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The Education and Implementation of Clinical Reasoning Education in Post-Graduate Emergency Medicine Training: An Integrative Review

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Abstract

The ability to clinically reason is a necessity for doctors to reduce the possibility of diagnostic error in patients. Emergency medicine doctors work in a highly active, challenging and, at times, cognitively formidable setting that can affect clinical reasoning. This review aims to study the literature on post-graduate training programs and how clinical reasoning education is incorporated. Methods: CINAHL, Embase and Medline were used to obtain relevant literature from 2010 to 2023. A review was undertaken of clinical reasoning curriculums and resources in medical and surgical specialties in Australia, New Zealand, USA, UK, Ireland and Canada. Results: 23 articles were included in the review. Educational themes to teach clinical reasoning were a) simulation b) technological and innovative methods, c) morning report, d) peer teaching, and e) curriculum related. Surgery, General practice, and Internal Medicine colleges appear to have embedded clinical reasoning courses and resources within their curriculum and training. Conclusion: Specialty colleges are recognising the importance of clinical reasoning and have incorporated formal curricula into their training. Teaching can occur at a college, hospital and departmental level using a variety of educational modalities that vary in the resources required and is a possible option for Emergency Medicine training.

I INTRODUCTION

A Background

A doctor's cardinal objective is to be adept in their clinical reasoning abilities, so they are a capable diagnostician. Previously it was thought that clinical reasoning was adequately taught via experience in the clinical setting (Sudacka et al., 2021). However, recent statistics and reports in diagnostic error have prompted a need for specific education in clinical reasoning and diagnostic decision-making that excludes this outdated approach (Sudacka et al., 2021).

Newman-Toker et al. (2022) cite that diagnostic error is attributable to considerable morbidity and mortality worldwide. In the US, diagnostic error occurs in nearly 6% of all Emergency Department (ED) presentations. 2% of these presentations are preventable harmful results, significant harms 0.3% and deaths 0.2%. In 2019, Hautz et al. determined that the diagnosis given at admission from the ED was different to that at discharge in 11% of patients and contributed to prolonged admission rates and increased mortality. Medico-legally, medical practitioners are at risk with nearly 90% of diagnostic error malpractice claims attributed to poor clinical decision-making (Newman-Toker et al., 2022).

There are concerns that medical professionals are lacking in acceptable training on the process of making diagnoses (Croskerry, 2017; Balogh et al., 2015). Rencic et al., (2017) discovered that nearly 60% of medical schools were deficient in structured education focusing on teaching clinical reasoning. Balogh et al. (2015) also state that post-graduate education in hospitals is out of date in the learning sciences and the diagnostic process. Areas that need to be addressed are "clinical reasoning, teamwork, communication, the use of diagnostic testing and health information technology" (Balogh et al., 2015).

The emergency department can be highly complex, unpredictable, and demanding. Patients may present to the ED with symptoms that could possibly be due to a wide-ranging list of diseases or attend at the beginning of their illness before the full array of symptoms or signs identify the disease. Additional challenges for ED doctors are that they are tending to an aging population with multiple medical problems (Australian Institute of Health and Welfare, 2021), caring for diverse cultural and socioeconomic groups (Australian Institute of Health and Welfare, 2022a; 2022c), and dealing with rising numbers of patients presenting with mental health problems (Australian Institute of Health and Welfare, 2022b).

EDs also must manage logistical challenges with access blocks, greater numbers of patient presentations, and time-based targets (D'Angelo, 2017). These added barriers may cause emergency doctors to rely on heuristics, potentially causing inaccurate assessments (history, examination and choice of investigations) and clinical synthesis of findings (Whelehan et al., 2020). This is reinforced by Bartmaans et al. (2022) who identified that human errors associated with serious adverse events in the ED occurred in the assessment phase.

There has been no discernible change in clinical reasoning education in medical schools since the 2015 landmark report "Improving Diagnosis in Healthcare" (Balough et al., 2015; Majumder et al., 2019; Rencic et al., 2017). This deficit in the current working environment in EDs is further affecting emergency doctor's experiential learning and education (Sng & Smith, 2020), which are significant factors contributing to gaining skills to clinically reason.

B Aim

The aim of this review was to analyse how clinical reasoning education is implemented in different medical specialties. The findings from the research may inform future practice in the delivery of Emergency Medicine training.

