**INTRODUCTION**

Clinical decision-making, clinical judgment, problem solving or clinical reasoning are terms used interchangeably and are defined as “*the cognitive thought processes, or thinking used in the evaluation and management of a patient*” (Jones 1992 p.876). Clinical decision-making (CDM) is seen as essential for being an autonomous practitioner, as it enables practitioners to take ‘wise action’, which means taking the best-judged action in a specific context (Cervero 1988; Harris 1993). Clinicians often have to care for patients with multifaceted issues and consider patients with a variety of conflicting and complex factors and take the best course of action (Lasater 2007). In the context of acute respiratory care such as surgical high dependency units, acute surgical and medical wards, clinical decisions often have to be made in unpredictable circumstances, with many competing factors, and CDM is subject to human error. For this reason, CDM is regarded as a highly complex skill that requires several years of clinical experience to master (Jensen 1992), which can make it challenging to teach students with little or no prior clinical experience to transfer their theoretical knowledge into a practical application. If however, the complex processes can be broken down and smaller components identified by scrutinising good practice of experienced staff, then this information can be used to facilitate the development of appropriate skills. Furthermore, if we can use teaching methods that facilitate the cognitive stages of the clinical decision making process, then potential errors in practice maybe reduced.

**Background**

Given the importance placed on clinical decision-making, it is perhaps unsurprising that interest has grown over the past four decades. CDM has been particularly well researched in the field of medicine, and it is from this discipline that the hypothetico-deductive model was proposed, based on studies of novice and expert doctors (Elstein et al, 1978). In this model, clinicians begin with a hypothesis about a patient that develops as the clinician questions and examines the patient. This questioning and examination is instrumental to the clinician confirming or disconfirming their original hypothesis. Further research into the differences between experts and novices and their organisation of knowledge; such as memory recall and mental representations, led to the concept of pattern-recognition (Groen and Patel 1985, Boshuizen and Schmidt 1992). This can also be referred to as inductive or direct automatic retrieval, which (Patel and Groen 1986) observed was characterised by speed and efficiency. Furthermore, illness scripts (Barrows and Feltovitch 1987) were recognised in experts, these too are a form of pattern recognition, whereby knowledge and clinical experience have become encapsulated, further enhancing the speed and efficiency of decision-making. In contrast, novices, and some experts, when faced with a more complex problem, tend to use a deductive process (which is much slower than pattern recognition) to analyse information and form a hypothesis (Elstein et al 1978, Arocha et al 1993). Furthermore, Croskerry (2009) suggests that CDM is based on a ‘dual process theory’ in which system 1: is heuristic and intuitive, system 2: is systematic and analytical with experienced practitioners tending to favour system 1 and novices system 2.

At a broad level, similarities to the medical model (Elstein et al 1978) have been shown to occur within Physiotherapy and reasoning has been described as being primarily a diagnostic process(Payton 1985). In contrast, the clinical decision making and clinical judgments in nursing, are most often influenced by what nurses bring to the situation rather than the objective data about the situation at hand (Tanner 2006); decision making rests on knowing the patient and his or her typical pattern of responses, as well as an engagement with the patient and his or her concerns. Clinical judgments are influenced by the context in which the situation occurs and the culture of the nursing care unit (Tanner 2006). However, there appears to be a compromise in physiotherapy as subsequent research within musculoskeletal and neurological physiotherapy(Jensen 1992, Edwards et al 2004) has identified that CDM involves more than making a diagnosis about the patient and the process is ‘interactive and collaborative’ with the patient (Jones et al 2000). Despite the differences in the processes observed in these disciplines, there appears to be agreement that there are essential elements required for the clinical decision making process, these are: a strong underpinning of discipline-specific knowledge, context-specific cognitive skills, reflection on practice and metacognition, (which provides the interaction between cognition and knowledge (Higgs and Jones 2008).

