participants without sleep-disordered breathing.
Morin et al., 1999	Adults aged 55 years and older (mean age 65 ± 6.9 years) with insomnia (N=78).	Eight weekly individual and group sessions of CBT (consisting of stimulus control, sleep restriction, sleep hygiene and cognitive therapy), pharmacotherapy (temazepam), or a combination of both.	The same CBT protocol plus placebo medication.	Sleep diaries, polysomnography, SII.	The three active treatments showed significantly greater improvements than placebo control at post-treatment for WASO, SE, TWT and TST ($p<0.05$ for all), with the combination treatment showing the greatest improvements on all outcomes. Participants, participants' significant others, and clinicians rated behavioral treatment (either alone or combined with medication) as significantly more effective than medication alone ($p=0.01$) or placebo ($p=0.002$).
Lovato et al., 2021	Older adults (mean age 63.3 ± 6.4 years) with sleep-maintenance insomnia, classified as short sleepers (<6 hours) or normal sleepers (>/=6 hours) (N=91).	Four weeks of brief 60-minute group CBT-I.	Waitlist.	Sleep misestimation, sleep diary, actigraphy, SOL, WASO, TST.	Intervention group showed significantly improved WASO and TST immediately post-treatment and at 3-month follow-up compared to control (all p-values <0.01). There were no significant differences between those with either short or normal objective sleep duration before the trial.
Lichstein et al., 2013	Late middle-age and older adults with insomnia aged 50 years and older (mean age 63.4 ± 10.9 years) who were dependent on hypnotics (N=70).	Eight weeks of 45-minute CBT plus drug withdrawal, placebo biofeedback (PL) plus drug withdrawal.	Six biweekly 30-minute sessions of CBT combined with drug withdrawal via slow tapering (MED).	Polysomnography, sleep diaries, hypnotic consumption, daytime functioning questionnaires, drug screens.	Significant improvements in SOL ($p<0.05$) in the CBT group compared to control. Trended improvements in sleep diary measures and daytime functioning in all groups (not statistically significant; $p>0.05$). Significantly decreased hypnotic use in all groups from baseline to post-treatment ($p<0.05$).
McCurry et al., 2021	Older adults aged 60 years and older (mean age 70.2 ± 6.8 years) with insomnia and osteoarthritis pain symptoms (N=327).	Eight weeks of six 20-30 minute telephone-delivered CBT-I sessions.	Education-only group.	Primary outcome: ISI (2-months post-treatment and at 12-month follow-up). Secondary outcomes: pain (BPI-SF), depression (PHQ-8), fatigue (FFS).	2-month post-treatment ISI scores decreased significantly in the CBT-I group compared to EOC group ($p<0.001$); results were sustained at 12-month follow-up ($p<0.001$). At 12-month follow-up, 56.3% of participants receiving CBT-I remained in remission, compared to 25.8% of participants receiving EOC. Fatigue was significantly reduced in the CBT-I group compared to the EOC group at 2 months post-treatment ($p<0.001$) and 12-month follow-up ($p=0.003$). Post-treatment significant differences were found for pain on BPI-SF regarding severity & interference ($p=0.05$; $p=0.02$) but were not continued by 12-month follow-up ($p=0.75$; $p=0.45$).
Lovato et al., 2014	Older adults (mean age 63.76 ± 6.45 years) with sleep maintenance insomnia (N=118).	Four weeks of 60-minute CBT-I (consisting of bedtime restriction therapy, sleep education and cognitive restructuring).	Waitlist.	7-day sleep diaries, actigraphy, ISI, FFS, ESS, DFFS, SSES, SAAQ, DBAS.	Intervention group showed significant improvements in sleep timing and quality compared to control via reported WASO ($p<0.001$), SE ($p<0.001$), number of awakenings ($p=0.044$), subjective sleep timing ($p<0.001$), lights-out time ($p=0.001$), sleep onset time ($p=0.025$), out-of-bed time ($p<0.001$), and time in bed ($p<0.001$). The intervention group also had significantly reduced scores on ISI ($p<0.001$), FFS ($p=0.004$), ESS ($p=0.002$), DFFS ($p=0.001$), SAAQ ($p=0.003$), DBAAS ($p<0.001$), and improved scores on SSES ($p=0.001$) compared to control.
Irwin et al., 2014	Older adults aged	2-hour group sessions	2-hour group sessions	Primary outcome:	CBT group had significantly improved outcomes