The research questions for this review were:

1. To determine if medical specialties implement clinical reasoning education in their training programs for doctors post-graduation from medical school.

2. To identify in what way is clinical reasoning education implemented in fellowship training programs.

II METHODOLOGY

An integrative review allowed data to be combined from various quantitative and qualitative studies and included proposals, reports, narratives and opinions (Lubbe et al., 2020). In addition, an attempt was made to determine if and how specialty colleges were incorporating formal clinical reasoning education in their curriculum. The integrative review was undertaken to synthesise the current practices and pedagogical approaches in teaching clinical reasoning in post-graduate medical education and, therefore, has the potential to contribute to future research, practice, teaching, and strategic initiatives (Whittemore & Knafl, 2005). Kable et al. (2012) 12-step systematic approach has been used to structure the search strategy.

A Literature Search

The electronic reference databases Medline, Embase and CINAHL were used for the literature search. The search parameters included the period between 2010 and 2023 as it is assumed that most curriculums would be evaluated and amended in this time. For articles to be included, they had to focus on clinical reasoning or the decision-making process. It was a requirement that the articles had to include curriculum or teaching methods or learning in post-graduate medical education. Articles had to be in English.

Articles were not included if the subjects were restricted to nursing, allied health, medical students, and certified specialists. Articles were also excluded if the decision-making was related to explicit diseases, an evaluation or assessment process or organisational checklist intended to improve clinical decision-making.

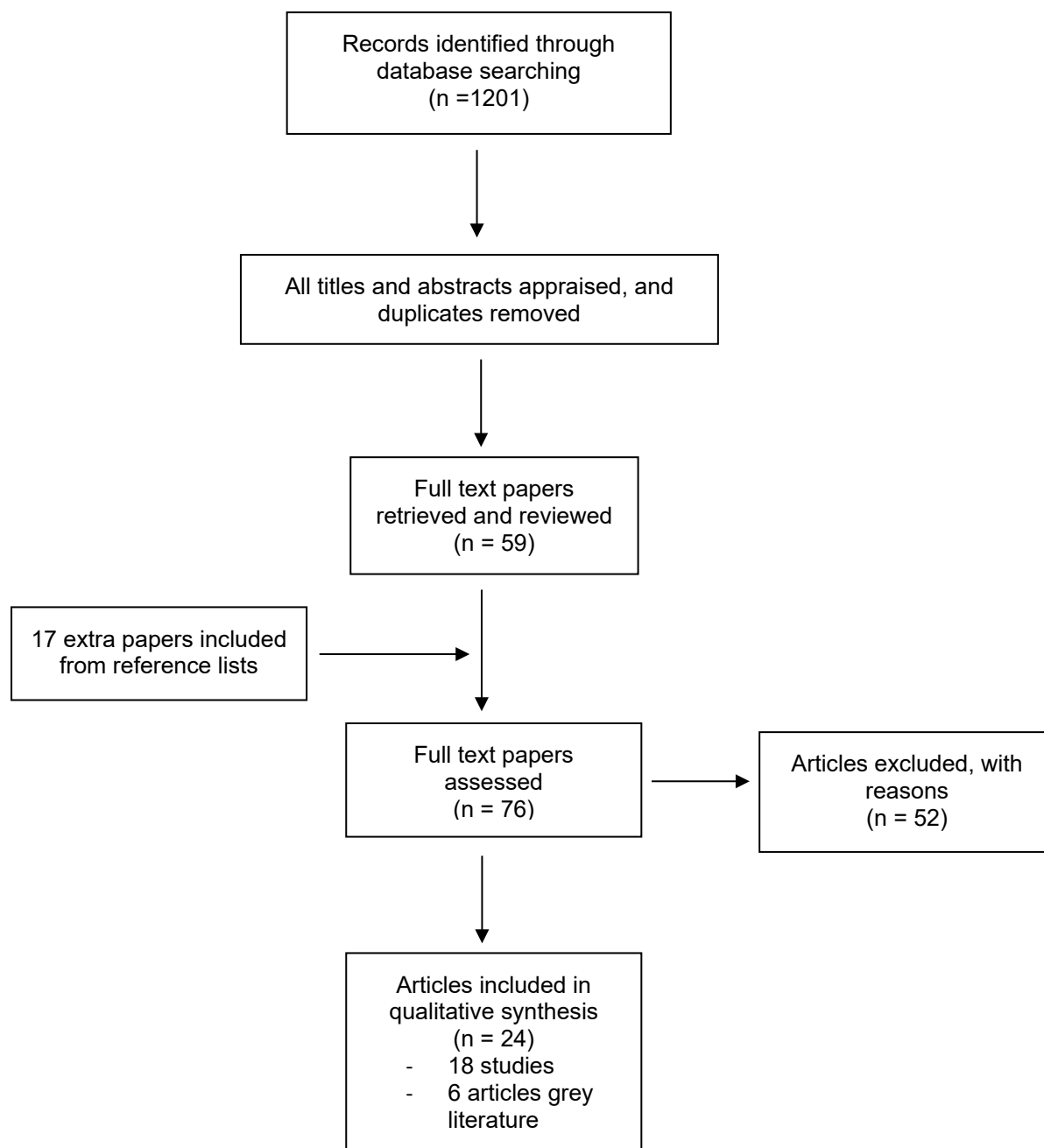
The key search terms were clinical reasoning, post-graduate and medical education. However, in view of the multitude of terminology for clinical reasoning (Young et al., 2019), other search terms such as decision-making, diagnostic thinking, diagnostic justification and therapeutic reasoning were included.