To date, there have only been a few studies that have specifically explored the CDM in cardiorespiratory physiotherapy(Case et al 2000, Roskell and Cross 2001, Mishoe, 2003 and Smith et al 2007). Whilst these studies have given some valuable insight into the complex nature of the CDM process, none of these studies have identified the components of CDM commonly employed by cardiorespiratory physiotherapists, which would be particularly useful to educators and clinicians tasked with facilitating these skills. Furthermore, most of these studies did not use methods that allowed real time CDM to be captured and the data were gathered retrospectively. This dearth in the literature highlighted the need for further research using methods that permit CDM to be recorded in action. This paper will describe how the clinical reasoning of experienced cardiorespiratory physiotherapists was explored and present a new conceptual model and how this can be used educationally.

**OBJECTIVES**

The main objectives of this study were to identify theactions, behaviours and thought processes that constitute the CDM processes of cardiorespiratory physiotherapists as they undertake an assessment of a simulated patient, presenting with cardiorespiratory problems.

**METHODS**

**Study Design**

As this study aimed to explore both participant actions and thoughts, a mixed methods study was appropriate, combing observation to capture actions and think-aloud practices to record physiotherapists’ thought processes with a post intervention interview. Whilst mixed methods are usually associated with studies combing quantitative and qualitative methods, it is equally apt when describing studies that involve multiple qualitative methods (Cresswell 2003). This study was undertaken using a pragmatic approach as the most suitable method for answering the research question. A University Research Ethics Committee approved the study. All participants gave written informed consent before data collection began and debriefing following simulation was used to support and protect participants from harm.

**Setting**

Data were collected using a Human Patient Simulated (HPS) manikin (SimMan 3G Laerdal TM) within a simulated surgical high dependency unit (HDU) at the University’s clinical skills centre to replicate an acute clinical setting. Simulation was chosen over observing real life practice for two main reasons: Firstly, it enabled the scenario to remain consistent and controlled between participants, increasing the comparability of the CDM processes observed. Secondly, it meant that a controlled respiratory deterioration could be introduced without any risk to patients (Gaba 2004, Lasater, 2007, Dreifuerst 2009). Simulation is being used today in a variety of health care programmes to enhance clinical skills without danger of harming a patient and for this study, simulation enabled the CDM process of the participants to be the central focus of the study. The patient scenario was based on a real case study from clinical practice of a 54-year-old male, who had developed respiratory complications following an emergency laparotomy for abdominal pain two days earlier (see appendix 1 for more detail). Psychological, and environmental fidelity (Norman et al 2012) were considered carefully, the HDU was set-up like a four-bedded unit and appropriate supporting staff, data and equipment were used. A trained nurse acted as the HDU staff nurse to look after the HPS, for which an actor provided the patient voice. A doctor could be called to the unit if required by the physiotherapist. The nurse and patient actor followed a script to standardise the proceedings. Supporting data for this patient’s care over the past two days in HDU was available at the bedside including notes, chest x-rays, charts and results of all tests and investigations.

**Participants**

Recruitment of participants was based on the inclusion criteria used by Smith et al 2007 in their observational study of the factors influencing clinical decision-making in which 14 cardiorespiratory physiotherapists, working in acute respiratory care, were directly observed in practice. The specification was also informed by advice from a research representative from the Association of Chartered Physiotherapists in Respiratory Care (ACPRC, UK) who considered two years of clinical experience sufficient, as these physiotherapists would have expert attributes such as, working independently, undertaking on-call duties and the supervision of students and junior staff. The key factor being that participants could make their own clinical decisions, as this was the attribute of expertise being investigated. In considering the sample size ten observations and interviews were sought. There is no universal ‘right amount’ of video data to collect rather the amount of video data required needs to be determined by the research approach, aim and questions of a study and pragmatic questions of time and resource. The amount of data to be collected will also depend on the approach to the analysis and the time and labour intensity of that approach (Jewitt, 2012). Hence this study used a sample size similar to other studies that have explored clinical reasoning in physiotherapy (Case et al 2000, Roskell and Cross 2001, Mishoe, 2003 and Smith et al 2007, Shoemaker et al 2009). Participants were recruited by distributing information about the study at an ACPRC conference and sent to physiotherapy managers within a 50-mile radius.