	over 55 years (mean age 65.5 ± 9.7 years) with insomnia (N=123).	each week for 4 months of CBT or Tai Chi interventions.	each week for 4 months of sleep seminar education (SS).	Insomnia diagnosis by DSM-IV-TR criteria. Secondary outcomes: PSQI, AIS, sleep diary, fatigue (MDFSI), ESS, depressive symptoms (IDS-C), inflammation (C-reactive protein levels).	compared to both TCC and SS groups in insomnia remission (p<0.01), as well as for sleep quality, sleep parameters, fatigue and depressive symptoms (all p-values <0.01). TCC group also showed significant improvements in sleep quality, fatigue and depressive symptoms compared to SS group (all p-values <0.05).
Morin et al., 2002	Older adults (mean age 64.7 ± 6.9 years) with insomnia (N=72).	Eight weekly individual and group sessions of CBT (consisting of stimulus control, sleep restriction, sleep hygiene and cognitive therapy), pharmacotherapy (temazepam), or a combination of both.	The same CBT protocol plus placebo medication.	Sleep diary, polysomnography, DBAS.	CBT and combined groups showed greater improvements DBAS scores than placebo controls (all p-values <0.05). Post-treatment DBAS scores were significantly correlated with SE via sleep diary measures at 3-month, 12-month, and 24-month follow-ups (all p-values <0.05).
Yeung et al., 2022	Older adults aged 60 years and older (mean age 70 ± 7.1 years) with insomnia and osteoarthritis pain (N=325).	Eight weeks of treatment consisting of six telephone-delivered CBT-I sessions.	Education-only control.	Quality of life (QALYs), arthritis-specific quality of life (WOMAC), ISI, nights without clinical insomnia, intervention and healthcare utilization costs.	CBT-I group significantly improved in ISI and WOMAC measures compared to control (ISI – mean point difference of -2.6 (95% CI: -2.9 to -2.4; WOMAC – mean point difference of -2.6 (95% CI: -3.4 to -1.8). CBT-I had a 95% or greater probability of being cost-effective compared to control. No significant differences in quality of life measures were reported. **No p-values were reported in this study, which instead reported statistical significance in confidence intervals.*
Godzik et al., 2021	Older adults aged 55 years and older (mean age 65.39 ± 1.55 years) who experienced the death of a loved one within the past five years and reported insomnia symptoms (N=30).	Six weeks of online delivery CBT-I.	Attention control group using six weeks of online psychoeducational modules distinct from CBT-I content.	ISI, depression and anxiety (DASS-21), quality of life (WHO-QOL BREF), use of sleep medications (McNemar tests).	No significant differences reported on any outcome measures between groups (all p-values >0.05).
Song et al., 2021	Older veterans aged 60 years and older (mean age 72.2 ± 7.7 years) with insomnia (N=144).	Five weeks of weekly CBT-I manual-based sessions either individually or in small groups (consisting of sleep restriction, stimulus control, cognitive therapy, sleep hygiene, relaxation and relapse prevention).	Five weeks of manual-based, general sleep information only without directed guidance.	DBAS, actigraphy, SE, sleep diary, PSQI, ISI, ESS, FFS, severity of depression, health-related quality-of-life.	CBT-I group showed significant improvements in DBAS sleep expectation scores only compared to control (p<0.01). DBAS total score change was significantly associated with changes in PSQI, ISI, ESS, FFS, PHQ-9 and SF-12V2 (all p-values <0.05). CBT-I group had significantly stronger associations between reduced DBAS total score and improvements on PSQI, ISI, ESS, and FSS compared to control (all p-values <0.05).
Siebmanns et al., 2021	Patients with cardiovascular disease and insomnia (mean age 72.52 ± 9.81 years) (N=48).	Nine weeks of nurse-led CBT-I with support.	Nine weeks of Internet-based self-study program without support.	Primary outcome: ISI. Secondary outcome: SF-12.	CBT-I group showed significant improvement in ISI scores compared to control at post-treatment (p=0.004). The mean scores for SF-12 PCS and SF-12 MCS improved in both CBT-I and control groups, though not significantly between groups (p=0.14 and p=0.18, respectively).
Sadler et al., 2018	Older adults aged 65 years and older (mean age 75 ± 7 years) referred by a community mental health service who met the criteria for insomnia disorder and major depressive disorder (N=72).	Eight weeks of standard CBT-I or advanced CBT-I+ (added positive mood strategies).	Eight weeks of psychoeducation.	Primary outcomes: ISI, depression severity (GDS). Secondary outcomes: Sleep diary, SOL, WASO, TST, SE, sleep quality, DBAS, SLEEP-50 scale, anxiety (GAI-SF), depression (Beck Hopelessness Scale), quality of life (EQ-5D-3L).	CBT-I and CBT-I+ groups had significantly greater decreases in severity of insomnia and depression symptoms compared to control (p<0.001), sustained at 20-week follow-up.