B Search Outcome

Relevant articles were obtained via a two-part process. The search strategy found 1201 records requiring title and abstract review to exclude relevant articles. 59 full-text papers were identified at this stage, and their reference lists were searched for additional suitable papers. A further 17 articles were found. Therefore, a total of 76 full-text papers were analysed. 52 of these papers did not meet the inclusion criteria (Figure 1).

A Google search was undertaken of the Colleges in Anaesthetics, Physician training (Internal Medicine), General Surgery, Emergency Medicine, General Practice, and Obstetrics and Gynaecology in Australia and New Zealand, USA, UK, Ireland and Canada. A review of the specialty's college website was undertaken to determine if and how they addressed clinical reasoning.

Figure 1
Post-Graduate Clinical Reasoning Education Search Outcome



C Data Evaluation

Hawker's et al. (2002) evaluation form was used to analyse data quality. The evaluation requires rating the standard of abstracts and titles, introductions and aims, methods and data, sampling, ethics and bias, data analysis, results, transferability and generalisability and implications and usefulness. Scorings were given with 4 = good, 3 = fair, 2 = poor and 1 = very poor. To obtain a global score on methodological quality, an average score of the 9 categories was calculated (4.00-3.51 = good; 3.50-2.51 = fair; 2.50-1.51 = poor; and 1.50-1.0 = very poor). These evaluations are listed in Table 1.

One study was not used as despite being published in 2012, the study curriculum was commenced in 2004 and the cross-sectional survey assessing its success was done in 2006. The period between the results and publication was deemed to be significant and outside the integrative review's time period. Subsequently, 23 papers were included in the review.

D Data Analysis

Tables 1 and 2 document the data extracted based on author, year of publication, country, mode of learning, specialty, learners, objectives of the program, duration, outcomes, and limitations to the study. Data was analysed, categorized and placed in groups. Opinions, proposals, and narratives were separated and tabled under grey literature (Table 3).

Table 1
Study Characteristics

Article	Author (et al., year)	Country	Study Design	Specialty	Learners/Subjects	Duration of the program	Quality of Study	Limitations
1	Altabbaa (2019)	Canada	Quantitative/ Coding of actions	Internal Medicine	18 medical students, 20 PGY1 residents	5 months	Good	Small group
2	Battista (2018)	USA	Qualitative/ Reflective tools	Internal Medicine, GP, and Surgery	12 subjects. 8 were PGY1-3, 4 attending physicians		Fair	Small group (12), difficulty in designing scenarios, time for think aloud, logistics
3	Chan (2020)	Canada	Quantitative/Qualitative	Orthopaedics	55 residents and key informants (nurses, consultants - 17)	4-week terms	Fair	Poor responses due to being voluntary
4	Close (2015)	USA	Quantitative	General Surgery	71 residents (PGY 1 = 21, PGY2 = 11, PGY3 = 14, PGY4 = 13, PGY5 = 12)	2013-2014 academic year	Good	Number of subjects in each year group
5	Compere (2015)	France	Experimental/Quantitative/Tests	Anaesthetics	17 (control group) Vs 19 (experiment) residents	6 months	Good	Lack of randomisation of subjects
6	Graafland (2014)	Netherlands	Quantitative/Questionnaire	Surgery	41 participants played the game.	3 months	Fair	Poor response to questionnaire
7	Harris (2019)	USA	Quantitative/Tests	Internal Medicine	81 residents	6 months	Good	Poor response rates
8	Iyer (2018)	USA	Quantitative/Questionnaire	Internal Medicine	47 PGY2 residents	2013-2016	Fair	Survey tools developed different times, curriculum changed after 1st year
9	Kamra (2018)	USA	Quantitative/Questionnaire	Paediatrics	16 medical students and 45 residents	5 months	Poor	Small, non-randomised groups, struggles to get staff to attend both types