**Inclusion Criteria**

Participating physiotherapists needed to have:-

* At least 2 years clinical experience, working independently in an adult cardiorespiratory specialty such as surgical, medical, or intensive care unit (ICU);
* At least 24 hours experience of working in a cardiorespiratory speciality area per week;
* At least 6 weeks’ recent experience (defined as within the last 6 months) in adult cardiorespiratory care;
* Familiarity with working out-of-hours (twilight, on-call, weekend rotas);
* The ability to independently manage their own caseload and make their own clinical decisions;
* A willingness and ability to discuss their clinical decision-making.

The exclusion criteria were:

* Physiotherapy novice or student status - not yet working independently in this field/ fulfilling the inclusion criteria;
* Not having practised within the last 6 months in adult cardiorespiratory physiotherapy.

**Data Collection**

Physiotherapists individually attended the simulated HDU on one occasion over a one-week period. Data were collected using three methods. Observational data of the physiotherapists’ actions and behaviours during the simulation were video-recorded. This allowed the whole assessment and treatment of the simulated patient to be captured, including the physiotherapists’ interactions with the patient, nurse and also doctor if called. Video recording is considered an essential methodological tool in interpretive approaches (Greeno, 1989; Jordan and Henderson, 1995) enabling the researcher to observe the video repeatedly during analysis. Secondly, the concurrent think-aloud technique (Van Someren et al, 1994) was used to capture the physiotherapists’ CDM thought processes. This technique is based on the premise that talking is a type of recordable behaviour that can be analysed as such (Ericcson and Simon, 1993). The output of this is considered to be a direct verbalisation of cognitive processes as there are no interruptions or suggestive prompts or questions. A participant was asked to ‘think-aloud’ whilst working through their assessment of the clinical scenario; this ‘think-aloud’ component was also captured on the video-recordings. Thirdly, participants took part in semi-structured interviews immediately after their simulation experience, in which they were invited to watch their video and discuss their experience of the simulation. These debriefing interviews are a common feature of simulation, allowing the physiotherapists to reflect on their experiences and to explain their chosen actions (Fanning and Gaba, 2007). These interviews were audio-recorded and transcribed verbatim and thus provided contextual information to support the analysis.

Each participant was provided with study information prior to their appointment and were given the opportunity to ask any questions on the day, before written informed consent was obtained. Participants were instructed on how to ‘think-aloud’ and they rehearsed the technique using an example of verbalising the number of windows in their house and a description of where they were situated (Erricson and Simon 1980). Participants were taken through to the simulated HDU, where the staff nurse introduced herself, gave a handover about the patient and requested the physiotherapist to assess. The scenario started with the manikin upright in the bed and the patient actor making loud breathing noises. A desaturation (a drop in oxygen levels seen in the blood) occurred at the time participants started to examine the manikin’s chest with their stethoscope. This was set-up so as to observe the physiotherapist’s response to an acute deterioration of the patient, an event that might well occur in clinical practice. The interaction between the physiotherapist, the patient, the nurse and sometimes a doctor (who could be called to the unit if required), proceeded with each physiotherapist deciding their own course of action. Treatment continued until the physiotherapist believed they had exhausted all possibilities and/ or the patient’s condition improved. This marked the end of the assessment and the physiotherapist was taken through to an adjacent room to watch their simulation and undertake a debrief interview.

**Data analysis**

Data were analysed using a combination of content analysis (Cresswell 2003)*,* and thematic analysis (Burnard 1991) to identify and contextualise the main actions and behaviours observed from the video data. Secondly, a Framework approach (*Spencer et al 2003)* was used to manage the data, allowing analysis of these actions in depth, to identify common patterns of behaviour, knowledge and cognitive processing skills.

# 1. Content analysis of observational data

For the content analysis, Synote 34 (Synchronised annotation) was used. This is a novel web-based Hypermedia that stores annotations (but not recordings) and enables an audio-recording to be synchronised with the transcript. Cresswells’ step-by-step process of content analysis was followed. All the videos were watched several times, for familiarity and the actions and behaviours used by the participants were coded to describe the content. Coding in this manner provided insight into the nature and frequency of the CDM actions and behaviours displayed. Similar codes were grouped together to form categories, and similar categories, then were grouped to form themes.