Original Research

Medical students' career perceptions of radiology

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ABSTRACT

Objective: Understanding and identifying the factors that influence third- and fourth-year medical students perceptions of radiology at Memorial University of Newfoundland and Labrador (MUN) aims to inform future initiatives in medical education and workforce strategies. Gaining insight into these perceptions is important for informing the direction of the medical school curriculum and identifying necessary changes to enhance students' perception of radiology, ultimately ensuring they develop the knowledge and skills needed for their future clinical practice. Taking the results from this survey to inform targeted curriculum adjustments and educational interventions will help create a more positive and impactful learning experience, fostering greater interest and competence in radiology among medical students.

Methods: Third- and fourth-year medical students at MUN participated in a voluntary and anonymous online survey consisting of 17 questions. The survey was distributed through the Office of Learner Well-Being and Success at the Faculty of Medicine and remained open for three months. It included a mix of closed-ended and open-ended questions, with responses to some of the closed-ended questions provided on a slider scale, where participants rated their answers on a scale from 0 to 10. The aim of the survey was to gather insights into students' perceptions of radiology within the medical school curriculum. Data analysis was conducted using the Qualtrics online survey platform and statistical analyses were performed using Microsoft Excel.

Results: Of the 160 medical students surveyed, 25 responded (15.63%; n= 25). Sixteen percent (n= 4) of the respondents expressed an interest in pursuing radiology. The majority (56.00%; n= 14) found the exposure to radiology from pre-clerkship to clerkship to be inadequate. According to the slider scale data, on average, respondents ranked "quality of family life" highest (8.52 out of 10) in influencing their perception of clinical radiology as a career, followed by "amount of patient contact" (7.83 out of 10) and "suitability to skills/aptitude" (7.33 out of 10). Students recommended interactive radiological lectures and shadowing opportunities to enhance their learning experience.

Conclusion: This survey reveals that factors influencing medical students' views on a career in radiology at MUN are multifactorial. The majority's perception of inadequate exposure to radiology could impact efforts to refine the medical school curriculum and develop broader workforce strategies aimed at attracting more students to the field.

INTRODUCTION

Selecting a residency specialty can be a daunting task for medical students, influenced by various factors that shape their decision-making process.[1,2] In this intricate process, the importance of exposure to different medical fields and access to comprehensive information cannot be overstated. Radiology emerges as a fundamental discipline within medicine, playing a crucial role in diagnostics and treatment planning.[3] Understanding medical students' perceptions of a career in radiology and evaluating their exposure to this field during their pre-clerkship and clerkship years at Memorial University of Newfoundland and Labrador (MUN) is of paramount importance. This survey research study aims to explore students' current perceptions of radiology, while also identifying potential gaps in their exposure and understanding of the field. Such insights offer the potential to inform educational strategies and workforce planning, ensuring that medical students are equipped with the knowledge and exposure necessary to make informed career decisions. Attracting medical students to the field of radiology involves providing them with the knowledge, tools, and experiences needed to develop a deeper understanding of the field. Discovering the factors that may negatively impact students' career choices is vital for fostering informed decision-making. Research into the factors shaping medical students' perceptions of radiology can help develop strategies to positively influence these perceptions and encourage interest in the field. There is a lack of published data reflecting the perceptions of medical students in the medical program at MUN towards radiology as a career choice. A survey of MUN third- and fourth-year medical students' perceptions of choosing a career in radiology would help to fill this gap in the literature and provide insights into the factors that influence medical students' decisions about radiology careers at this university. This leads to the research question of concern: What are the perceptions of medical students, in their third and fourth year of clerkship at MUN, regarding a career in radiology? This question sets the stage for a comprehensive exploration of the factors influencing medical students' attitudes toward radiology, with implications that extend beyond individual career choices to broader educational and systemic considerations within the medical profession.

METHODS

The research utilized a survey based research design, which facilitated an in-depth investigation of the factors influencing MUN medical students' perceptions on choosing a career in radiology. This design was appropriate given its emphasis on capturing students' firsthand personal experiences and varying levels of exposure to the radiology field. A survey based research study allowed for exploration of the perspectives of third- and fourth-year medical students at MUN regarding a potential career in radiology.