Article	Author (et al., year)	Country	Study Design	Specialty	Learners/Subjects	Duration of the program	Quality of Study	Limitations
10	Kiran (2016)	India	Experimental/Quantitative/Qualitative	Internal Medicine	24 residents, randomised 2 groups – study and control	12 months	Poor	Small groups, unable to extrapolate findings
11	Kobner (2020)	USA	Qualitative/interviews	Emergency Medicine	89 virtual audience of residents and faculty (no delineation given)	Conference workshop	Fair	Very small group interviewed (11 in total) covering different roles (participants, audience, facilitators)
12	Mohan (2015)	USA	Quantitative/Quiz and questionnaire	Paediatrics	82 residents PGY 2 and 3	Oct 2010-March 2013	Good	Poor response rates
13	Murray (2015)	USA	Quantitative/checklist, global rating	Surgery, Emergency Medicine and Anaesthesia	83 residents	9 months	Good	Inter-reliability bias, markers rated priorities different
14	O'Connor (2010)	USA	Quantitative/Qualitative	General Surgery	14 PG2 residents	3 weeks	Fair	Small group, lacking objective analysis of outcome components
15	Sabbagh (2015)	Lebanon	Quantitative/Questionnaire	Emergency Medicine	63 residents	12 months	Fair	50% response rate to questionnaire, single centre
16	Schaye (2019)	USA	Quasi-Experimental	Internal Medicine	71 residents	6 months	Fair	Quasi-experimental, poor response rates
17	Volk (2011)	USA	Quantitative and Qualitative/survey	Otolaryngology	59 individuals - ENT residents, fellows, anaesthesiology residents, fellows, nurses, OR nurses	19 months	Good	Survey not validated

Table 2
Objectives and Outcomes of the Studies

Article	Author (et al., year)	Mode of learning	Objectives of the program	Outcomes
1	Altabbaa (2019)	Simulation	To assess the value of a curriculum designed for doctors to experience and identify cognitive biases allowing CR to be reframed	Learner's experience of the risk of bias in decision making.
2	Battista (2018)	Simulation	To practice and reflect on CR of 2 scenarios	Scenarios can be used to practice CR, think aloud, and reflection and can be used at all levels of training
3	Chan (2020)	Experience	To improve Orthopaedics residents' knowledge and comfort in care of Geriatric patients via Geriatric Medicine term.	Improved knowledge and comfort in residents exposed to Geriatrics rotation
4	Close (2015)	Web based virtual patient case scenarios	To evaluate validity and effect on decision-making accuracy of web-based virtual patient case scenarios	CR improved with the stage of post-graduate training and with repetition
5	Compere (2015)	Senior Led practice exchange group tutoring	To test if senior led tutoring improved clinical reasoning	Greater knowledge and CR in peer exchange groups
6	Graafland (2014)	Game	To determine if gaming can be used for teaching decision making and if there is a discriminatory ability between levels of expertise	Clear discriminatory ability between levels of expertise in biliary tract disease management and teaching capability
7	Harris (2019)	Curriculum	To test the impact of a Bolus/booster CR curriculum	Improved scores in PGY1 cohort, no significantly seen differences were seen with PGY2 and 3 residents
8	Iyer (2018)	Curriculum	To design, implement and assess a CR curriculum for Internal Medicine residents.	Improved skills in recognising and applying CR skills, knowledge assessment improved from 58% to 81%
9	Kamra (2018)	Game	To evaluate game-based learning in morning report	Game based morning report scored higher in self-rated learning, enjoyment, ability to sustain attention, participation and desire to attend similar sessions in the future compared to traditional morning report
10	Kiran (2016)	Novel	To enhance CR via extracurricular books: medical nonfiction and nonmedical fiction	The extracurricular books enhanced the CR skills of PG students
11	Kober (2021)	Game	To advance CR skills and engagement among trainees during a virtual conference	Increased audience and faculty engagement and discussion when compared to historical case conference
12	Mohan (2015)	Simulation	To ascertain whether high fidelity simulation can enhance resident learning when designed to a subspecialty rotation for Paediatric residents	High fidelity simulation with a structured content curriculum improves the performance of Paediatric residents on a case quiz than residents without exposure