**2. Framework Analysis of transcripts**

Verbal data were transcribed and managed using a Framework approach (Spencer et al 2003). This approach involves familiarisation, framework development, indexing,

charting data, and mapping (Ritchie and Spencer 1994)whereby information from each participant was synthesised to produce a model that reflected the CDM across all the participants. This comprehensive model was distilled further to produce a simplified conceptual model of the CDM process.Debrief interviews with the participants were used to enhance understanding and add context.

Development of the model was shared with clinicians and educators at two professional conferences to ensure face validity and feedback was obtained on the arising theoretical concepts.

**RESULTS**

In the recruitment window available, nine female physiotherapists fulfilled the inclusion criteria. Of these nine, one dropped out due to personal reasons and eight were consented to take part in the study. Their experience ranged from 3.5-16 years with a mean of 7 years’ experience. They worked in a range of areas within sub-specialities of cardiorespiratory, including: surgical, medical, HDU, Intensive Care Unit (ICU), or cardio-thoracics and were familiar with on-call duties, working out of hours and supervising junior and student physiotherapists.

The duration of the assessment videos ranged from 45-60 minutes each and the debrief interviews 20-30 minutes each. In all eight participants, similarities were evident in the sequence of their actions, aligning with two clinical reasoning models: the collaborative hypothetico-deductive (Jones et al 2000) and the five-rights reasoning model, (Levett-Jones et al 2010). The sequence of clinical events observed across the participants is summarised as nine stages shown in in Figure 1.

**Common Actions, Behaviours and thought processes**

All eight participants began their assessment process by gathering information. This can be divided into the initial ‘information perception’ whereby they make an initial impression of the situation based on what they observe immediately on arrival and then they go into an active stage of ‘information gathering’ whereby they ask the nurse, and the patient questions, read notes and look at the charts and x-rays. As they are doing this, they begin to process the information and conceptualise the patient’s problem and form an initial hypothesis. This was evident from the think-aloud data: Louise (Pseudonym) made an association between the patient having had B Cell Lymphoma from his past medical history, requiring radiology and his current presentation stating “*they can get quite nasty chest infections with this”* and collated thiswith his clinical signs of a raised white cell count, and raised temperature to reach a provisional hypothesis that he was presenting with a chest infection. Anne focused on the social history, noting “*he smoked six cigars per day,* collating this with the background information of having had an “*anaesthetic, causing paralysis of the cilia and retention of secretions, leading to a chest infection”*. These think-aloud comments, suggest that the physiotherapists were actively processing and interpreting the information from the notes and had begun to assimilate the different clues to form an initial hypothesis about the patient. Anne went on to say:

*“I’m already thinking that if pain is a problem and his PCA* [patient-controlled analgesia] *has been changed – not using properly, not ideal and respiratory function is going to be compromised after surgery if pain isn’t well controlled. Looking at his sats* [oxygen saturations] *although OK – 95% but it’s not, because he’s on 60% a lot of oxygen, that concerns me and that his pain is not controlled. He says he’s not feeling well and he’s tired he didn’t sleep much last night … I’m already thinking if you smoke prior to an operation, it can make you more likely to have respiratory complications post-operatively… So I’m thinking that he’s had a laparotomy and anaesthetic, he’s not been moving* [immobility] *can lead to a decreased lung volume and retained secretions and already smokes 5-10 cigars a day then cilia not working well and that he’ll* *have secretions and pain all add up to him having decreased lung volume and infection”*.

Sarah hypothesised after she had listened to the patient’s perspective and before she read the notes:

*“Just had a quick chat with Mr Day and I want to find out a bit more about him, more of his background history. Just reading notes at moment... The type of op he had was a laparotomy procedure ... He’s a smoker of 6 cigars a day so that will be taken into consideration for the patency of his lungs ... looked at the x-rays its showing a left lower lobe collapse and consolidation, today its showing right middle lobe collapse and consolidation there’s also collapse of his right lower lobe. So from the chat with Mr Day, his pain is an issue. He needs encouragement to use his PCA. I need to speak to him to get him to use that a bit more. I can see he’s nil-by-mouth he’s telling me his secretions are very thick and he’s got a lot, but he can’t get them up that indicates to me that he may need a bit more fluid, some saline. That’s just what I’m thinking at moment; having had a look at the charts and everything, I want to objectively assess Mr Day by auscultation and running through my assessment there*.”