Primary source data collection was conducted to gather firsthand insights from the target participants. A questionnaire-based survey comprising 17 questions was created to collect responses from the target participants. The survey questions were developed by the authors, drawing on existing literature that employed similar survey instruments and addressed comparable research objectives.[4,5,6,7] These questions were then adapted to align with the specific aims of our study. The survey was developed and administered via the online computerized platform, Qualtrics. Once the participants completed the survey, it was submitted back to Qualtrics. The survey comprised both closed-ended questions and open-ended questions. Some of the closed-ended questions utilized slider scale items, allowing participants to rate their responses on a continuous scale from 0 to 10, while others were structured as simple Yes/No or multiple-choice questions. The open-ended questions allowed participants to provide written responses. Target participants were specifically selected from the cohort of third- and fourth-year medical students at MUN. These students were chosen for their likely deeper understanding of the radiology field, as they are currently in their clerkship years and nearing decisions about specialty selection and applying to residency. The sampling method employed was purposive sampling, as participants were selected based on their year of study. The survey was distributed exclusively to third- and fourth-year medical students at MUN to ensure alignment with the study's objectives. The Faculty of Medicine's Office of Learner Well-Being and Success at MUN oversaw the survey dissemination process, ensuring ethical standards and participant confidentiality were maintained. The survey proposal, along with the survey itself, underwent an ethics review by the Newfoundland and Labrador Health Research Ethics Board and received approval.

While this research offers potential benefits to medical school curricula across institutions, ensuring the integrity of the survey responses was paramount. Participants were encouraged to provide honest and unbiased feedback. Clear communication about the study's objectives, the utilization of gathered data, participants' roles and the voluntary nature of their involvement was provided to all participants. This transparency aimed to facilitate understanding of the study's purpose, encourage meaningful contributions and empower participants to influence potential improvements in medical school curricula, thereby aiding future students in career decision-making.

During the data collection period from August 28th to December 12th, 2023, reminders were sent periodically (each month) to participants to maximize response rates. The collected numerical data was thoroughly analyzed using Microsoft Excel. Open-ended responses were analyzed by grouping and sorting common themes and patterns, which were then categorized to identify key insights.

The survey aimed to examine various aspects of their attitudes, understanding and experiences with radiology as an academic subject and a potential career path. By thorough analysis of the responses gathered, we aim to provide insights into medical students' prevailing sentiments and perspectives on radiology, highlighting potential areas of interest, concern and improvement within radiology education and training.

RESULTS

In this section, we present the findings from an online survey distributed to medical students to explore their perceptions of radiology. Of the 160 medical students surveyed, 25 responded, constituting a 15.63% (n= 25) response rate. Their responses formed the basis of the analysis conducted. Of the respondents, 44.00% (n = 11) were third-year medical students at MUN, and 56.00% (n = 14) were fourth-year medical students at MUN.

In this results section, the analysis is structured to align with the key questions posed to participants in the online survey. These categories include: Interest in Radiology, Exposure to Radiology, Factors Influencing Choosing a Medical Specialty, Factors Influencing Choosing a Career in Radiology, Work-Life Balance, Perceptions of the Importance of Radiologists in Medicine, Exposure to Radiology in Pre-Clerkship Years (Open-Ended Reponses) and Enhancing Radiology Exposure in Pre-Clerkship Years (Open-Ended Reponses).

By organizing the analysis according to these distinct categories, the aim is to provide a comprehensive understanding of medical students' perceptions and experiences related to radiology, thereby offering valuable insights that could enhance radiology education and career pathways.

Interest in Radiology

Figure 1 represents interest (ever or currently) in pursuing a career in radiology. When asked if they **ever** had an interest in pursuing radiology, 48.00% (n= 12) of medical students responded "Yes" as is depicted in the figure. However, in the follow-up question, when asked if they **currently** have an interest in pursuing radiology, 16.00% (n= 4) of medical students responded "Yes", indicating a 3-fold decrease in interest.