13	Murray (2015)	Simulation	To evaluate the use of simulation in managing trauma scenarios using heuristic and analytic diagnostic skills	Senior resident led teams scored higher when managing heuristic scenarios compared to scenarios requiring a more analytic approach, simulation can provide CR experiences, improve diagnostic skills, and provide opportunity to study the CR process
14	O'Connor (2010)	Curriculum	To assess how effectively the Problem Based Learning and Improvement curriculum addressed quality improvement, CR, and self-directed learning	There was an increase in all measured elements
15	Sabbagh (2015)	Morning reports	To assess the standard of presentations, discussions, ethics and professionalism, evidence-based medicine, CR, and implication of the ED physician at morning report.	Scores were considered acceptable for discussion on differential diagnosis (82.5%), approach (82.5%) and treatment (90.5%). The data showed that the evidence-based medicine discussion was satisfactory at 85.7% as well as CR at 87.3%
16	Schaye (2019)	Curriculum	To evaluate the value of a CR curriculum based on dual process theory and script theory	Residents in the intervention groups (full and partial) were more proficient in using CR concepts to clinical practice
17	Volk (2011)	Simulation	To apply in-situ high-fidelity medical simulation to 1) instil teamwork and CRM skills and 2) provide CR practice in simulated high risk low frequency airway emergencies	90% of the responses were favourable or very favourable in course organisation, realism, debriefing, and relevance to future practice

CR = Clinical Reasoning, PG = Post-graduate, CRM = Crisis Resource Management

Table 3
Summary of Grey Literature

Article	Author (et al., year)	Country	Article Type	Specialty	Mode of learning/Curriculum
18	Goyal (2019)	USA	Report	Internal Medicine	Case Orientated Report and Exam Skills (CORES) an innovative morning report structure to improve clinical reasoning and enhance it with bedside teaching
19	Hassan (2012)	Saudi Arabia	Proposal	Internal Medicine	3 models used to promote clinical reasoning - Competency structured presentation, BESD model and the 5S model
20	Morgan (2013)	Australia	Proposal	General Practice	Proposal of a framework of random case analysis based on RACGP curriculum
21	Simpkin (2017)	USA	Opinion	Internal Medicine	Recommendations on how clinical reasoning could be emphasised in internal medicine training
22	Trowbridge (2012)	USA	Narrative	All specialties	Longitudinal curriculum designed to extend from medical school to practicing physicians using a tripartite agenda
23	Young (2023)	Canada	Proposal	Internal Medicine	Suggestion on how the 2025 CanMEDS competency framework could incorporate clinical reasoning

III RESULTS

23 articles were selected to reflect post-graduate medical education that focuses on improving clinical reasoning since 2010. 17 of these were studies, and 6 were incorporated into the category of grey literature. Summaries of those used in this integrative review are outlined in Tables 1 and 2. 15 studies were undertaken in the United States of America, 3 in Canada, and 1 each in Australia, France, Lebanon, India, Saudi Arabia, and the Netherlands. Specialties that were involved include Internal Medicine, Anaesthetics, Emergency Medicine, Paediatrics, Orthopaedics, Surgery and Ears, Nose and Throat (ENT). The Post-Graduate Years for junior doctors ranged from PGY1 to PGY 5. There were some studies that also included medical students and consultants.

The review of the literature identified 5 educational themes based on pedagogical approaches to learning: a) simulation, b) technological and innovative methods, c) morning report, d) peer teaching, and e) curriculum-related.