Information gathering progressed to a second more active stage, whereby the participants assessed the patient to gather new information: to either confirm or disprove their original hypotheses. In this study, the desaturation event occurred just as the participant began to examine the manikin with auscultation. This event created two immediate responses: it caused the participant to take immediate action to prevent further deterioration of the patient such as: increasing his oxygen requirements or encouraging to take deep breaths and hence the safety of the patient came first and 2) they also started to gather new information relating to this event to try to identify what was causing it. Kate hypothesised after the desaturation:

 “...*so in my head just thinking why he had this drop in sats - maybe he had a plug of phlegm there, he’s got a little bi-basal collapse because he’s not getting up and moving about and taking deeper breaths after surgery, being laid down for a while in surgery and after – wasn’t particularly mobile prior to surgery because of pain that’s been going on.”*

This highlighted the ongoing process of information gathering. Following the desaturation event, each participant continued her own unique approach of treating the patient i.e. ‘taking action’. Various treatment approaches were undertaken such as giving a nebulizer, taking deep breaths as part of the active cycle of breathing technique, (ACBT), a nebulizer, use of adjuncts such as the Bird, (Intermittent Positive Pressure Breathing IPPB) and Continuous Positive Pressure (CPAP) were suggested. Each treatment was administered until they felt satisfied he had improved sufficiently for them to stop. In order to make this judgment, each participant reviewed the patient and re-evaluated the situation concluding that they could not achieve any further improvement without some further medical intervention or time lapse. Please see Table 1 for further details on treatment, evaluation and goal setting.

It also evident that there is a process of synthesis occurring at the end of the treatment session as most of the physiotherapists summarise their findings with the nurse, patient or both and document such in the notes. They then suggest and discuss a treatment plan and goals with the nurse and patient for later on. There is a mirroring of the handover seen initially, but the roles are now reversed with the physiotherapist leading the conversation. Reflection of the events was after the session in the debrief interview.

**Development of the theoretical model:**

The analysis of the data was an iterative process and involved several stages before the conceptual model was formed. Clear actions and behaviours were identified from watching the video recordings several times over and these actions and behaviours were summarised for each participant in flow diagrams and these were collated together to create a summary of the common actions and behaviours used by all eight participants to produce the stages of CDM. These nine sequential stages are summarized in Figure 1 and have informed the inner ring of the conceptual model see Figure 2.

The verbal data was analysed using a framework approach that was based on stages identified from the hypothetico-deductive model (Jones et al 2000) and the cognitive skills identified by Levett-Jones et al (2010). The ‘think-aloud’ thought processes were analysed and seven key cognitive skills identified: *recognition, matching, discriminating, relating, inferring, synthesising and prediction.* These cognitive skills were used sequentially in each stage of the CDM process i.e. when participants were gathering information; processing information; forming a hypothesis; forming a problem list; taking action; evaluating and goal setting. These cognitive skills have been shown in the second ring of the conceptual model (Figure 2), and are mapped to the stages of CDM in the inner ring.

The outer ring incorporates the underpinning essential skills that are required for CDM: the subject knowledge, situational awareness and communication skills, which are all fundamental to CDM process. Therefore to bring all these concepts together, the design incorporated the three rings to encapsulate all the findings.

**DISCUSSION**

This study has identified the actions, behaviours and thought processes that constitute the CDM processes of eight experienced cardiorespiratory physiotherapists as they undertook an assessment of a simulated patient presenting with an acute respiratory deterioration.

The findings have been presented as a new conceptual model of clinical decision-making and this will now be discussed in relation to other models and how the new model has implications for healthcare providers.