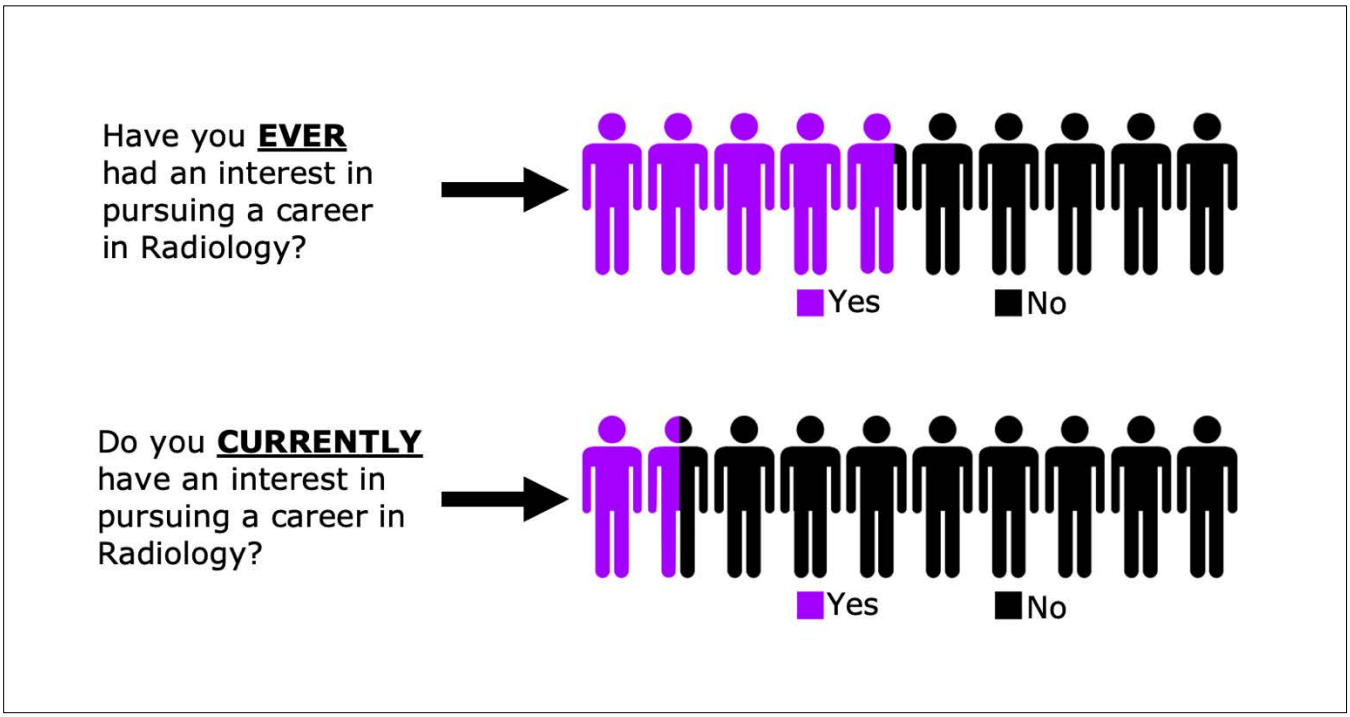

Figure 1. *Representation of interest (ever or currently) in pursuing a career in radiology.*

Exposure to Radiology

All surveyed students (100.00%; n= 25) confirmed having exposure to radiology in the MUN Medical School curriculum, as depicted in Figure 2. However, when asked about clinical exposure (i.e.: shadowing, clerkship, etc.), only 36.00% (n= 9) responded "Yes". Furthermore, only 44.00% (n= 11) believed they had adequate exposure to radiology during pre-clerkship and clerkship years.

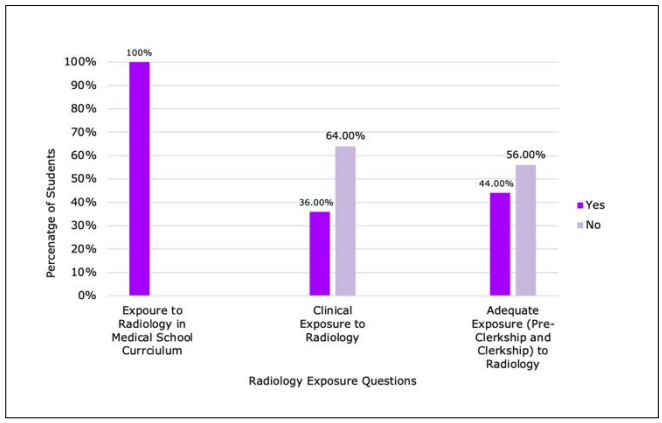

Figure 2. *Bar graph depicting medical students' responses regarding radiology exposure in the curriculum and clinical settings.*

Factors Influencing Choosing a Medical Speciality

Figure 3 displays the scores captured on a slider scale ranging from 0 (not important at all) to 10 (extremely important) regarding the impact of various factors on the selection of a medical speciality. The most important factor medical students indicated when choosing a medical speciality was "quality of family life", with an average score of 9.04 out of 10. "Artificial intelligence (AI)" received a score of 2.48 out of 10 for its impact on students' decisions in selecting a medical specialty, making it the least influential factor in their choice.