A Simulation

There were five studies that utilised simulation with the objective of enhancing clinical reasoning. Simulation gives the opportunity to teach teamwork and crisis resource management skills (Volk et al., 2011), as well as providing decision-making experience to residents in scenarios with specific objectives (Altabbaa et al., 2019; Battista et al., 2018; Mohan et al., 2015; Murray et al., 2015; Volk et al., 2011;). Scenario design in the scenarios was aimed at improving clinical reasoning in high-risk low-frequency settings (Volk et al., 2011) or targeting known deficiencies in knowledge in subspecialties such as Paediatric Cardiology (Mohan et al., 2015). Other studies were focused on exploring the clinical reasoning process where specific scenarios were planned so doctors were susceptible to biases (Altabbaa et al., 2019), were exposed to using heuristic or analytical thinking (Murray et al., 2015), or were complex (Battista et al., 2018) to provide opportunities to practice clinical reasoning with exploration and teaching of clinical reasoning skills after.

B Technological and Innovative Methods

Three studies demonstrated how clinical reasoning could be taught via gaming. 1 study encouraged clinical reasoning with real-world cases with learning objectives related to pathophysiology, assessment, and management (Graafland et al., 2014) and the other allowed learners to explore unexpected patient findings via problem-solving (Kamra et al., 2018).

Kobner et al. (2020) used low-fidelity simulation with aspects of gamification to foster clinical reasoning skills at a virtual conference. In this study a group of residents submitted a real clinical case, and another resident team problem solved through a gamified, simulated version of the case live on a video conference platform.

Gaming can be a method to increase motivation and participation of subjects (Graafland et al., 2014; Kamra et al., 2018; Kobner et al., 2020), possibly due to a competitive mode where gamers were competing against time and the scores of other players on popular social platforms (Graafland et al., 2014) or in the Kamra et al. study (2018) it was thought that due to the fact there was not a single right answer junior doctors participated more as they had less anxiety about saying the wrong answer.

Similar to the gaming concept, Close et al. (2015) had web-based virtual patient cases that students were required to assess and manage 1 week prior to scheduled debriefing sessions. Students obtained results and feedback and had the option of repeating cases if they received a low score. Facilitators running the debriefing sessions received student scores, and areas of deficiencies or disagreements in diagnostic or decision plans, allowing for focused training.

Although not technologically based, Kiran et al. (2016) studied a unique approach to teaching clinical reasoning. Their aim was to improve the clinical reasoning skills of the students using extracurricular books: medical nonfiction and nonmedical fiction. The study group were assigned chapters of a medical nonfiction book and particular stories of Sherlock Holmes and, at scheduled times, discussed the topics. The authors found that the extracurricular books enhanced the students clinical reasoning skills.

C Morning Report

Three studies explored the use of clinical reasoning in morning report. Goyal et al. (2019) used a case-orientated report and paired it with exam skills at the bedside for Internal Medicine interns to enhance clinical reasoning. Kamra et al. (2018) applied the gaming concept to morning-report which scored favourably in comparison in areas such as self-directed learning and enjoyment to traditional morning report. Morning report is not a standard teaching method in Emergency Medicine, however Sabbagh et al. (2015) introduced a trial over a 12-month period and showed that discussions on evidence-based medicine and clinical reasoning were considered satisfactory (85.7% and 87.3%, respectively).

D Peer Exchange Groups

Peer exchange groups are small groups of professionals from the same specialty who come together to discuss cases. Students take an active role as teachers as well as learners. Compere et al. (2016) examined the impact of weekly peer exchange/learning tutorial groups held over a 6-month period in anaesthesiology. They discovered that study participants had greater knowledge and clinical reasoning compared to the control.

Kamra et al. (2018) also noticed that with a gaming-based morning report, there was an indication that participants were learning from their peers in addition to the facilitator. This is different to traditional morning report where the facilitator is the principal educator.

E Curriculum Related

There were ten articles that were grouped together as they either discussed reviewing the curriculum, had slight variances to standard pedagogical approaches or provided suggestions on how to incorporate clinical reasoning in the workplace.