**Similarities and differences of theoretical framework to other models:**

From the overall actions undertaken by all of the physiotherapists, the stages observed are similar to the physiotherapy hypothetico-deductive and nursing five-rights clinical reasoning models (Jones et al 2000, Levett-Jones et al 2010). However, the process appeared to be more complex, iterative, and dynamic and more reflexive than these models suggest, with one stage affecting another, hence the process is iterative, rather than linear or cyclical. The physiotherapists inferred and made deductions or formed opinions that followed logically by interpreting cues; they also considered alternatives and consequences. Thus, cognitive processing requires knowledge that can be easily retrieved from memory. The physiotherapists compared the new information obtained to pre-existing knowledge in their long-term memory and this determined the gaps in the information and the questions they needed to ask. Information was synthesised and used as an interim stage to reform hypotheses prior to commencing treatment as evidenced in the think-aloud processes and interviews. Then as treatment commenced, there was an evaluative process that occurred, which again used the cognitive skills of recognition and comparison to see if the treatment had made a difference. The physiotherapists in this study constantly used their cognitive skills to evaluate their effectiveness.

The seven cognitive processes identified in this study are similar to the cognitive skills identified by Levett-Jones et al 2010 who identified that nursing staff: *interpret, discriminate, relate, infer, match, and predict.* The findings also concurwith Mishoe 2003, who identified the key critical thinking skills required in respiratory care practice are the ability to *prioritise, anticipate, troubleshoot, communicate, negotiate, reflect, and make decisions*. The cognitive skills identified in this study, were evident throughout the whole interaction with the patient from initially collecting information about the patient, to the desaturation event. In particular, including the desaturation event highlighted how the physiotherapists took immediate, appropriate action and demonstrated predictive, troubleshooting skills so as to prevent the patient from deteriorating further. In conclusion, the CDM demonstrated appears to be a combination of i) a slow deductive process, as seen when the physiotherapists were collecting information from the patient, nurse, notes, charts and x-rays and ii) the fast inductive process, when the desaturation event occurred. This finding would appear to concur with the “*dual processing theory*”, (Croskerry, 2009) in which the inductive fast-forward process occurs in response to a pattern that has been seen before, which then triggers the appropriate knowledge retrieval and action or a certain procedural response, which distinguishes an expert clinician from a novice who can only operate deductively.

Communication and exchanges between the physiotherapist, the patient, the nurse and the doctor were seen as part of the CDM processes. The social influence on decision-making has been described previously in multi-disciplinary settings, such as intensive care units. Patel and Groen (1986) reported that where multiple players were involved in decision-making, the process and outcomes were influenced by the urgency of the situation and the hierarchy and social structure of the organisation. Smith et al 2008 p.97 “*found that practitioners referred aspects of their decision-making to others in the context, particularly when a decision was difficult to make, used chatting with others to generate novel perspectives, and anchored their decision-making to decisions others had made in the past*”. It has also been recognised by Smith et al 2008, Higgs et al 2004, Lette et al 2003, Thornquist 2001that CDM is influenced by the physical factors such as the equipment available in the area, the organisational factors of the workplace e.g. staffing, multi-tasking etc., and the relationships between professionals.

**Implications for healthcare education:**

This study highlights the complexity of the clinical decision-making process and that it is an iterative process that constantly evolves in the specific context of the situation. As a consequence of this study, it is proposed that simulation based-education is a suitable method for facilitating CDM as the simulation scenario can be structured to incorporate the seven stages of the CDM process as identified in this study, with appropriate learning outcomes such as psychomotor and cognitive skills to suit the level of the learner; by designing the simulation scenario to be contextual to a real life scenario, it can also incorporate the complexities of the physical environment, and relationships that can influence the CDM process as was highlighted in this study. For example, level 4 students are set learning outcomes that focus on the information perception and information gathering stage, level 5 students can progress through information perception, gathering and hypotheses stages and level 6 students and postgraduates conduct the full seven stages of CDM process. The seven cognitive processes identified for each stage can therefore be facilitated in the session and the CDM model becomes a ‘scaffold’ as in the principle of Vygotsky, that learners are given a clear structure that supports their learning activities and work in their area of current knowledge and are not taken out of their zone, known as the ‘zone of proximal development’ (Vygotsky 1978). The educational facilitator of the session observes and supports the students, whereby opportunities are given to the students to advance the boundaries of their knowledge and then that support is slowly withdrawn in an appropriate manner so as to encourage independence as they progress. In the debriefing of the simulated session, the educator facilitates the students to reflect and checks that the learning outcomes of the session have been achieved, which further enhances the development of the higher order cognitive skills of reflection after-action and metacognition. Therefore a simulated case scenario may enable the students confidence to develop prior to clinical experience, as they have had an opportunity to practice parts of the complex CDM process (without any harm coming to a real patient), so that less intense, less complex, less vital tasks are learned before more central aspects of clinical practice (Bradley and Postlethwaite, 2003a). Hence, these carefully designed scenarios can offer a safe learning environment in which cognitive errors can take place without any harm coming to the patient. Further details on how to model the CDM process into the simulation instructional design will follow in a second paper.