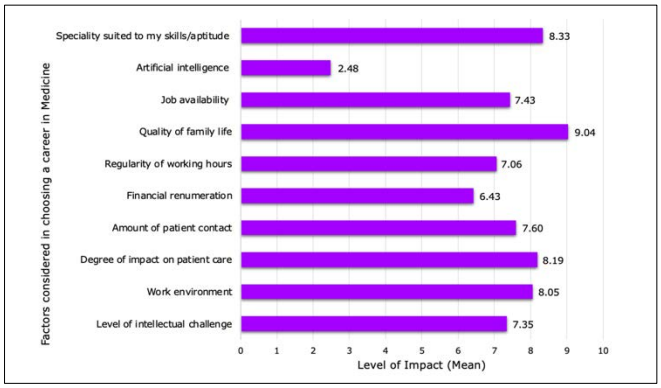

Figure 3. *Bar graph illustrating the level of impact, as indicated by mean scores, assigned by medical students evaluating factors influencing their decision in choosing a Medical Speciality.*

Factors Influencing Choosing a Career in Radiology

Figure 4 displays the scores captured on a slider scale ranging from 0 (no impact) to 10 (extreme impact) regarding the impact of various factors on choosing a career in radiology specifically. The most important factors influencing students' perceptions of radiology were "quality of family life" with an average score of 8.52 out of 10 and "amount of patient contact" with an average score of 7.83 out of 10. "AI" received a score of 4.94 out of 10 for its influence on students' decisions in choosing a career in radiology, making it the least significant factor in their decision-making process.

Work-Life Balance

Figure 5 depicts medical students' perceptions of 11 different specialties' work-life balance, where a score of "0" signifies worst and "10" best. Radiology ranked second among the 11 specialties in terms of work-life balance, with an overall score of 7.58 out of 10. It was surpassed only by Psychiatry, which scored the highest at 8.77 out of 10.

Perceptions of the Importance of Radiologists in Medicine

In Figure 6, medical students' perceptions of radiologists' roles in specific areas of medicine were measured on a scale of 0 to 10, with 0 representing "not important at all" and 10 signifying "extremely important". Students' perceived radiologists as most essential in "interpreting and reporting scans", which scored 9.15 out of 10. Radiologists were also seen as important in "establishing the correct diagnosis for a patient" and "discussing scan results with other specialities", both of which scored 7.45 out of 10.

Exposure to Radiology in Pre-Clerkship Years (Open-Ended Reponses)

In this section, we explored participants' experiences and exposure to radiology during the early years of their medical education, emphasizing their open-ended question responses. In response to the open-ended question, "What aspect of the program in your pre-clerkship years offered exposure to the field of radiology?" participants shared varied insights about their initial experiences with radiology. Commonly cited aspects included: lectures/didactic teaching, shadowing experiences, Radiology Interest Group events, anatomy labs, and POCUS (Point-of-Care Ultrasound) sessions.

Enhancing Radiology Exposure in Pre-Clerkship Years (Open-Ended Reponses)

Lastly, we examined participants' suggestions and insights on how to enhance radiology exposure during the pre-clerkship years, based on their responses to the open-ended question. In response to the open-ended question "What type of radiological exposure, do you feel, would provide the best experience to the field of radiology in your pre-clerkship years?" participants offered a variety of suggestions. Frequently mentioned ideas included more shadowing opportunities, hands-on learning experiences, clinical skills sessions for radiology, making radiology a mandatory part of clerkship, radiology learning modules and more lectures dedicated to radiology.

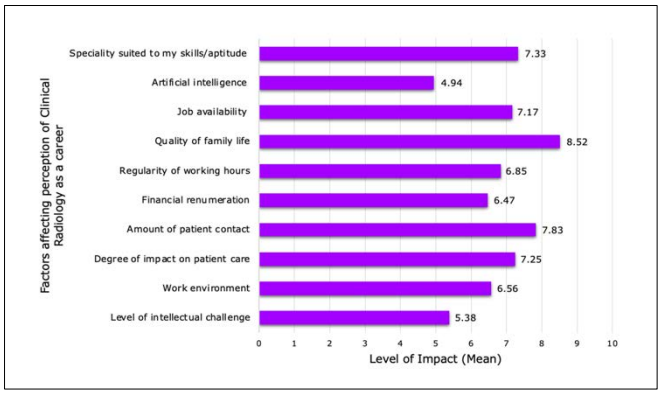

Figure 4. *Bar graph illustrating the level of impact, as indicated by mean scores, assigned by medical students evaluating factors influencing their perception of Clinical Radiology as a career.*