Young et al. (2023), Simpkin et al. (2017), Morgan & Ingham (2013) and Trowbridge et al. (2013) provided recommendations for current curriculums and making modifications to emphasise clinical reasoning at the specialty college level. Young et al. (2023) proposed changes to the CanMEDS competency framework to better incorporate the theoretical concepts of clinical reasoning and the awareness of the complexities of patient care. Simpkin et al. (2017) acknowledge the demands on clinical work and made recommendations for rebuilding the focus on diagnostic reasoning in internal medicine training, focusing on three main areas, ie. Change the teaching conferences and structure of teaching rounds, change the training environment to embrace the diagnostic reasoning process and develop new approaches to assess and monitor competence in diagnostic reasoning. Simpkin et al. (2017) incorporated case-based discussions at morning report, weekly sessions with the Department of Pathology and Internal Medicine faculty to improve the use of diagnostic tests in key areas and a clinical reasoning course. Trowbridge et al. (2013) suggested a tripartite educational agenda for improving clinical reasoning among all medical practitioners at all levels. This program comprises reinforcing the metacognitive skills of clinicians, encouraging intuitive reasoning, and building an awareness of the diagnostic process.

Morgan & Ingham (2013) proposed the use of random case analyses as a form of teaching, supervision, and assessment for clinical reasoning and how this could be embedded in the Royal Australian College of General Practitioners curriculum framework.

After a survey highlighted Orthopaedics trainees' concerns about their knowledge deficits in Geriatrics and perioperative management, Chan et al. (2021) introduced a 4-week Geriatrics term in Orthopaedics training with the aim to improve knowledge and comfort in the care of managing geriatric patients.

There were 5 articles that looked at a variety of approaches to teaching clinical reasoning over various time periods. These articles occurred at a departmental level and either studied specific learning approaches or models. Learning approaches included formal lectures (Harris et al., 2019, Iyer et al., 2018; Schaye et al., 2019), a problem-based learning program (O'Connor et al., 2010) and teaching models to promote clinical reasoning (Hassan, 2012).

The studies described clinical reasoning programs that were of variable duration. Harris et al. (2019) incorporated a "bolus/booster approach" over a few years, Iyer et al. (2019) provided an elective curriculum over 2-4 weeks, and Schaye et al. (2019) study over a 6-month period. O'Connor et al. (2010) problem-based learning and improvement curriculum was a 3-week program, and it would be expected that the aim of Hassan's (2012) models to assist with clinical reasoning would be incorporated in teaching and used in daily clinical practice.

F Current College Activities

Specialties that included clinical reasoning education at the college level were mainly Surgery (www.surgeons.org; www.rcsi; www.rcseng.ac.uk; www.facs.org.au), General Practice (www.racgp.org.au; www.dfpc.ca; www.icgp.ie; www.aafp.org), and Physician colleges (www.racp.edu.au; www.acponline.org). Resources that these colleges provided included podcasts, courses, or articles on how to encourage clinical reasoning and incorporate clinical reasoning into their education. Surgery colleges in the UK and Ireland include clinical reasoning as part of their formal curriculum in their Surgical training orientation. In Australia, there were 4-hour clinical decision-making courses (www.surgeons.org), and the USA included clinical reasoning workshops at conferences and had resources available on their website (www.facs.org).

In the General Practice/Family Physician colleges, resources were available for supervisors and trainees in most of the countries researched. In Australia, particularly, there was a large emphasis on clinical reasoning that gave the impression that it was embedded in their supervision and training.

IV DISCUSSION

In general, the objectives of specialty curriculums require trainees to have the ability to assess, gather data, interpret, and synthesise information, generate hypotheses and diagnoses, develop management plans, and avoid cognitive errors (Connor et al., 2020). This is the essence of clinical reasoning, and yet there is limited specific education on the concepts of clinical reasoning (Sudacka et al., 2021). Hayes et al. (2017) proposed that a dedicated curriculum should cover the fundamentals of clinical reasoning, metacognition, cognitive biases, and de-biasing techniques to improve clinical reasoning abilities in medical practitioners.

This review sought to synthesise the educational learning curriculums that specialties are undertaking to teach clinical reasoning to their post-graduate doctors. The review indicated that there are multi-modal educational approaches to teach clinical reasoning. Some approaches were traditional, with different emphases on the curriculum to promote clinical reasoning, e.g. Simulation, Problem Based Learning, Random Case Analysis and peer group learning. Other approaches were innovative with gaming, virtual conferences, and reading fiction novels to encourage an inquisitive approach to clinical care.

Simulation is not a new educational methodology however it continues to advance in approaches to healthcare topics based on experiential learning (Herrera-Aliago & Estrada, 2022). This review showed that the ability to be able to design scenarios with specific clinical reasoning objectives in mind, makes this an attractive pedagogical approach. However, it was identified that simulation can be resource and time-intensive, with difficulty in scheduling doctors to participate due to clinical demands (Battista et al., 2018; Mohan et al., 2015).