There is growing evidence to suggest that simulation-based education may be the way forwards to develop these high-order cognitive processing skills in healthcare students and that SBE can optimise learning in preparation for clinical practice, especially in stressful and rapidly-changing situations encountered in clinical practice (Shoemaker et al 2009, Cioffi et al 2005, Gough et al 2016). Further evaluative studies, are necessary to determine what the impact of embedding the CDM model within SBE has on clinical decision-making skills compared with traditional teaching methods.

In summary, this new conceptual model gives novice physiotherapists or other health care professionals an opportunity to follow the same CDM pathway of a more experienced physiotherapist when assessing an acute patient with deteriorating respiratory function. The inner ring: the nine sequential stages of CDM are a framework that can be used for teaching, such that a novice can be guided to start with the information processing stage and develop the specific cognitive skills: recognise, identify, match, relate, interpret and analyse information about the patient, they then move on to forming a hypothesis in which they infer, synthesise, relate and predict, this leads to forming a diagnosis and/or problem list, which leads them to taking action, after taking action they need to evaluate if what they have done is effective and re-evaluate and set new goals, finally they must reflect on their actions and consider what they might do differently if they review the patient again later. Thus the CDM model gives a structure to follow and we are suggesting that simulated scenarios can be designed with specific learning outcomes linked to this CDM model, which will enable students to rehearse the stages of CDM and gain confidence and knowledge in the clinical decision making process. Similarly, nurses could use the CDM model and create learning outcomes linked to the CDM model in simulated learning experiences. Furthermore, clinical educators could use the model to support and facilitate learners when on clinical placements.

**Strengths:**

As previously mentioned the primary reason simulation was used for this research study was to ensure no harm came to a patient during the study. Ethically, simulation enabled the researcher to explore the actions and behaviours of experienced clinicians. Likewise, simulation can be used as a teaching method to enable learners to explore issues of deontology i.e. doing their ‘duty’ for a patient, whilst simultaneously exploring the consequences of their actions. Through practical experience with immediate feedback, simulation is a powerful learning tool that enables students to make decisions and act, without risk of harm to an actual patient. Furthermore, simulation training assists in learning principles of the ethics of patient care such as autonomy, beneficence, justice, consent, non-maleficence, fairness, truthfulness, advocacy, and dedication (Pinar and Peksoy 2016).

**Limitations:**

Whilst every effort was made to ensure all aspects of fidelity (Fritz et al 2007) were considered, and care was taken to include contextual factors, the simulation did not fully replicate an acute clinical setting as the participants only had one patient to see and they did not have the stress of competing priorities that is common in the workplace (Smith et al 2007). In this study, the participants were able to focus solely on the patient, which may not be the case in practice. Therefore, the transferability of these findings is limited; and any generalisations, theoretical (Yin, 2008). The alternative viewpoint, (based on feedback from the participants) was that the scenario was realistic enough that they were suitably immersed and engaged with the simulation and that this scenario probably replicated the stress of an on-call/ out of hour’s duty. A second limitation was that the participants did not want to watch back their video assessment; this was because participants felt embarrassed to watch themselves. This is a common finding in video ethnography and in order to overcome in future studies, participants would need to be exposed to video recording on several occasions to become comfortable with the process (Roberts and Bucksey, 2007).

**CONCLUSION**

This study has used an innovative methodology of simulation, video recording and think-aloud to explore the CDM of experienced cardiorespiratory physiotherapists. It has revealed similarities and differences to the collaborative hypothetico-deductive and five-rights models of clinical reasoning and has advanced our understanding of this complex phenomenon,to generatea new conceptual model of CDM in cardio-respiratory physiotherapy.

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