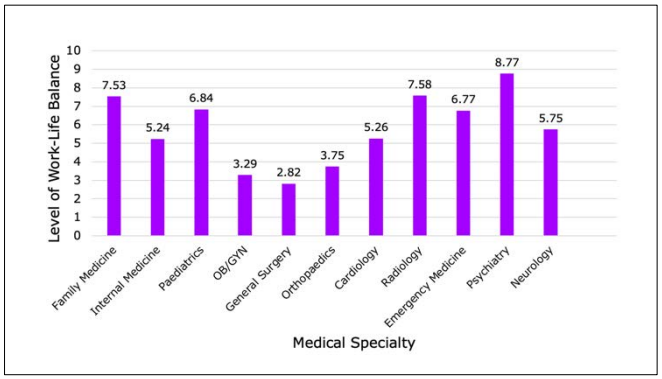

Figure 5. *Work-Life Balance perceptions of medical students across 11 specialties.*

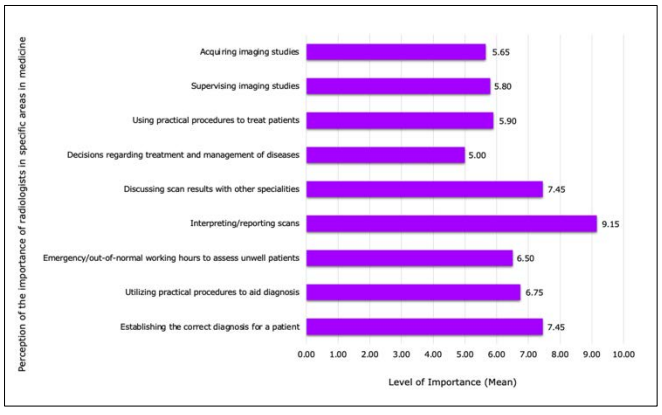

Figure 6. *Medical students' perceptions of the importance of radiologists in specific areas in medicine.*

DISCUSSION

Radiology has a crucial role in modern medicine, integrating knowledge of anatomy, pathology and clinical medicine to contribute substantially to accurate diagnoses and effective patient treatment.[1] Therefore, it is important to acknowledge the necessity of incorporating radiology education in the curriculum for all prospective medical doctors.

The data reveals a significant decline in interest among medical students in pursuing radiology, with 48.00% (n= 12) initially interested but only 16.00% (n= 4) currently interested, pointing to a notable shift in preferences over time (Figure 1). This trend prompts questions about the factors affecting medical students' changing attitudes toward pursuing radiology.[8,9] Identifying and understanding the reasons for this decline in interest is important for medical education and career counseling.

All surveyed students reported exposure to radiology as part of the curriculum (100.00%; n= 25), highlighting the integration of radiology teachings within the academic program. However, when evaluating clinical exposure to radiology through activities such as shadowing or clerkships, the response rate decreased to 36.00% (n= 9) (Figure 2). This suggests a disparity between theoretical classroom learning and practical clinical exposure, potentially indicating a need for increased opportunities for students to engage with radiology in clinical settings. Furthermore, when assessing the students' perception of the adequacy of their exposure during pre-clerkship and clerkship years, only 44.00% (n= 11) believed they had adequate exposure. This aligns with prior research that reported 87% of Canadian medical students from 17 medical schools expressed a lack of adequate exposure to radiology.[10] This implies that students may feel their exposure to radiology in these critical stages of medical education is insufficient. Addressing this perception is vital to ensuring that medical students feel adequately prepared and informed about the field of radiology as they progress in their training. While there is theoretical exposure to radiology in the MUN medical school curriculum, the lower rates of clinical exposure and the mixed perception of adequacy emphasize the importance of refining the integration of radiology in both classroom and clinical settings to better align with students' educational needs and expectations.[1,11] A prior study examined the effect of a 2-week course entitled "Foundations of Diagnostics and Therapeutics" that included introduction to radiology through small group seminars. The study demonstrated that with an early introduction to the field of radiology, students' academic interest in the field and their understanding of the significant impact imaging has on patient care was enhanced. [12]

Survey participants placed the highest importance on quality of family life when choosing a medical specialty, with suitability to skills/aptitude and the degree of impact on patient care following close behind (Figure 3). The challenge of balancing work and family responsibilities is a key consideration for individuals when deciding on a career path. Medical students place great importance on lifestyle as a factor influencing their choice of specialty, favoring fields that offer a favorable work-life balance.[13] These factors not only influence the trajectory of a healthcare provider's career but also profoundly impact their overall well-being and satisfaction in their chosen field. AI was found to be the least influential factor overall in students' selection of a medical specialty. This suggests that advancements in AI may have minimal impact on students' decisions regarding specialty choices. A previous study stated that it has been shown that AI has been part of imaging technology for decades, and its potential role in radiology is growing, especially in helping radiologists with reporting and backlog issues.[14]