In comparison, gaming is a relatively new tool for learning in the health arena (Gentry et al., 2019). The studies that were used in this review have highlighted how gaming and digital education can be used for individual learning in the private setting, in formal teaching sessions including morning report and virtual conferences (Close et al., 2015; Graafland et al., 2014; Kamra et al., 2018). Gentry et al. (2019) undertook a systematic review on gaming and gamification education to find this educational modality can increase knowledge, skills and satisfaction. However, there is limited high-quality research available.

The demands on the emergency department make it impossible to rely heavily on experiential learning. Some learning approaches discussed are not common practice in ED e.g. Morning reports and may be difficult to implement into the schedule of Australian Emergency Departments. However, there does appear that clinical reasoning education can be incorporated at the department, the hospital, and the Specialty college level. Formal clinical reasoning curriculum could be provided at all levels either in a course format or during scheduled education sessions. In hospitals and departments, simulation scenarios can be designed with specific clinical reasoning objectives that also allow for emergency medicine-related content to be covered. At the College level, providing resources to assist in the supervision may be an appropriate introduction to educating clinical reasoning and the introduction of gaming or gamification education may assist in standardising knowledge requirements and assist with assessments.

It is important to note that the above educational approaches (simulation, case-based learning, problem-based learning, bedside learning) are instructional methods that are favourable to teaching clinical reasoning (University of Notre Dame, 2016). However, it is the teaching strategies during the chosen instructional method that give learners an opportunity to practice their clinical reasoning skills (University of Notre Dame, 2016). Thinking aloud (Battista et al., 2018) and peer learning (Compere et al., 2015; Kamra et al., 2018) were strategies that were mentioned in a few studies, but a lack of awareness of these teaching techniques might limit optimising clinical reasoning education (Sudacka et al., 2021).

Sudacka et al. (2021) highlights that the barriers to teaching clinical reasoning include deficiency in the teaching process and the lack of culture supporting clinical reasoning. The authors found that educators did not believe in explicit clinical reasoning teaching, lacked awareness of methods or competency frameworks, lacked qualified educators, leadership, and had no specific guidance. Another popular subtheme was the resistance to change, and other considerations include the lack of time, infrastructure, and motivation (Sudacka et al., 2021).

A few specialties, in particular General Practice, Internal Medicine, and Surgery are incorporating clinical reasoning into their curriculum frameworks and are providing their members with resources such as podcasts, courses, and articles on how to encourage clinical reasoning and include clinical reasoning into their education. The question is whether an overarching governing body such as the specialty colleges would change the resistance that Sudacka et al. (2021) describes at a hospital and departmental level.

There were common limitations in the studies in that many were of small size and had questionable participation rates potentially leading to bias and limited ability to generalise the results. The Hawthorne effect may have influenced results as well as the use of surveys rather than formal and standardised assessments of clinical reasoning.

A *Review Limitations*

There is a lack of standardisation in terminology and definitions for clinical reasoning. It is complicated by variation amongst and within different health disciplines and the application of this concept. Young et al. (2019) discovered 110 terms were used for clinical reasoning when examining 625 papers over 18 specialties, and they agreed on 74 terms that could be divided into 6 main concepts. In this review, 5 terms were used for the literature search.

Other limitations included difficulty navigating around some of the college websites, with some sites requiring member logins to access information. In addition, some colleges e.g. Royal College of Physicians and Surgeons of Canada govern multiple specialties. In the USA, there was a distinction between specialty boards and colleges in which each had different functions compared to other countries.

V CONCLUSION

There is a need to improve clinical reasoning education and reduce diagnostic errors. Current workloads in the ED prevent traditional educational processes from being used to teach our post-graduate doctors. Innovative methods, such as gaming, may appeal to current post-graduate doctors and provide standardised, easily assessable learning to large numbers of trainees. Multiple educational approaches can be used to incorporate clinical reasoning education at the department, hospital, and college levels. Several specialty colleges have taken the lead by emphasising the importance of clinical reasoning by incorporating it into their formal curriculum and providing resources available to train the educator and educate the trainee. Embedding clinical reasoning at a Specialty College level may filter down to the department level and may break down current training barriers.

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