When focusing specifically on clinical radiology as a career choice, respondents reiterated the importance of quality of family life as the most influential factor (Figure 4). This aligns with the overall appeal of radiology in "Medical Students' Perceptions of Work/Life Balance", where it ranked second with a score of 7.58 out of 10 (Figure 5). This suggests that clinical radiology is viewed as a field conducive to a balanced family life, consistent with a prior study where 92% of students viewed radiology to be conducive to a good family life.[15] The second most important factor for choosing clinical radiology was the amount of patient contact, indicating that even in a specialized field like radiology, patient interaction remains a significant consideration. This challenges stereotypes about certain specialties having minimal patient interaction.[2] The third-ranking factor, suitability to skills and aptitude, emphasizes the ongoing importance of aligning one's abilities with the demands of the chosen specialty. In contrast, AI was deemed the least influential factor in students' decision to pursue a career in radiology, suggesting that advancements in this area may not significantly sway students' specialty choices at this stage in their education. This finding aligns with a prior study where an electronic survey of undergraduate medical students at German universities showed that 82.9% disagreed with the notion that radiologists could be replaced by AI in the future.[16] This finding that AI is the least likely factor influencing students' choice of a career in radiology also aligns with its minimal impact on their decisions when selecting a medical specialty overall.

When evaluating medical students' perspectives on the importance of radiologists in specific medical domains, it is clear that students regard radiologists as essential in interpreting and reporting scans, which underscores their ability to provide precise and thorough interpretations of medical imaging. Furthermore, students acknowledge radiologists' role in establishing the correct diagnosis for a patient and discussing scan results with other specialties, emphasizing their critical involvement in assisting clinicians with accurate diagnostic processes based on imaging findings (Figure 6).

The analysis of open-ended questions reveals a consensus among respondents on the importance of increasing exposure to radiology. Notably, participants reported varied experiences concerning their exposure during pre-clerkship years, with some citing specific radiology lectures integrated into various courses, while others noted participation in Radiology Interest Group activities, shadowing opportunities and clerkship preparation sessions. However, many participants noted minimal exposure to radiology clinically, which aligns with the findings depicted in Figure 2. These findings highlight the need for a more consistent and structured incorporation of radiology components in the pre-clerkship curriculum to provide well-rounded early education in the field. Additionally, the responses reveal a preference for practical experiences such as shadowing, hands-on learning sessions and dedicated workshops, suggesting a desire for an experiential approach to complement traditional lectures and enhance understanding and engagement in radiology. Overall, the findings emphasize the importance of a multifaceted approach that combines theoretical knowledge with practical skills in radiological education during the early stages of medical training.

A limitation of this study is the short data collection timeline, which may have contributed to a low response rate among participants. This can affect the reliability and generalizability of the findings, as the low response rate may suggest a smaller and potentially less representative sample. Consequently, capturing the views or experiences of the broader population may be challenging, which could limit the applicability of the results to other medical programs and institutions. Future research should aim to extend the data collection period to gather more responses and improve the overall reliability of the findings. Additionally, due to the limited number of responses, the data were analyzed as a whole, rather than being separated by year of study. Stratifying the data between third- and fourth-year students would have provided further insights and strengthened the analysis.

CONCLUSION

This survey reveals that factors influencing medical students' views on a career in radiology at MUN are multifactorial.[1,10,17] The prevalent perception of insufficient exposure to radiology among the majority of students surveyed suggests an opportunity for refining the medical school curriculum and implementing broader workforce strategies to attract more students to this field. The study's practical implications extend to both medical students and medical programs across universities, providing valuable insights into the factors influencing students' career decision-making, particularly in relation to choosing a career in radiology. The findings support the need to enhance the level of exposure provided to medical students from pre-clerkship through clerkship years to equip them with the necessary resources to develop a deeper understanding of the radiology profession. These practical measures will be instrumental in orchestrating a shift in students' perceptions toward a career in radiology.

By identifying the factors that shape students' views on choosing a career in radiology, initiatives can be focused on enhancing the overall perception of the radiology profession among students. This study lays the groundwork for subsequent surveys of medical students over a quantified period, which could facilitate the assessment of perceptual changes. Additionally, it underscores the potential for future research endeavors, including the exploration of conducting focus groups with medical students to gain deeper insights into their thoughts and concerns. It also encourages collaboration between medical schools and radiology professionals to develop engaging and informative materials aimed at promoting the field. In essence, this study serves as a catalyst for ongoing research and collaboration to enhance the appeal and understanding of a career in radiology among medical students at MUN.

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